Textbook of
EAR, NOSE AND THROAT

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Second Edition

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Foreword

Ravinder Nath Salhan

JAYPEE BROTHERS MEDICAL PUBLISHERS (P) LTD.

New Delhi • London • Philadelphia • Panama

Jaypee Brothers Medical Publishers (P) Ltd.

Headquarters
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New Delhi 110 002, India
Phone: +91-11-43574357
Fax: +91-11-43574314
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83, Victoria Street, London
SW1H 0HW (UK)
Phone: +44-2031708910
Fax: +02-03-0086180
Email: info@jpmedpub.com

Jaypee-Highlights Medical Publishers Inc.
City of Knowledge, Bld. 237, Clayton
Panama City, Panama
Phone: + 507-301-0496
Fax: + 507-301-0499
Email: cservice@jphmedical.com

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The Bourse
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Website: www.jaypeebrothers.com
Website: www.jaypeedigital.com

Textbook of Ear, Nose and Throat

First Edition: 2005

Second Edition: **2013**

ISBN: 978-93-5025-715-9

Printed at

Dedicated to

- My grandfather's trust [Tuli Sunder Dass Seva Kendra (Regd), Samana, Patiala, Punjab, India] with whose blessings all of this has been possible
- My father, (Late) S Balwant Singh Tuli (1916-2010), for the uncompromising principles of his life and teaching me hard work with dignity
- My mother, (Late) Smt Kartar Kaur Tuli (1925-2007), for her love and desire to lead our family into intellectual pursuits
- My wife, Smt Ranjit Kaur, for her unflinching devotion to the family and without her support, I would not be where I am today
- My children, Dr Mandeep Singh Tuli, Dr Isha Preet Tuli, Dr Navneet Kaur Tuli and Dr Amandeep Singh, for making my life worthwhile and their consistent advice to complete the project
- My grandchildren, Abhai, Samar, Mehr, Aamya and Ekam, for their smiles, which made my day's efforts worthwhile
- Above all the 'Almighty God' for giving me the courage to take up this project with zeal keeping in mind the needs of the patient and the students
- Last but not least, my colleagues, students and postgraduates for their constant innovations, inquisitive questions encouraging me to work more about the needs of our specialty.

God could not be everywhere all the time,
so He created mothers and fathers.

Foreword

An excellent effort has been made by an outstanding teacher of ENT, which will go a long way to help the student community not only in india but also abroad. Dr BS Tuli has made an attempt to give the useful clinical and practical tips to the students by giving tables, diagrams and flow charts, wherever required and this will give a positive support to the learning curve.

Dr Tuli has shown a devotion to the subject and presented the topics in a comprehensive and concise manner, which would be of immense help to the students as a valuable book. The second edition has been added with surgical aspects of thyroid, stapes surgery, salivary glands, dacryocystorhinostomy (DCR) and written in a simple way, which will help to learn and practice the essentials of surgery in a well-illustrated form. I congratulate him on writing the second edition of the book.

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Preface to the Second Edition

The present edition is an effort to improve upon my first humble effort since its inception in the year 2005, to bring out a book on ENT, which would be comprehensive in dealing with the subject. As medical knowledge is expanding day-by-day broadening our vision, changes become a must. Although this book is primarily meant to serve the undergraduate students, but the interest of the postgraduate students has also been kept in mind. The salient features of the book have not been changed and it continues to have colored photographs, flow charts, latest trends in surgical procedures, key points and attractive student-friendly layout. In keeping with the latest concepts, I have also included chapters on Speech Disorders, Olfaction, Stapedectomy, Dacryocystorhinostomy, Surgery of Salivary and Thyroid Glands, Snoring and Sleep Apnea Syndrome and Multiple Choice Questions. Model Test Papers have also been given in the Appendix for the benefit of the students.

When I started work on the second edition, I was amazed to find the work much more demanding than before. I am pleased with the results and hope the readers would also have similar feelings. Some chapters have not been altered much and the temptation to make a change has been dropped. Appropriate modifications, wherever found necessary have been done. Some new materials have been included for enthusiastic students, who really want to excel. The book would also act as a foundation for those who want to pursue this specialty as a career. Reorganized and revitalized second edition of the book has only been possible due to efforts and encouragements of all of my friends, who have given their invaluable feedback.

I will be failing in my duties if I do not thank Dr Isha Preet Tuli, Sikkim Manipal Institute of Medical Sciences, Gangtok, Sikkim; Dr Amandeep Singh, Government Medical College and Hospital, Chandigarh, and Dr Navneet Kaur Tuli, Himalayan Institute of Medical Sciences and Research Center, Dehradun, Uttarakhand, India, for their constant encouragement and invaluable support in reading the manuscript, preparing the photographs and for their student-friendly suggestions. My deepest gratitude is also to my wife Professor Ranjit Kaur (Principal Retd) and my son Dr Mandeep Singh Tuli (IPS), for the constant encouragement throughout my life to write the new edition of the book under the registered trust *Tuli Sunder Dass Seva Kendra,* Samana, Patiala, Punjab, India.

Finally, I would like to thank God Almighty for making all this possible through M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India. In compiling the book, I have gone through many authoritative books and publications and I sincerely express my gratitude to all of them. In the past, the book has been reasonably well received by the students, postgraduates and senior colleagues. Suggestions and constructive criticism for improvement in the book are always welcome from readers. I look forward to the productive years ahead that His Almighty grants me for carrying out my duties in the best possible manner so that I would be what I could not be.

BS Tuli

Preface to the First Edition

The present book is the outcome of my humble experience as a medical man and teacher of Otorhinolaryngology. Although intended primarily as a textbook for the undergraduate students, this book should appeal to the postgraduate students as well, since technical and specialized details have also been included. The salient features of the book include colored photographs, flow charts, latest trends in surgical procedures, key points and attractive student-friendly layout. In keeping with the latest concepts of holistic healing, I have also included a chapter on *Yoga* besides Skull Base, HIV in ENT, Imaging in ENT, Computers in ENT, Medicolegal Aspects of Injuries and Sleep Apnea Syndrome to name a few.

I wish to express my sincere appreciation to all my friends and colleagues for all the assistance and critical comments during the preparation of the book. I am deeply indebted to many doctors, who have contributed valuable chapters for this book, such as Dr RC Deka (New Delhi), Dr M Lateef (Srinagar), Dr Arjun Dass (Chandigarh), Dr Hemant Chopra (Ludhiana), Dr Ashok Gupta (Udaipur), Dr TS Anand (New Delhi), Dr Karan Sharma (Amritsar), Dr Chander Mohan (Shimla), Dr SK Verma; Dr RK Gorea; Dr A Kapila; Dr Harjot Kaur; Dr Baldev Singh; Dr BS Sohal and Dr GPS Gill (Patiala, India).

I am very grateful to Dr AK Aggarwal, Maulana Azad Medical College and Dr JK Sahni, Lady Hardinge Medical College, New Delhi, India, for going through the manuscript and giving their very valuable suggestions.

I will be failing in my duties if I do not thank my postgraduates like Dr Sanjay Arora, Dr Sukhbir Singh, Dr Charanjit Singh, Dr Amandeep Singh and Dr Isha Preet Tuli, for their invaluable support in reading the manuscript, preparing the photographs and for their student-friendly suggestions. I also thank my residents Dr Manjit Singh, Dr Prasun Chattopadhaya, Dr Parwinder Singh, Dr Rajwant Kaur, Dr Ramesh and Dr Ravinder Singh, for their timely and valuable help in writing the book.

My deepest gratitude is also to my wife Ranjit Kaur (Principal) and son Dr Mandeep Singh (IPS), for their constant encouragement throughout my life to write the book under a registered trust *Tuli Sunder Dass Seva Kendra,* Samana, Patiala, Punjab, India.

Finally, I would like to thank God Almighty for making all this possible through M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India, to bring out the book in your hands.

BS Tuli

Acknowledgments

To study the phenomenon of disease without books is to sail an unchartered sea
while to study books without patients is not to go to sea at all.

—Sir William Osler of Oxford

The book will be in 8th year of its publication since its inception in the year 2005. I understand fully well that it is not possible for one person to cover the whole field of ENT specialty from his personal knowledge and experiences alone. Therefore, I acknowledge my greatest gratitude to all my colleagues in ENT, who gave me unstinted support and stood solidly beside me in my joint venture to write this book. Although artists and expert photographers have drawn most of the colored photographs including text, however, I apologize for any inadvertent resemblance to anyone by oversight. The book itself will bear an indelible imprint of the meticulous effort of all the following doctors to bring out the second edition enriched by the outstanding contributions of many distinguished and eminent ENT teachers, under the registered trust *Tuli Sunder Dass Seva Kendra,* Samana, Patiala, Punjab, India. We will certainly learn from the immense knowledge of these pioneers in the field of otolaryngology. I further welcome any positive comments concerning omissions and errors for improvement in subsequent editions. I have no doubt that it is only due to the generosity and grace of my colleagues for any merit this new edition may deserve. I wish to express my sincere appreciation to all my friends and colleagues for all the assistance and critical comments during the preparation of the book. I am deeply indebted to many doctors, who have contributed valuable suggestions for the improvements in the second edition, such as:

Dr AK Aggarwal (Delhi)
Dr Anoop Raj (Delhi)
Dr RC Deka (Delhi)
Dr Rafiq Pampori (Srinagar)
Dr M Lateef (Srinagar)
Dr S Varshney (Dehradun)
Dr Arjun Dass (Chandigarh)
Dr Chander Mohan (Bareilly)
Dr Anice Chaudhary (Jammu)
Dr J Paul (Jammu)
Dr Hemant Chopra (Ludhiana)
Dr Munish Munjal (Ludhiana)
Dr PP Singh (Delhi)
Dr JK Sahni (Delhi)
Dr Mrs S Naik (Mullana)
Dr Sajad (Srinagar)
Dr Achal Gulati (Delhi)
Dr JC Passey (Delhi)
Dr Karan Sharma (Amritsar)
Dr Uma Garg (Sonepat)
Dr Baldev Singh (Patiala)
Dr BS Sohal (Patiala)
Dr Ashok Gupta (Rajasthan)
Dr Dev Raj (Shimla)
Dr Vikas Kakkar (Rohtak)
Dr Dalbir Singh (Mullana)
Dr R Parekh (Baroda)
Dr SP Gulati (Rohtak)
Dr Masood (Srinagar)
Dr S Abrar Hassan (Aligarh)
Dr Naresh Panda (Chandigarh)
Dr RK Saxena (Nepal)
Dr Oaris (Mauritius)
Dr Ranjit K Jha (Mauritius)
Dr Hakimudin (Mauritius)
Dr Dukharam (Mauritius)
Dr JL Davesar (Faridkot)
Dr S Chakraborty (Gangtok)
Dr I Pal (Kalyani, Kolkata)
Dr TL Parmar (Bhatinda)
Dr S Sengupta (Gangtok)
Dr Jagjeet S Tuli (Mullana)
Dr Sunder Singh (Banur)
Dr TS Anand (Delhi)
Dr Laxmi Vaid (Delhi)
Dr Alok Takkar (Delhi)
Dr JL Davesar (Faridkot)
Dr LN Garg (Mullana)
Dr RC Dogra (Tanda)
Dr Harvinder Arora (Jalandhar)
Dr Kawaljeet (Srinagar)
Dr Sanjay Arora (UAE)
Dr Ishwar Singh (Delhi)
Dr Shelly Chadha (Delhi)
Dr Sunil Kumar (Delhi)
Dr N Mathur (Delhi)
Dr SC Sharma (Delhi)
Dr Alok Takkar (Delhi)
Dr Nitin Nagarkar (Chandigarh)
Dr Baldev Singh (Amritsar)
Dr NK Mahendroo (Shimla)
Dr Ashok Gupta (Chandigarh)

I sincerely acknowledge Shri Jitendar P Vij (Group Chairman) and Mr Ankit Vij (Managing Director) and staff of M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India, for their invaluable advice and valuable suggestions.

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Chapter 1 Surgical Anatomy of Ear

What Students Must Know!

- **Development of Ear**
- **Anatomy of Ear**
  - External Auditory Meatus
  - Tympanic Membrane with Diagram
  - Walls of Middle Ear Cavity with Diagram
- **Facial Recess and Sinus Tympani**
  - Anatomy of Eustachian Tube
- **Anatomy of Internal Ear**
  - Bony Labyrinth
  - Membranous Labyrinth
- **Scala Media with Diagram**
  - Prussak's Space

INTRODUCTION

Basic knowledge of the anatomy of ear is necessary for a better understanding of the diseases of this magic box concerned with hearing and equilibrium.

DEVELOPMENT OF EAR

External Ear

- The pinna develops from a series of six ectodermal tubercles (Hillocks of His) that appear on first and second pharyngeal arches in the 6th week of intrauterine life (IUL) and it is completely formed by 20th week.
- Tragus develops from the tubercle of first arch, while rest of the pinna develops from remaining five tubercles of second arch.
- **Preauricular sinus** results from failure of fusion of these tubercles of first and second **branchial arches** (**Figure 1.1A**).
- External auditory meatus development starts by 8th week and by about 16th week there occurs invagination of dorsal end of first branchial cleft or groove by the process of canalization starting from near the tympanic membrane outwards and it is well formed by 28 weeks (**Figure 1.1B**).

Middle Ear

- Middle ear develops from endoderm of tubotympanic recess arising mainly as a diverticulum of the first and partly from second pharyngeal pouches in the 3rd week of IUL and development is complete by 30 weeks.
- Proximal part of the tubotympanic recess forms the auditory tube and distal part gives rise to middle ear cavity
- Tympanic membrane develops from all three germinal layers in the 28th week of IUL.
- Malleus (except handle) and incus (except lenticular process) develop from mesoderm of first arch (Meckel cartilage) between 6 to 8 weeks.
- Stapes along with styloid process and hyoid bone are formed from second arch cartilage between 5 and 28 weeks.
- Footplate of stapes develops from otic capsule.
- Ossicular chain appears at 4th week and by 15 weeks attains the adult size.

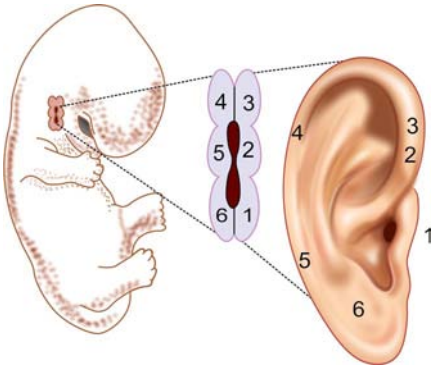


Figure 1.1A Development of external ear (1-6 tubercles)

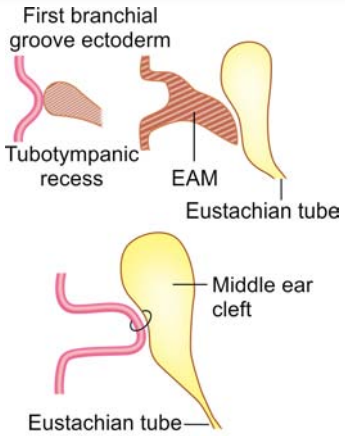


Figure 1.1B Development of external auditory meatus (EAM) and middle ear

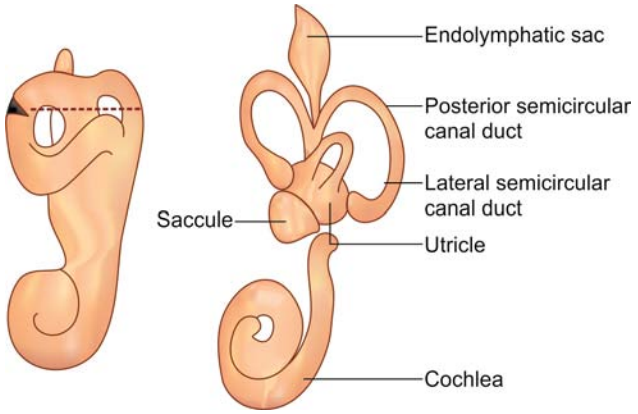


Figure 1.1C Development of membranous labyrinth

- According to some, chorda tympani is a dividing line; parts of the ossicles above it develop from first branchial arch and below it from second arch
- At birth mastoid antrum size approximates that of an adult whereas mastoid process develops after the first year of life (by the pull of sternomastoid due to proper head holding).

Inner Ear

- Otic placode is an ectodermal thickening, which invaginates to form otic pit, its mouth gets narrowed to form otocyst, which differentiates into various parts of inner ear.
- Bony labyrinth develops from mesoderm around otocyst.
- Membranous labyrinth develops from ectoderm around otocyst in the 3rd week of fetal life and is complete by 16th week of IUL.
- Between 6 and 8 weeks semicircular canals and utricle are fully formed.
- Cochlea is well developed by 20 weeks of gestation (**Figure 1.1C**).

Labyrinth is the first organ, which develops before other organs has yet started forming in the embryo. Vestibular apparatus develops before cochlea. Summary of development of ear is given in **Table 1.1**.

ANATOMY OF EAR

Ear can be divided into three parts:
1. External ear
2. Middle ear
3. Inner ear.

External Ear

External ear consists of pinna and the external auditory meatus.

Pinna

- Pinna is made up of fibroelastic cartilage covered by skin and connected to the surrounding parts by ligaments and muscles. The cartilage of pinna is continuous with the cartilage of external auditory meatus, but it is absent in lobule of the pinna.
- Various landmarks on the pinna are helix, antihelix, lobule, tragus, concha, scaphoid fossa and triangular fossa (**Figure 1.2A**).
- Pinna has two surfaces, i.e. medial or cranial surface and a lateral surface which is concave and shows the above said landmarks.
- Cymba concha lies between crus helix and crus antihelix. It is an important surface landmark for mastoid antrum.
- Bat-ear is the most common congenital anomaly of pinna in which antihelix has not developed and excessive conchal cartilage is present.
- Corrections of pinna defects are done at 6 years of age as graft from the costal cartilage can be easily obtained by then.

Ligaments and muscles of pinna

There are both extrinsic and intrinsic ligaments and muscles:
- Extrinsic muscles are anterior, posterior and superior auricularis
- Intrinsic muscles are helicis major and helicis minor, tragus and antitragus
- Both groups of muscles are supplied by branches of facial nerve.

Sensory nerve supply of pinna

Lateral surface
- Upper two-thirds is supplied by auriculotemporal nerve (branch of fifth nerve)
- Lower one-third by greater auricular nerve (C_2, C_3) (**Figures 1.2B and C**).

Table 1.1: Summary of schedule of development of ear

Parts of ear	*Period of Development*		*Derivative of*
	Start	*Complete*	
I. External ear			
a. Pinna	6 weeks	20 weeks	First and second branchial arch
b. EAC*	8 weeks	28 weeks	Dorsal end of first branchial arch
II. Middle ear	3–4 weeks	30 weeks	Dorsal end of first and second branchial pouch
a. TM†	28 weeks		All three germinal layers
b. Malleus and incus	6–8 weeks	15–20 weeks	First and second branchial arch derivatives
c. Stapes	5–28 weeks		Develops from otic capsule
Footplate	—	—	
III. Inner ear	3–4 weeks	25 weeks	
a. SCC†† and utricle	3–4 weeks	6–8 weeks	
b. Cochlea	3 weeks	20 weeks	Otic capsule
c. Membranous labyrinth	3–4 weeks	16 weeks	
Organ of Corti	4–6 weeks	20–25 weeks	

*EAC = External auditory canal
†TM = Tympanic membrane
††SCC = Semicircular canal

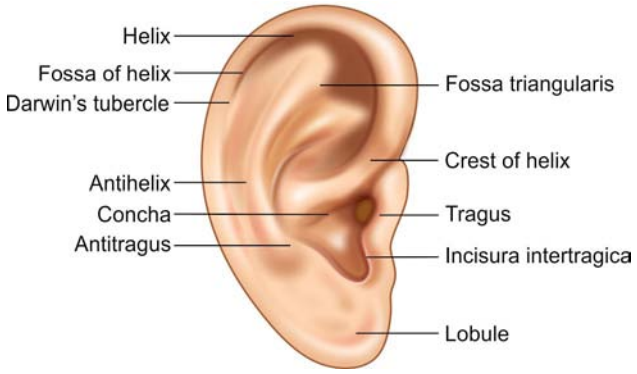


Figure 1.2A Various landmarks on the lateral surface of pinna

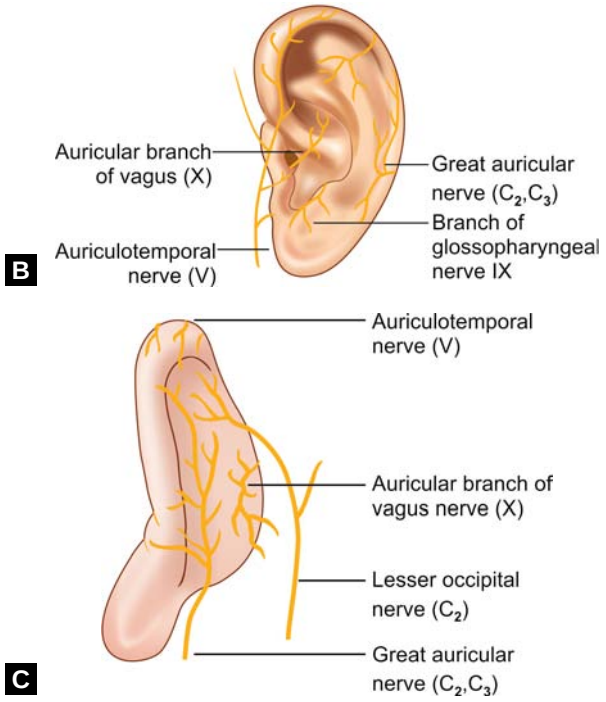
Medial or cranial surface of the pinna

- Lower two-thirds is supplied by greater auricular nerve
- Upper one-third by the lesser occipital nerve.
- Arnold's nerve (a branch of vagus nerve) also called Alderman's nerve and another nerve branch of facial nerve supplies concha on the lateral surface of pinna.

Blood supply of pinna

- Posterior auricular branch of external carotid
- Anterior auricular branch of superficial temporal
- A branch of occipital artery.

Veins corresponding to the arteries drain into external jugular and common facial vein.



Figures 1.2B and C Cutaneous innervations of pinna. (B) Lateral surface; (C) Cranial surface

Lymphatic drainage

They drain into parotid group, upper deep cervical and preauricular and postauricular lymph nodes (**Figure 1.3A**).

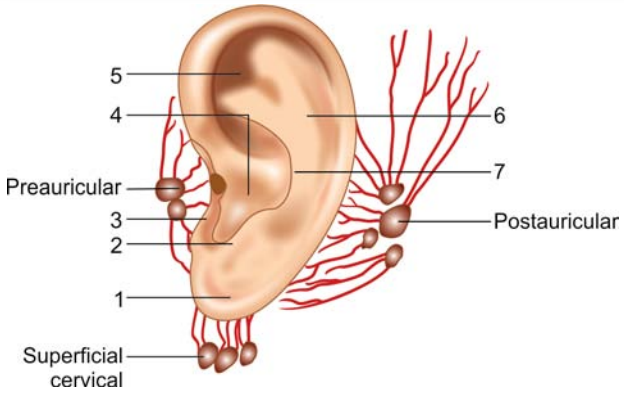


Figure 1.3A Lymphatic drainage of pinna

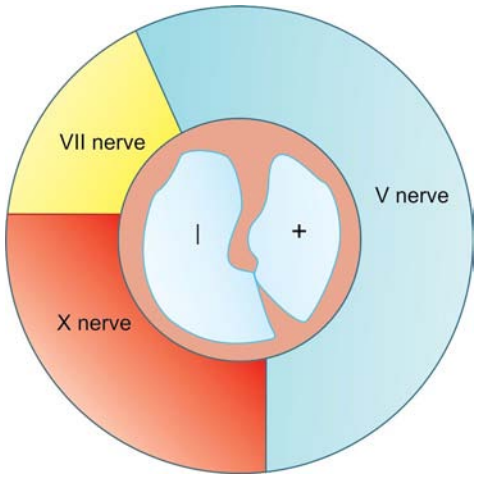


Figure 1.3B Nerve supply of external auditory canal (EAC) and tympanic membrane (TM)

External Acoustic Meatus

- At birth only cartilaginous meatus is present because the bony part develops from tympanic ring, which is incompletely formed at that time, i.e. bony part of meatus is absent in newborn.
- Its length is 24 mm, outer one-third (8 mm) being cartil-aginous and inner two-thirds (16 mm) bony. The canal forms a mild S-shaped curve directed medially, upwards and forwards and then medially, backward and downward.
- The canal has two constrictions in the external auditory canal (EAC); one, near the medial end of cartilaginous part and the other 5 mm short of tympanic membrane in the osseous part called isthmus.
- Floor and anterior wall of meatus are longer than the roof and posterior part due to oblique position of tympanic membrane (TM).
- Anterior, inferior and posterior bony walls of meatus are formed by tympanic part of temporal bone. Roof and part of posterior wall are formed by squamous part of temporal bone.
- A meatal recess is present in relation to the inferior wall of the meatus and is a common site for lodgement of debris and foreign bodies.
- **Foramen of Luschka** is a deficiency in anteroinferior part of bony meatus. It closes around 4 years of age**.**
- **Fissures of Santorini** are deficiencies seen in cartilaginous portion of EAC through which infection of mastoid and parotid gland can spread to the meatus.
- Skin is very thin and firmly attached to the bone and cartilage of meatus, therefore, inflammation is very painful due to increased tension in these tissues. Ceruminous glands and hair are present mostly in the subcutaneous tissue of cartilaginous part.

  Important relations include:
- Condyloid process of mandible is in close relation to anterior wall
- Middle cranial fossa lies above the osseous meatus
- Mastoid air cells are posterior to it.

Nerve supply of meatus

The nerve supply of EAC and TM are shown in **Figure 1.3B**.

- Anterior and superior walls by auriculotemporal branch of mandibular nerve
- Posterior and inferior walls are supplied by auricular branch of vagus (Arnold's nerve)
- A sensory branch of the facial nerve (nerve of Wrisberg) may supply a part of the posterior wall of meatus.

Internal Acoustic Meatus

- Internal acoustic meatus is approximately 1 cm long and has a vertical diameter of 2 to 8 mm, which is symmetrical on both sides and the difference between the two sides is not more than 1 mm. It is roughly parallel to the EAC.
- It has three parts:
  - Porus (inlet of internal acoustic meatus [IAM])
  - Canal
  - Fundus (applied to labyrinth).
- **Bill's bar** is a vertical crest of bone, which divides superior compartment of canal into anterior compartment for facial nerve and posterior compartment for superior vestibular nerve (**Figure 1.3C**).
- Contents:
  - Meninges
  - Facial nerve
  - Nervus intermedius
  - Cochlear and vestibular nerve
  - Blood vessels.

Middle Ear Cavity (Tympanum)

- Middle ear cleft consists of middle ear proper, eustachian tube and mastoid antrum (**Figure 1.3D**).

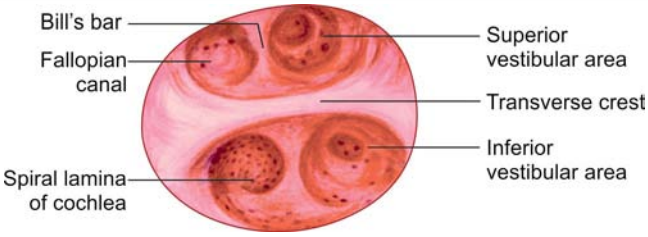


Figure 1.3C Fundus of internal acoustic meatus

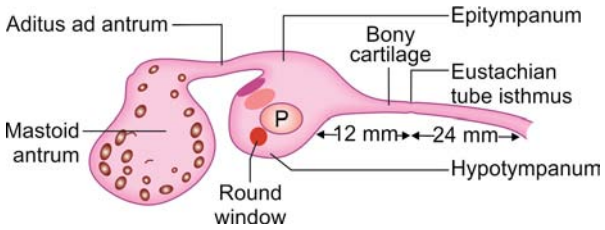


Figure 1.3D Middle ear cleft

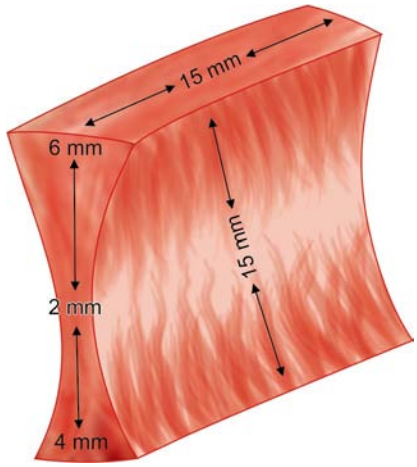


Figure 1.3E Dimensions of middle ear space

- It is a biconcave irregular space contained in the petrous part of temporal bone, which is fully developed to adult size at birth.
- Middle ear resembles a six-sided box (like a matchbox)
- It measures 15 mm each both vertically and antero-posteriorly, while transverse diameter will be 6 mm above, 4 mm below and 2 mm opposite umbo (**Figure 1.3E**).
- Contents of middle ear is only air. Ossicles and tendons of stapedius and tensor tympani lie outside the mucous membrane.
- It communicates with nasopharynx through eustachian tube and with the mastoid antrum posteriorly through aditus opening.
- Middle ear cavity is further subdivided into:
  - Epitympanum
  - Mesotympanum
  - Protympanum (area of tympanum around eustachian tube)
  - Hypotympanum.
- Part of middle ear extending above the tympanic membrane is known as epitympanic recess or attic.

Walls of Tympanic Cavity (Figures 1.4A and B)

Roof

- Roof is formed by tegmen tympani, a part of petrous and squamous bone forming petrosquamous suture through which veins communicate with the meninges or superior petrosal sinus
- Roof of middle ear is also pierced by greater and lesser petrosal nerves.

Floor

- Floor is a thin convex plate of bone, which separates the floor from superior bulb of internal jugular vein
- An aperture for the passage of Jacobson's nerve (tympanic branch of glossopharyngeal nerve) lies in the floor close to the medial wall of tympanic cavity.

Lateral wall

This wall of a tympanic cavity is shown in **Figures 1.4A and B**.

- Upper most part of lateral wall is formed by lateral attic wall called scutum (Shield of Liedy).
- Tympanic membrane, which forms the major part of lateral wall of middle ear and separates it from external acoustic meatus (**Figures 1.5A to D**).
- Tympanic membrane is a semitransparent, pearly, gray trilaminar membrane that weighs nearly 12 to 14 mg. Its thickness varies from 0.1 to 0.15 mm.
- Anteroposteriorly, it is 8 to 9 mm and vertically it is 9 to 10 mm.
- Total surface area is 85 sq mm, while vibrating surface area is nearly 55 sq mm.
- Tympanic membrane of an infant is thicker than that of an adult and is placed almost horizontal in infants. In adults it is placed at an angle of 55° with the floor.
- Posterosuperior part of TM is nearest to the observer while anteroinferior part is farthest.
- The membrane is convex towards the middle ear cavity and the tense part is called pars tensa.
- Peripheral part of tympanic membrane (pars tensa) is thickened to form fibrocartilaginous ring attached to **tympanic sulcus.** This sulcus is deficient superiorly **(notch of Rivinus).** This notch of Rivinus lies medial to pars flaccida**.** Lamina propria of Pars tensa has a predominance of Collagen Type II making this part of membrane tense.

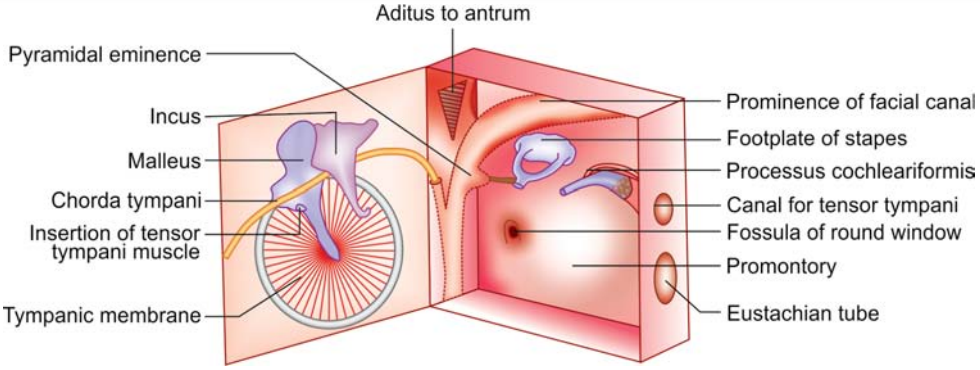


Figure 1.4A Walls of middle ear cavity with lateral wall opened up

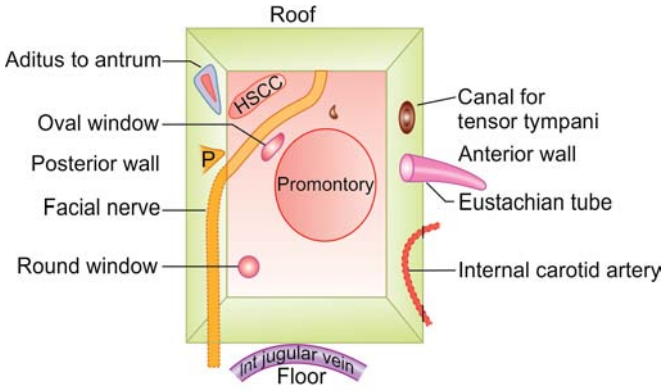
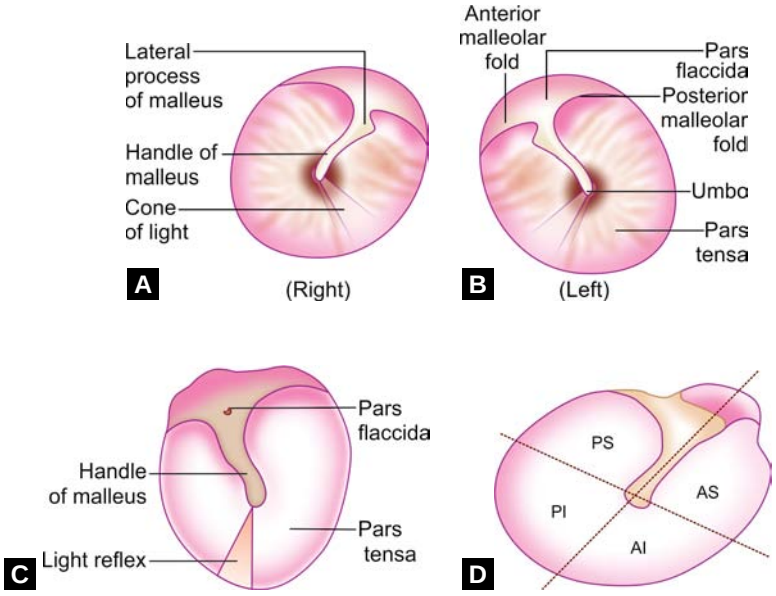


Figure 1.4B Walls of middle ear cavity



Figures 1.5A to D Various landmarks of normal tympanic membrane. (A) Right tympanic membrane; (B) Left tympanic membrane; (C) Left tympanic membrane; (D) Right tympanic membrane showing quadrants (PS: Posterosuperior, AS: Anterosuperior, PI: Posteroinferior, AI: Anteroinferior)

- Flaccid part above the malleolar folds is called pars flaccida (Shrapnel membrane), which is approximately 2 to 3 mm only. Flaccidity is due to random and loose arrangement of fibers in middle fibrous layer and absence of an annulus to keep the fibrous layer taut, and this allows free movements of the head of malleus.
- Cone of light is always seen in anteroinferior quadrant of pars tensa as this is the only part that is nearly at right angle to the meatus and therefore in a position to reflect back light of the mirror. The light reflex may be absent or its position may be altered, if the curvature of drum changes.
- The tympanic membrane has three layers:
  - Outer cuticular
  - Middle fibrous layer which consists of inner circular and outer radiating fibers
  - Inner mucosal layer.
- **Umbo is the most reliable landmark in otoscopy.**
- Retraction of tympanic membrane is indicated by:
  - Absent cone of light
  - Anterior and posterior malleolar folds become prominent
  - Lateral process of malleus becomes prominent
  - Handle of malleus becomes fore shortened and assumes a horizontal position
  - Drum looses its normal luster
  - Mobility is restricted.
- *Arterial supply:*
  - Deep auricular branch of maxillary artery to cuticular layer
  - Stylomastoid branch of occipital or posterior auricular artery
  - Tympanic branch of maxillary artery to middle and mucosal layer.
- *Veins* drain to external jugular vein and transverse sinus.
- *Nerve supply:*
  - Auriculotemporal branch of mandibular nerve
  - Auricular branch of vagus (Arnold's nerve)
  - Tympanic branch of glossopharyngeal nerve (Jacobson's nerve) through tympanic plexus.

Medial wall

Also called the surgical floor of middle ear and this labyrinthine wall separates middle ear from inner ear.

The main features on medial wall are (**Figures 1.6A and B**):

Promontory formed by basal turn of cochlea.

- **Fenestra vestibuli** (oval window) lies posterosuperior to the promontory and opens into scala vestibuli. It measures 3.25 × 1.75 mm. It is occupied by footplate of stapes fixed by annular ligament**.**
- **Fenestra cochleae** (round window) lies posteroinferior to promontory, opens into floor of scala tympani of cochlea, measures 1.5 × 1.3 mm and is closed by secondary tympanic membrane. The round window is closest to ampulla of posterior semicircular canal.
- **Horizontal part of facial nerve is** enclosed in a bony canal (Fallopius canal), which lies above the fenestra vestibuli curving downwards into posterior wall of middle ear (**Figure 1.7**). The facial nerve here separates epitympanic region above from mesotympanic region below.
- Anterior to oval window is a hook-like projection called the **processus cochleariformis** for tendon of tensor tympani. It marks the level of genu of facial nerve. Ponticulus is a bony spicule which runs from promontory to pyramid below the oval window. Subiculum is just posterior extension of promontory lying above the round window.
- **Tympanic plexus** is formed by tympanic branch of glossopharyngeal nerve and the superior and inferior branches of sympathetic plexus around internal carotid artery. Tympanic plexus in front of oval window is highly sensitive and painful on surgical manipulation.

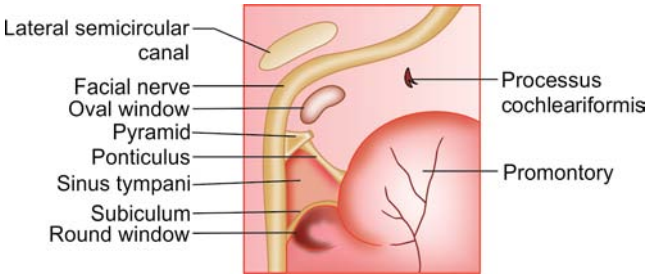


Figure 1.6A Various structures on the medial wall of middle ear

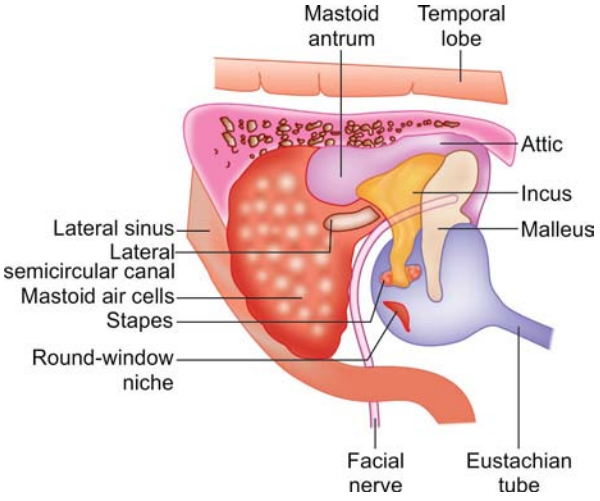


Figure 1.6B Inside view of middle ear

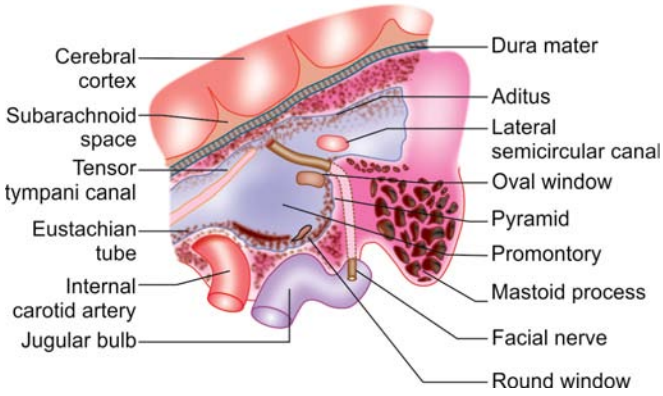


Figure 1.7 Left tympanic cavity in relation to the facial nerve

Posterior wall

Posterior wall has the following main features:

- **Aditus ad antrum** is an irregular aperture leading back from epitympanic recess into upper part of mastoid antrum. Aditus word in Latin means access.
- **Pyramidal eminence** lies just behind fenestra vestibuli and contains stapedius muscle**.**
- **Fossa incudis** lies in epitympanic recess and contains short process of the incus.
- An opening below and lateral to pyramid is for entry of chorda tympani nerve into the middle ear.

Facial recess

Also called suprapyramidal recess, is a groove or depression on the posterior wall, which lies between pyramid and facial nerve and annulus of the tympanic membrane. It is a collection of air cells lying lateral to facial nerve.

- The term was coined by House and Sheehy
- It is bounded:
  - Medially by external genu of facial nerve
  - Laterally by chorda tympani
  - Superiorly by fossa incudis
  - Anterolaterally by tympanic membrane.
- Facial recess is superficial to sinus tympani and is separated from it by descending part of facial nerve.
- Importance of this recess is that one can approach the middle ear from behind without disturbing posterior meatal wall. This is one of the hidden areas where cholesteatoma can reoccur after surgery, so a surgeon should be extra cautious in clearing this area. Ear may continue discharging if this area is not cleaned during mastoid surgery.

Sinus tympani

Also called infrapyramidal recess or medial facial recess.

- It is a depression behind promontory deep to the pyramid, continuous with the hypotympanum and its position is opposite to ampulla of posterior SCC.
- It starts at oval window and occupies a space deep to descending part of the facial nerve and pyramid and passes behind round window niche to hypotympanum.
- Sinus tympani is the most inaccessible area in the middle ear and mastoid. Approach to this area is not possible via mastoid (retrofacial approach) because posterior SCC comes in the way. It cannot be visualized directly in the surgery of cholesteatoma, so can be a site of recurrence.
- It is also described as a triangular space between ponticulus above and subiculum below. These are two bony spicules extending from the promontory on to the posterior wall superiorly and inferiorly, respectively.
- Sinus tympani is bounded laterally by vertical segment of facial nerve and medially by medial wall of tympanum.

Anterior wall (carotid wall)

Anterior wall has the following openings (**Figure 1.8**):

- Above is the canal for tensor tympani extending to medial wall to form a pulley called processus cochleariformis
- Below is osseous opening of eustachian tube.
- Anteriorly the plate of bone, separates middle ear from internal carotid artery. It is perforated by superior and inferior carotico-tympanic nerves and tympanic branches of internal carotid artery.
- **Canal of Huguier** for passage of chorda tympani nerve out of temporal bone anteriorly through the medial end of petrotympanic fissure to join the lingual nerve in the infratemporal fossa. It carries taste from anterior two-thirds of tongue and secretomotor fibers to submaxillary and sublingual gland.
- **Glasserian fissure** below canal of Huguier transmits tympanic artery and anterior ligament of malleus.

Remember anterior wall of middle ear is closely related to internal carotid artery; posterior wall is occupied by facial nerve and floor is mainly venous occupied by internal jugular vein.

Surgical Anatomy of Mastoid Antrum

- It is an air sinus in the petrous temporal bone, with a capacity of 1 cc. It is the largest and the most consistent mastoid air cell present.
- It is of the same size (10 mm) in adults and children and it is always present.
- Its upper anterior wall has the opening of aditus.
- Medial wall is related to posterior and lateral semicircular canal.
- Posteriorly lies the sigmoid sinus.
- The roof is formed by tegmen antri separating it from middle cranial fossa and temporal lobe of brain.
- Anteroinferiorly is the descending part of facial nerve canal (or fallopian canal).
- Lateral wall is formed by squamous temporal bone and in adult is 12 to 15 mm thick. Mastoid process develops after 1st year of life and Cymba concha is the soft tissue landmark of mastoid antrum**.**

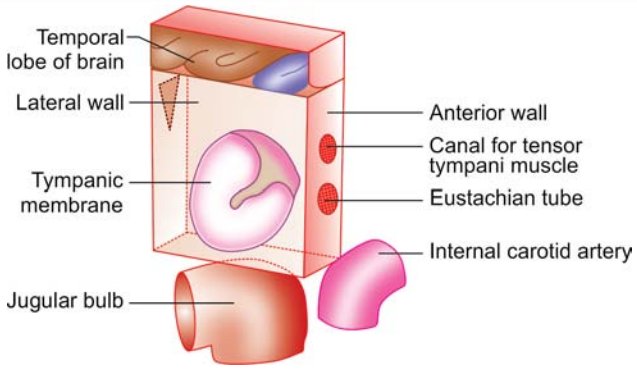


Figure 1.8 Anterior wall and floor of middle ear cavity

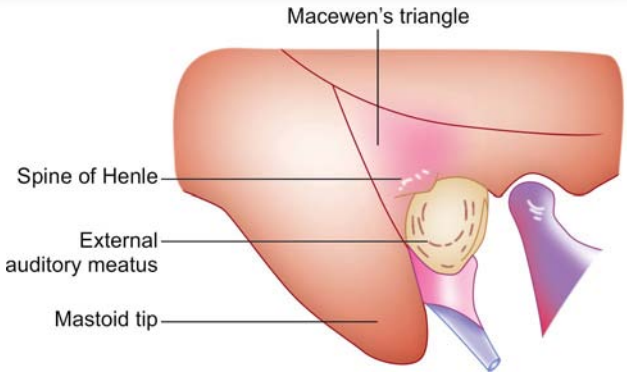


Figure 1.9A Boundaries of Macewen's triangle

Macewen's triangle or suprameatal triangle

Macewen's triangle is used to locate the mastoid antrum which lies about 1.5 cm deep to it**.**

It can be felt under cymba concha (**Figures 1.9A and B**). It is bounded:

- Above by supramastoid crest (base)
- Anteroinferiorly by posterosuperior margin of external auditory canal
- Posteriorly by a tangent drawn from supramastoid crest to spine of Henle.
- Spine of Henle lies in the triangle
- Mastoid antrum lies 15 mm deep
- **Korner's septum** is persistence of petrosquamous suture. Its presence leads to formation of false bottom of mastoid antrum. This may lead to incomplete exenteration of mastoid cells in mastoidectomy operation and if the surgeon mistakes it for the true mastoid antrum and drills anteriorly, he may damage the facial nerve.

Trautmann's triangle

It is bounded by:

- Sigmoid sinus posteriorly
- Bony labyrinth anteriorly
- Superior petrosal sinus superiorly.

The triangle identifies the location of posterior cranial fossa. Infection into the posterior cranial fossa can spread through this triangle and this can be approached by removing the bone in between the triangle.

Antrum threshold angle

Antrum threshold angle is bounded:

- Above by horizontal semicircular canal (HSCC) and fossa incudis

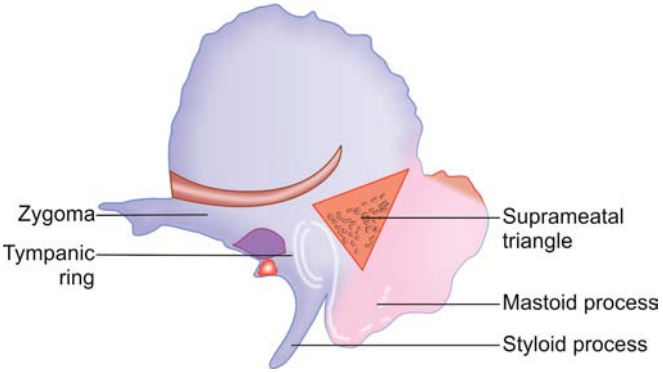


Figure 1.9B Parts of temporal bone

- Medially by descending part of nerve VII
- Laterally by chorda tympani nerve.

By drilling it, surgeon enters the facial recess from the antrum side.

Solid angle

Formed by solid bone in the angle formed by three SCCs.

Sinodural angle

The angle between tegmen antri and sigmoid sinus.

Types of mastoid antrum

- ***Pneumatized*** **(80%)**—there are present many groups of cells like tip cells, dural cells, perisinus cells, sinodural angle cells, retrofacial cells and zygomatic cells. Pneumatization starts in 1st year of life and is complete by 4 to 6 years.
- ***Sclerotic*** **(20%)**—there are present few or no cells. In this type, cells are absent and are replaced by dense bone.

- ***Mixed (Diploeic)***—there are small air cells and bone marrow spaces (**Figure 1.10**).

Extent of pneumatization depends on the following factors

- Eustachian tube function (Tumarkin's theory)
- Environment
- Heredity (Diamant's theory)
- Infantile otitis media (Wittmark's theory).

Eustachian Tube

- Named after Bartholomeus Eustachius (1520–1574 AD).
- It is also called pharyngotympanic tube and helps to equalize pressure on either sides of TM (**Figure 1.11**). It is trumpet like in shape.
- In infants, the auditory tube is short and wide and is placed horizontally.
- Eustachian tube measures 17 mm at birth and about 36 mm long in adults and descends at an angle of 45 degree with sagittal plane and 30 degree with horizontal plane.
- In resting state, tubal end in nasopharynx lies collapsed, opening during yawning and deglutition.
- Osseous part (12 mm long) starts from anterior tympanic wall and lies 4 mm above the level of floor of middle ear, which narrows to end at squamous and petrous part of temporal bone to become continuous with cartilaginous tube.
- Cartilaginous part (24 mm long) opens into the naso-pharynx between the petrous part of temporal bone and greater wing of sphenoid bone, 1.25 cm behind the posterior end of inferior turbinate.
- **Ostmann's pad** of fat is adipose tissue found between lateral aspect of eustachian tube and tensor palati muscle and it helps to keep the tube closed thus preventing reflux of secretions in middle ear.
- During Valsalva maneuver handle of malleus moves outwards with TM but incus does not, due to unlocking of incudomalleolar joint and this prevents stapes being torn away from fenestra vestibuli. Valsalva maneuver generates 20 to 40 mm Hg of pressure.
- **Muscles of eustachian tube**
  - **Tensor palati** opening the cartilaginous part of eustachian tube (dilator tubae is a part of it) supplied by branch of mandibular nerve.
  - **Levator palati** supplied by pharyngeal plexus through cranial nerve XI.
  - **Tensor palati** separates the eustachian tube from otic ganglion, mandibular nerve, chorda tympani nerve and middle meningeal artery (**Figure 1.12**).
- **Arterial supply** is through branches from ascending pharyngeal, middle meningeal and artery of pterygoid canal (both branches of maxillary artery). Venous drainage is to the pterygoid and pharyngeal venous plexus.
- **Nerve supply** is by tympanic plexus and pharyngeal branches of pterygopalatine ganglion.

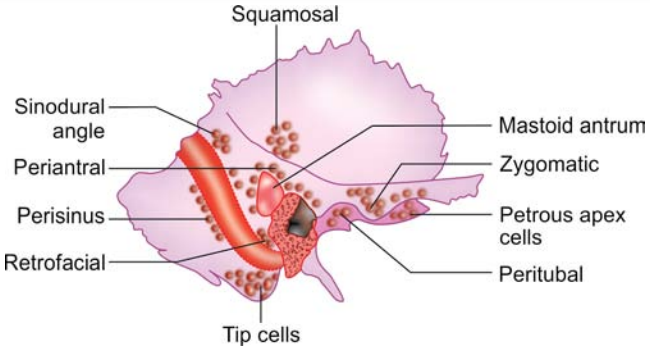


Figure 1.10 Various groups of air cells in the temporal bone

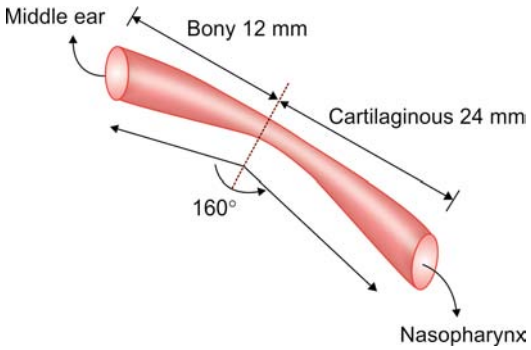


Figure 1.11 Right eustachian tube

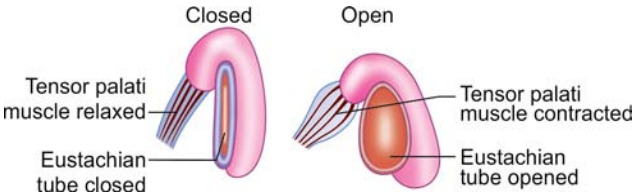


Figure 1.12 Tensor palati and eustachian tube

- Lymphatics drain into retropharyngeal lymph nodes.
- Lymphoid tissue related to eustachian tube has been called tonsil of Gerlach.

Auditory Ossicles

- Vesalius (1543) described malleus and incus
- Ingrassia (1546) described stapes oval window (OW) and round window (RW)
- Malleus, incus and stapes (**Figure 1.13**) are connected to each other by synovial joints forming ball and socket and saddle joint respectively
- Malleus and incus develops from mesoderm of first branchial arch, while stapes from second branchial arch. Footplate of stapes develops from otic capsule.

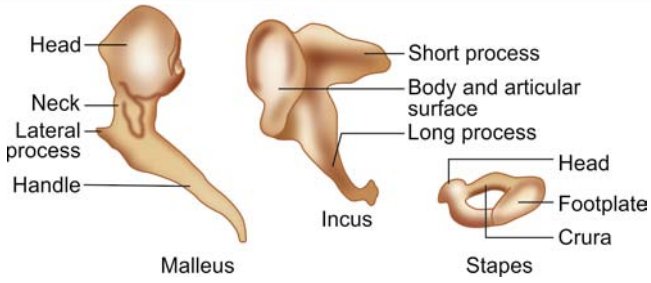


Figure 1.13 Ear ossicles and their parts

Malleus

- It is the largest ossicle shaped like a mallet and is 8 to 9 mm long and weighs 23 to 25 mg
- It has head, neck, manubrium (handle), anterior and lateral processes
- Head lies in epitympanic recess and articulates with the incus
- Neck lies against pars flaccida and related to chorda tympani nerve
- Handle of malleus extend downward, backward and medially.

Incus

- It is shaped like an anvil, weighs 25 to 30 mg and has a body and two processes
- Long process descends parallel to the malleus and ends in a lenticular process which articulates with stapes capitulum
- Short process lies in the fossa incudis of epitympanic recess, i.e. attic
- Pneumatization of long process of incus may occur.

Stapes

- It is the shortest bone of the body and weighs 2.5 to 3 mg
- It has a head, neck, two crurae and a base, which fits into the oval window
- Neck provides insertion to tendon of stapedius
- Stapes moves in a rocking fashion
- Stapes footplate area is 1.65 to 3.75 mm^2.

All these ossicles are supplied by branches of anterior, inferior and posterior tympanic arteries.

Muscles of the Tympanic Cavity

Tensor tympani

- First branchial arch muscle
- It arises from walls of cartilaginous part of the eustachian tube and adjoining region of greater wing of sphenoid and its tendon is attached to the handle of malleus near the neck
- It is supplied by a branch of mandibular nerve through otic ganglion
- Normally, the pulley action of tensor tympani muscle is opposed by elasticity of pars propria of TM.

Stapedius

- Second branchial arch muscle
- It arises from **interior of** pyramidal eminence and emerges from its apex and is attached to the **back of** neck of stapes
- It is supplied by branch of facial nerve.

Actions

Both muscles contract in response to loud sounds exerting a protective, dampening effect before vibrations reach the internal ear.

Paralysis of stapedius results in hyperacusis**.** Action of stapedius is opposite to the action of tensor, which tends to push in the footplate deep into fenestra **vestibuli**.

Compartments and Spaces of Middle Ear

- Epitympanum (3 mm) communicates with mesotympanum (7–8 mm) through isthmus tympani anticus and posticus.
- Upper part of mesotympanum has three compartments:
  - Inferior incudal space
  - Anterior and posterior pouch of von Troltsch (**Figure 1.14**)
  - Epitympanum is divided by superior malleolar fold into a smaller upper compartment and lower large compartment further subdivided by superior incudal fold into medial incudal and superior incudal space.

Prussak's Space

1. Also called superior recess of TM. It lies between neck of malleus (internally) and pars flaccida (externally). It is bounded above by fibers of lateral malleolar fold and below by lateral process of malleus.
2. *Importance of this space:* It is most common site of cholesteatoma. The cholesteatoma may extend to posterior mesotympanum under lateral incudal fold and infection here does not drain easily and causes attic pathology.

Facial recess and sinus tympani (described above Figures 1.15A and B):

- Facial recess also called suprapyramidal recess
- Sinus tympani also called infrapyramidal recess.

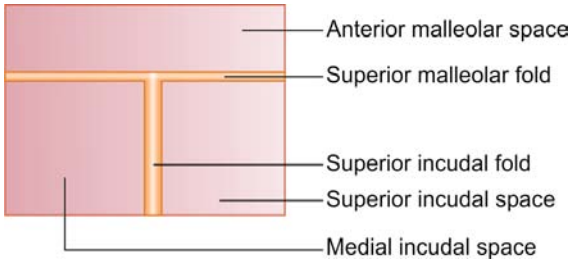
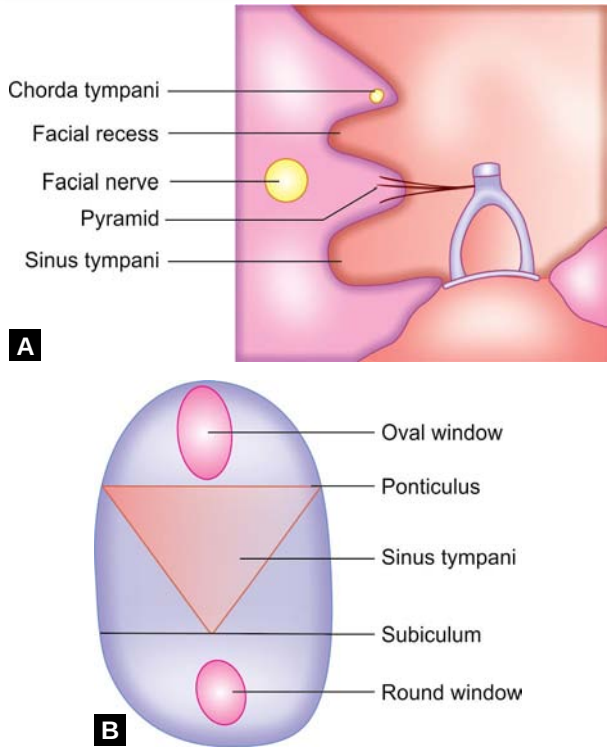
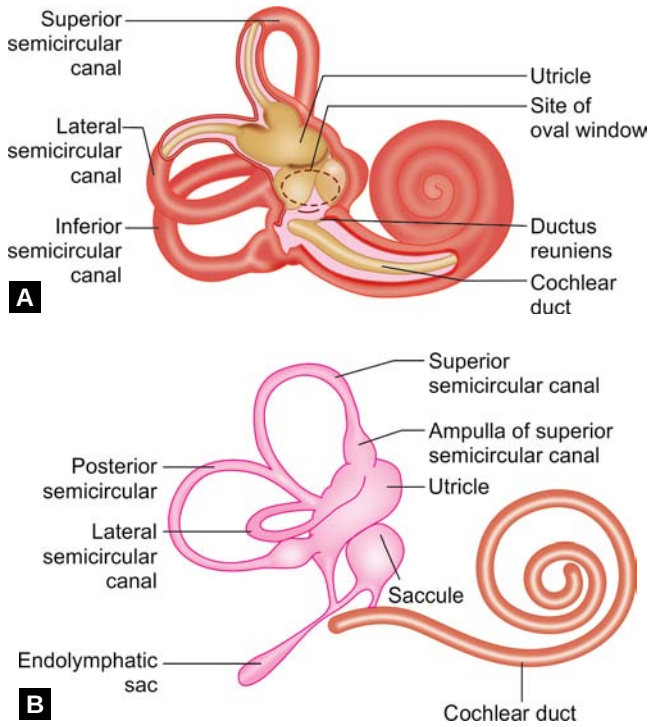


Figure 1.14 Middle ear spaces (diagrammatic view)



Figures 1.15A and B (A) Facial recess and sinus tympani; (B) Diagrammatic view of sinus tympani in relation to oval and round windows



Figures 1.16A and B Internal ear. (A) View of bony labyrinth; (B) Membranous labyrinth

Mucous Membrane of Middle Ear

Tympanic mucosa is pale, thin and slightly vascular ciliated columnar epithelium except on posterior wall where it is non-ciliated like that of the mastoid antrum.

Blood Supply of Tympanic Cavity

Arterial supply

- Anterior tympanic branch of maxillary
- Posterior tympanic branch of stylomastoid (which is a branch of posterior auricular)
- Superior tympanic branch of middle meningeal artery
- Inferior tympanic branch of ascending pharyngeal
- Deep auricular branch of maxillary.

Veins drainage

Drain into pterygoid venous plexus and superior petrosal sinus.

Lymphatics drainage

Drain to parotid and upper deep cervical lymph nodes.

Nerves

- Tympanic plexus formed by union of tympanic branch of glossopharyngeal nerve and caroticotympanic nerves of sympathetic plexus around internal carotid artery
- Mastoid antrum is supplied by meningeal branch of mandibular nerve.

Internal Ear

Internal ear consists of a bony labyrinth contained within the petrous temporal bone along with the membranous labyrinth (**Figures 1.16A and B**). It serves the most important function of hearing and equilibrium.

Otic capsule develops from 14 centers.

Bony Labyrinth

It consists of (**Figure 1.16A**):

a. Vestibule
b. Semicircular canals
c. Cochlea.

Vestibule

- Ovoid in shape measuring 5 mm × 3 mm and forms the central part of bony labyrinth
- It has a spherical recess containing saccule, a cochlear recess for cochlear duct and an elliptical recess for utricle. Opening of vestibular aqueduct lies below elliptical recess
- Posterior part of vestibule has five openings of three semicircular canals

- Lateral wall has the fenestra vestibuli or oval window. Its medial wall is related to internal acoustic meatus.

Semicircular canals

- There are three SCCs, i.e. superior, posterior and lateral. These are all about 0.8 mm in diameter and have a terminal swelling called ampulla (2 mm)
- These open into vestibule by five openings, the one common between anterior and posterior is called the crus commune
- Their lengths are: Posterior SCC is 18 to 22 mm, superior SCC is 15 to 20 mm and lateral SCC is 12 to 15 mm long
- The three canals lie at 90° to each other. Superior SCC is placed transverse to the long axis of petrous temporal and its upward convexity forms the arcuate eminence.
- Posterior SCC runs parallel to posterior surface of petrous bone
- Lateral SCC lies at 30° to the horizontal plane. After 30° flexion of head, the lateral canal becomes horizontal.

Remember that the two horizontal SCCs lie in the same plane, while superior SCC of one side is parallel with the posterior SCC of other side.

Cochlea

- **Fallopius (1561)** described cochlea and labyrinth**.**
- It is shaped like a conical snail shell, measures 35 mm (long) × 5 mm (base to apex) and 9 mm across its base.
- Cochlea has a central conical axis called modiolus with a spiral canal of 2.5 to 2.75 turns around it.
- Apex of cochlea points towards anterosuperior part of medial wall of middle ear cavity and the base is towards the fundus of internal acoustic meatus.
- An osseous spiral lamina projects from the modiolus and divides the cochlear canal into upper **scala vestibuli** and lower **scala tympani**.
- Both the scalae are continuous with each other through helicotrema at the apex of cochlea.
- Cochlea has three openings at its base, i.e.
  - Fenestra vestibuli
  - Fenestra cochleae
  - Cochlear canaliculus, which transmits a small vein to inferior petrosal **sinus.**
- The cochlear aqueduct is a bony channel connecting scala tympani with a subarachnoid space in posterior cranial fossa and vestibular aqueduct extends from vestibule to the posterior cranial fossa.
- Bony labyrinth contains perilymph, which resembles cerebrospinal fluid (CSF) in its composition and is rich in sodium and poor in potassium.

Membranous Labyrinth

It lies within the osseous labyrinth and is filled with endolymphatic fluid (**Figure 1.16B**).

Vestibulocochlear nerve fibers are distributed in the walls of membranous labyrinth. The membranous labyrinth is separated from the bony labyrinth by perilymphatic fluid.

It has the following parts:

a. Utricle
b. Saccule
c . Semicircular ducts.

Utricle

- It is an irregular oblong structure 2 to 5 mm in diameter
- It occupies elliptical recess of the vestibule
- The lateral wall and adjoining floor have a thickened area of 3 mm × 2 mm called utricular macula
- It is innervated by utricular fibers of vestibular nerve
- The semicircular ducts open into the utricle through 5 ampullary ends.

Saccule

- It is globular in shape of 1 to 1.5 mm in diameter and occupies the spherical recess near the opening of scala vestibuli
- Its anterior wall has the macula set at right angle to the utricular macula
- Saccule is connected to the utricle through a Y-shaped tube, to the endolymphatic duct and sac
- The sac lies under the dura mater on posterior surface of petrous bone
- Ductus reuniens passes inferior from lower part of saccule into the basal end of cochlear duct
- Donaldson's line is a landmark for endolymphatic sac and this line passes through HSSC and bisects posterior SCC. The endolymphatic sac lies below this line.

Semicircular ducts

- These open into the utricle by five orifices, one being common to the medial end of superior and posterior duct
- In the ampullary end of each duct, there is a transverse elevation shaped like an hourglass called septum transversum
- Its most prominent part is ampullary cristae, which are the sensitive organs to the movements of endolymph
- These cristae respond to pressure changes of endolymph, while maculae respond to gravitational changes.

Structure of utricle, saccule and semicircular ducts

Each has three layers:

i. External layer is fibrous and vascular.
ii. Middle layer is vascular connective tissue.
iii. Internal layer is simple epithelium varying from squamous to cuboidal with a basement membrane having light and dark cells.
   - In ampullary crests, the epithelium contains sensory hair cells of type I and type II and supporting cells of Hensen (**Figure 1.17**).

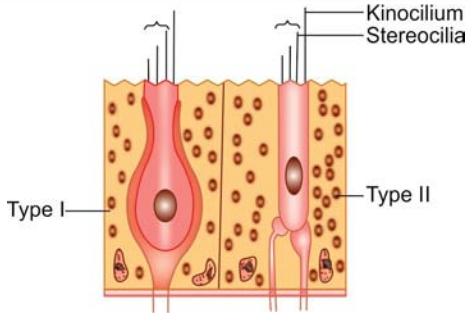


Figure 1.17 Sensory hair cells of vestibular organ

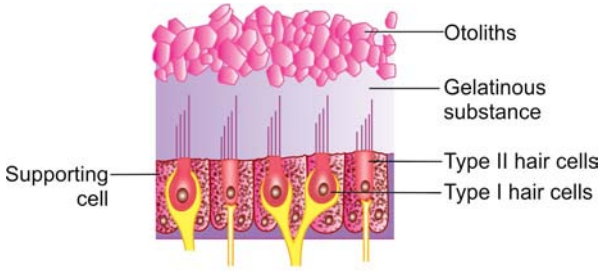


Figure 1.18 Structure of macula

- Type I cell is pyriform in shape and type II cell is cylindrical. Apical surface of both these cells carry 40 to 100 stereocilia or modified microvilli.
- A long kinocilium is also attached to each cell. These stereocilia and kinocilium are inserted into a gelatinous mass-like membrane called otolithic membrane containing many otoliths or statoconia (**Figure 1.18**).
- Macula is the organ for static balance, while ampullary crest is the organ for kinetic balance (or responds to angular acceleration).
- Endolymph resembles intracellular fluid being rich in potassium and poor in sodium ions.

Cochlear Duct (Scala Media)

1. The canal enclosed between scala vestibuli and scala tympani is the cochlear duct (or scala media).
2. It lies within the bony cochlea and has the sensory area called organ of Corti which is triangular in cross-section (**Figures 1.19A and B**).
3. The basilar membrane forms the horizontal limb of scala media, the Reissner's membrane forms the superior limb and the vertical limb of the triangle is formed by the stria vascularis and the spiral ligament.
4. Basilar membrane stretches from the osseous spiral lamina to spiral ligament.
5. Its total length is 35 mm and width is between 0.21 mm and 0.36 mm. It consists of two zones, i.e.
   - Zona arcuata, which supports organ of Corti
   - Zona pectinata, which is thicker and has three layers.
6. Vestibular membrane also called Reissner's membrane lies well over the basilar membrane below the scala vestibuli.

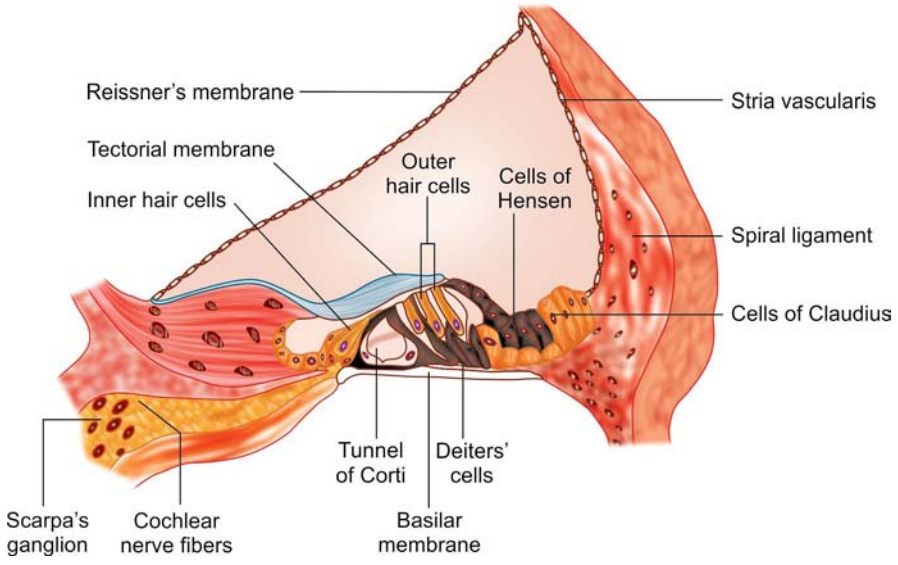


Figure 1.19A Section of the cochlea to show scala media

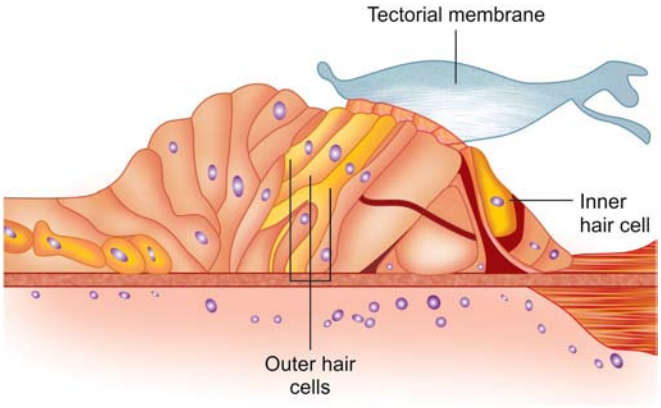


Figure 1.19B Magnified view of hair cells

7. Cochlear duct is filled with a fluid called endolymph and the scala vestibuli and tympani are filled with perilymph.
8. Organ of Corti consists of two rows of cells (Described in 1851 by Corti)
   - External rod cells (4000)
   - Internal rod cells (6000).
9. Inner-to-inner rods are inner hair cells (3500) in one row, while external-to-outer rods are three to four layers of outer hair cells (12000).
10. Organ of Corti is covered by tectorial membrane.
11. Supporting cells of Deiters' are situated between the outer hair cells. Cells of Hensen lie outside the Deiters' cells.
12. In addition to tunnel of Corti (between outer and inner rod cells), there is also an outer tunnel and space of Nuel (medial tunnel). These spaces are filled with cortilymph which resembles perilymph in composition.
13. Remember, the organ of Corti has no direct blood supply and depends for its metabolic activity from diffusion of oxygen from stria vascularis. This arrangement provides acoustic insulation of hair cells.

Vestibulocochlear Nerve

- **Gallen** (200 AD) described the VIII cranial nerve (Vestibulocochlear nerve).
- The nerve VIII divides deep in the internal acoustic meatus into anterior cochlear and posterior vestibular nerve.
- **Oort's anastomosis** is, in fact, a vestibulocochlear anastomosis.

Cochlear Nerve

It divides into many filaments at the modiolar base and ultimately ends in inner hair cells (95%) and outer hair cells (5%). A vestibular branch of cochlear nerve supplies the vestibular end of cochlear duct.

Vestibular Nerve

It supplies maculae of utricle, saccule and ampulla of SC ducts. Scarpa's ganglion, from where these fibers arise, lies in the internal acoustic meatus. Distal to the ganglion, it divides into superior, inferior and posterior vestibular branches.

- Superior branch supplies utricular macula and ampullary crest of anterior and lateral SC ducts
- Inferior branch supplies saccular macula
- Posterior supplies ampulla of posterior SC duct.

Arteries of Labyrinth

- Internal auditory artery is a branch of anterior inferior **cerebellar artery,** which itself arises from basilar artery
- Internal auditory artery (labyrinthine artery) divides into a cochlear and a vestibular branch
- Stylomastoid branch of occipital artery and posterior **auricular artery** also contribute.

Veins

- Cochlear vein and vestibular vein join to form the labyrinthine vein, which ends in superior petrosal sinus or in transverse sinus
- A small vein from basal turn of cochlea also joins the internal jugular vein.

Table 1.2: Measurement of ear

Name	*Measurement (mm)*	*Name*	*Measurement (mm)*
• EAC	24 (8C + 16B)	• Length of HSCC	12–15
• Middle ear	15 × 15 × 6 – 2 – 4	• Length of anterior SCC	15–20
• Tympanic membrane	10 × 9 × 0.1	• Length of posterior SCC	18–22
• Eustachian tube	36 (24C + 12B)	• Cochlea	5 × 9 × 35
• Fenestra cochleae	1.5 × 1.3	• Basilar membrane	35 × 0.3
• Fenestra vestibuli	3.25 × 1.75	• Pars flaccida	2–3
• Mastoid antrum	15 × 12	• Utricular macula	3 × 2
• Vestibule	5 × 3	• Saccular macula	1–1.5
• Semicircular canal diameter	0.8	• Vibrating surface	55 (mm^2)

Key Points

1. **Preauricular sinus** results due to failure of fusion of tubercles of first and second branchial arches.
2. Important **measurements of ear** are given in **Table 1.2**.
3. **Boundaries of facial recess** are facial nerve (medially), chorda tympani (laterally) and fossa incudis (above).
4. **Sinus tympani or infrapyramidal recess** lies between oval and round window, below ponticulus and above subiculum process of bone on medial wall.
5. **Trautmann triangle** is bounded by superior petrosal sinus (superiorly), sigmoid sinus (posteriorly) and bony labyrinth (anteriorly).
6. **Eddy currents** in the external auditory meatus do not allow water to reach tympanic membrane while swimming.
7. **Glasserian fissure** in the middle ear transmits anterior tympanic branch of maxillary artery, anterior ligament of malleus and chorda tympani nerve through canal of Huguier.
8. **Prussak space** is bounded by: lateral malleolar fold on anterior, posterior and superior side, lateral process of malleus on inferior side, neck of malleus medially and pars flaccida laterally.
9. **Cochlear aqueduct** is a bony channel of 6.2 mm length which connects scala tympani with subarachnoid space of posterior cranial fossa.
10. **Meckel cave** on the superior part of temporal bone houses the Gasserian ganglion (V nerve).
11. **Eustachian tube** is opened by tensor palati; levator palati and salpingopharyngeus muscles.
12. **Bill's bar** in internal acoustic meatus separates facial nerve from superior vestibular nerve.
13. **Mastoid process** develops at first year of age.
14. **Sensory supply of middle ear** and posterior wall of pharynx is by glossopharyngeal nerve.
15. Superiorly **roof of external auditory meatus** is related to middle cranial fossa.
16. **Caroticotympanic artery** is a branch of internal carotid artery which anastamose with branches of external carotid in the middle ear.
17. **Hyrtl's fissure** also called tympanomeatal hiatus which connects cerebrospinal fluid (CSF) space to middle ear just anterior and inferior to round window. Normally, it gets obliterated but if it persists may become a source of CSF otorrhea or meningitis from middle ear infection.
18. Structures of ear **fully formed at birth** are middle ear, ossicles, labyrinth and cochlea.
19. **Cartilage derivatives of 1st pharyngeal arch (mandibular)—remember mneumonic: I'M A Super Sexy Guy: Incus-Malleus-Anterior ligament of malleus; Spine of sphenoid; Sphenomandibular ligament; Genial tubercle of mandible.**

Chapter 2 Physiology of Hearing and Equilibrium

What Students Must Know!

- **Various Audiological Terms**
- **Transmission of Sound Waves**
  - Sound Conducting Mechanism
- **Middle Ear Transformer Mechanism**
  - Sound Perception Mechanism
  - Mechanism of Bone Conduction
  - Electrical Potentials of Cochlea
  - Theories of Hearing
  - Auditory Pathways
- **Physiology of Equilibrium**
  - Functions of Vestibular Apparatus
  - Vestibular Pathways

INTRODUCTION

- Helmholtz (1868) and George von Bekesy, a noble laureate (1961) were the pioneers in auditory physiology.
- Ear performs two important functions of hearing and equilibrium.

The hearing mechanism has two components:

1. Sound-conducting mechanism.
2. Sound-perception mechanism.
   a. Tympanic membrane (TM) and ossicles not only conduct sounds, but also increase the pressure exerted at oval window before passing it to the cochlea. It is called impedance matching function of middle ear. This is necessary to overcome the resistance to the sound transmission.
   b. When sound passes from middle ear (air medium) to cochlea (fluid medium), it causes a loss of 99.9 percent of acoustic energy.
   c. Once the sound waves are transmitted, footplate of stapes causes movement of cochlear fluid leading to displacement of basilar membrane.
   d. Organ of Corti gets stimulated and results in generation of cochlear microphonics and then nerve impulses are sent to central connections.

VARIOUS AUDIOLOGICAL TERMS

1. ***Sound:*** A subjective sensation produced by vibrating objects.
2. ***Sound waves:*** Produced due to vibration of air molecules in an alternate phase of condensation and rarefaction. When these molecules strike the TM, sound is heard.
   – Velocity of sound in air is 344 meters per second, while it is fastest in solid medium.
3. ***Frequency:*** The number of cycles or vibrations per second. It is described in Hertz (Hz) after the name of a German scientist, Heinrich Rudolf Hertz.
   - Pure tone is a sound of a single frequency such as 250, 500 Hz or 1 kHz to 8 kHz
   - Speech frequencies are 500, 1,000 and 2,000 cps and most of human voices fall in this range
   - In pure tone audiometry (PTA), the average of these three frequencies is called 'average threshold of hearing.'
4. ***Amplitude:*** The intensity of the sound, hence the loudness.
5. ***Pitch:*** Determined by frequency of sound waves, higher the frequency, higher the pitch.
6. ***Loudness:*** Depends upon intensity of sound waves.

Sound pressure is described in Pascal but as it is too less unit, it is quantified and described as Bel.

7. ***Intensity:*** Denoted in decibels (dB) (1/10 of a Bel). Bel is a log of the ratio of intensity of that sound and standard sound.

$$\text{(Alexander Graham Bel)}\ 1\ \text{Bel} = \text{Log of}\ \frac{\text{Intensity of sound}}{\text{Intensity of standard sound}}$$

8. ***Noise:*** An unwanted superfluous or random sound energy. It may be white noise, narrow band noise or speech noise (between 500 and 3,000 Hz).
9. ***Sound levels:***
   - Whisper at 4 feet = 20 dB
   - Office noise = 40 dB
   - Noisy street = 60 to 80 dB
   - Loud motor horn = 100 dB
   - Thunder = 120 dB
   - Jet engine = 140 dB.

   Since actual scale is logarithmic, therefore:
   - 1 Bel = 10^1, i.e. 10 times of 0 level
   - 2 Bel = 10^2, i.e. 100 times of 0 level
   - 3 Bel = 10^3, i.e. 1000 times of 0 level.
10. ***Audible range of frequencies:*** It lies between 20 Hz and 20,000 Hz. Above 20,000 Hz (supersonic) are heard by dogs and below 20 Hz (subsonic) are heard by bats.

TRANSMISSION OF SOUND WAVES

Sound-conducting Mechanism

Air Conduction Sounds

1. Pinna collects the sound energy, reflecting it into the external auditory canal (EAC) from where the sound waves reach the TM with resonance.
2. When sound waves fall on it, part of sound energy is transmitted to the inner ear through middle ear ossicular chain. Movements of malleus and incus are aided by the flaccidity of pars flaccida.
3. The TM vibrates the maximum at the periphery in the inferior part, just below the umbo.
4. Effective vibratory area of TM is nearly 45 to 55 sq mm.
5. Total effective vibratory area of TM is 14 times greater than the footplate of stapes.
6. Handle of malleus is longer than the incus by 1.3 times (ossicular leverage ratio).
7. So the pressure exerted at oval window works out to be 14 × 1.3 times = 18.3 times (some workers say it is 17 × 1.3 = 22 times). This is called middle ear transformer mechanism (**Figure 2.1**) also called areal or hydraulic ratio, which increases the force of sounds at oval window 18 times, i.e. it is that function of the middle ear by which the sound energy impinging on a large TM is transferred to a much smaller oval window with augmentation.
   - Phase difference between oval and round window with intact TM gives advantage of nearly 4 dB
   - Natural resonance of external auditory canal is 3,000 Hz and that of middle ear is 800 Hz, ossicular chain transmit frequencies between 500 to 2000 Hz and TM from 800 to 1600 Hz.

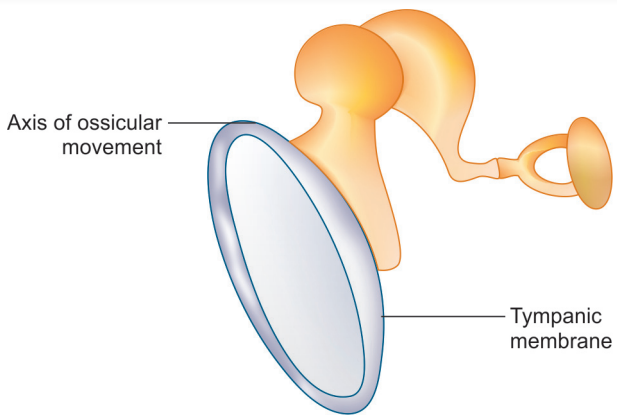


Figure 2.1 Transformer action of the middle ear

Bone Conduction Sounds

Another method of sound conduction to cochlear fluids is by bone conduction. Bone conduction threshold gives an index of inner ear functions.

Mechanism of bone conduction

Mechanism of bone conduction takes place by:

- ***Compressional mechanism:*** Sound energy causes compression and expansion of cochlea causing movement of cochlear fluid
- ***Inertial mechanism:*** Bone conduction by inertia leads to vibration of skull bones, which causes movement of stapes footplate, setting cochlear fluids in motion
- ***Osseo-tympanic skull vibrations*** and lagging behind of mandible causes air column in cartilaginous part of EAM to vibrate which are then transmitted to inner ear.
  - Movements of footplate and hence, cochlear fluid brings traveling waves and oscillations of basilar membrane
  - Stimulation of hair cells sets in neural impulses, which take place because of shearing action between tectorial membrane and reticular lamina (**Figure 2.2**).

Sound Perception Mechanism

1. Difference in sound pressure due to coupling of round window (RW) and oval window (OW) by incompressible inner ear fluid stimulates the inner ear. Sound waves

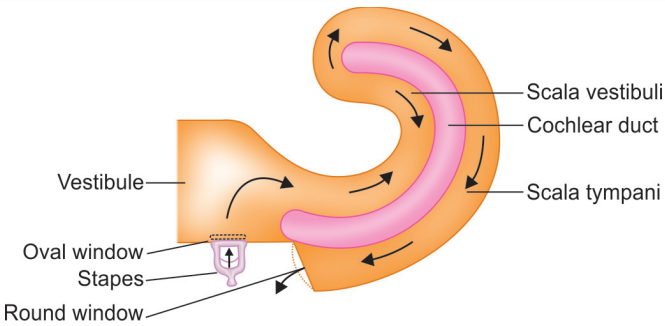


Figure 2.2 Physiology of hearing

reaching oval window sets perilymph into vibrations which in turn stimulates the organ of Corti setting up shearing force between tectorial membrane and hair cells.
2. Distortion of hair cells give rise to cochlear microphonics, which in turn triggers the nerve impulse exciting the cochlear nerve
3. Impulses go to dorsal and ventral cochlear nucleus, from there impulses travel to superior olivary nucleus, lateral lemniscus, medial geniculate body and finally to auditory cortex of temporal lobe.

THEORIES OF HEARING

Helmholtz Resonance Theory (Place Theory)

- According to this theory, sound waves entering the internal ear set up vibrations of particular fibers of basilar membrane depending upon the tones
- Lower tones stimulate longer fibers at the apex of cochlea and higher tones stimulate smaller fibers at the base of cochlea
- So each pitch will cause vibration of a particular place on basilar membrane.

Rutherford's Telephone Theory

- Rutherford's telephone theory says that cochlea acts like a telephone transmitter
- Hence, basilar membrane gets stimulated by every frequency of sound
- Pitch depends upon the action potential of the nerve fibers.

George von Bekesy's Traveling Wave Theory

George von Bekesy was awarded Nobel Prize (1961) for physiology of ear

- George von Bekesy's traveling wave theory is a combination of above two theories and is most widely accepted
- It explains the response of whole cochlea to low frequencies and also explains the cochlear analysis of higher frequencies above 5000 Hz at the basal turn of cochlea
- So high frequency stimulates basal part of basilar membrane, while low tones displace whole of basilar membrane.

ELECTRICAL POTENTIALS OF COCHLEA

It is because of electrical potential differences that acoustic impulses are transmitted as neural impulses.

These potentials are as follows.

Cochlear Microphonic Potentials

- Tasaki (1954) recorded these potentials, which originate in cochlea and spread to the neighboring structures and are produced due to acoustic stimulation of basilar membrane leading to flow of potassium ions through hair cells
- These potentials, cochlear microphonic (CM_1) and CM_2, can be recorded by placing an electrode in the scala media and another in the scala tympani
- These potentials are highly resistant to drugs, anesthesia, cold and fatigue and can even be recorded in recently died animal.

Summating Potential

- There are two negative and positive potentials due to acoustic stimulation of inner and outer hair cells
- Are recorded due to changes in endolymphatic potentials.

Endolymphatic Potentials

1. Endolymphatic potentials originate in the scala media (endolymph), where there is steady +80 mV potential.
2. Depends upon oxygen supply.
3. The potential increases, when basilar membrane moves towards scala tympani due to inward movement of stapes.

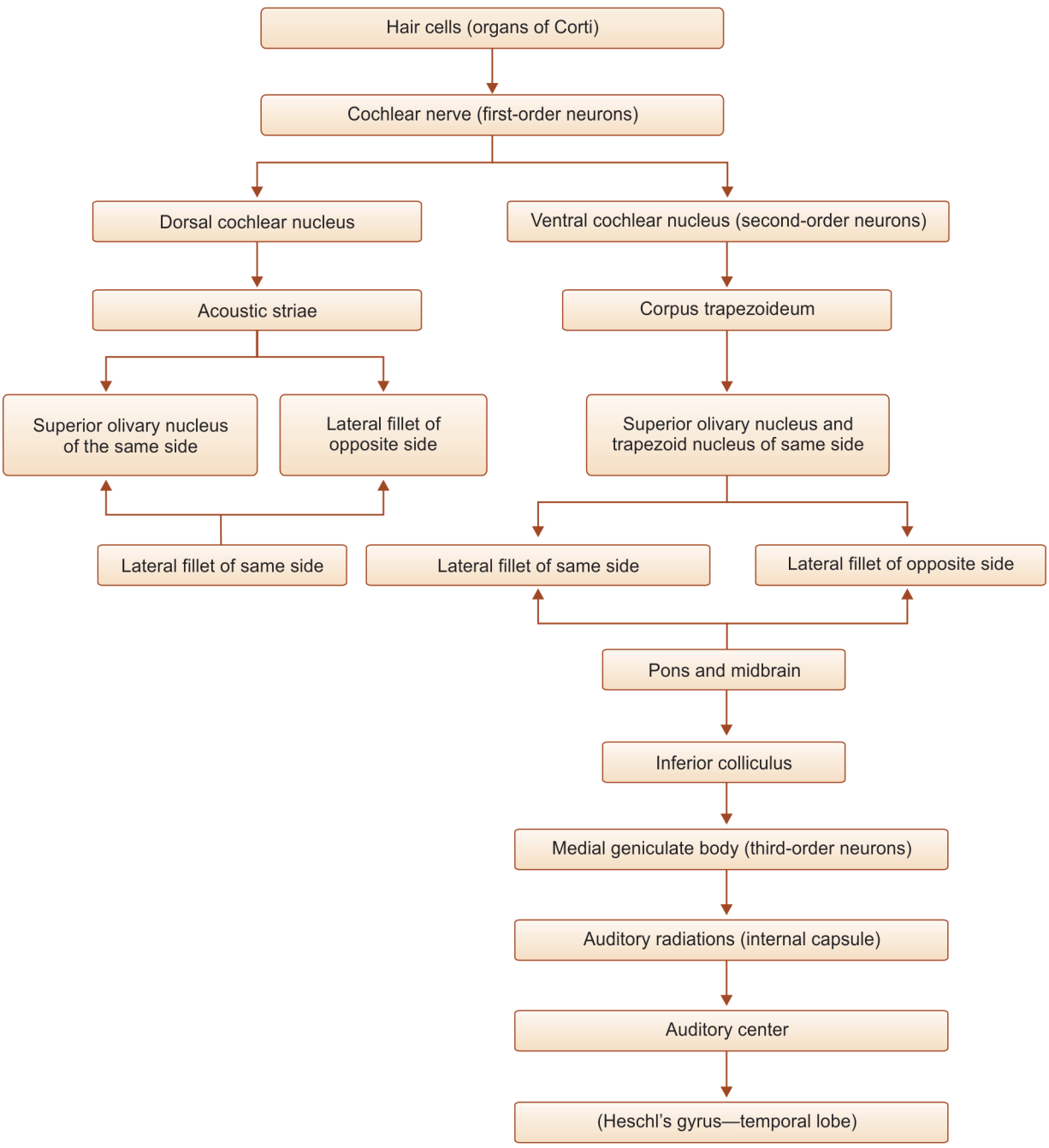
Cortilymph Potential

Cortilymph potential is recorded in the organ of Corti, where a potential of –20 mV to –80 mV is recorded.

Action Potential

- Tasaki recorded action potentials of auditory nerve fibers proportionate to the loudness of sound stimuli
- Auditory nerve has 25,000 fibers subserving 17,000 hair cells (**Flowchart 2.1**).

Flowchart 2.1: Pathways of auditory impulses



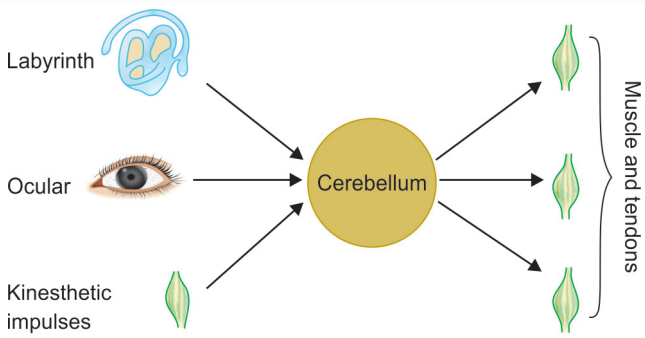


Figure 2.3 Physiology of equilibrium

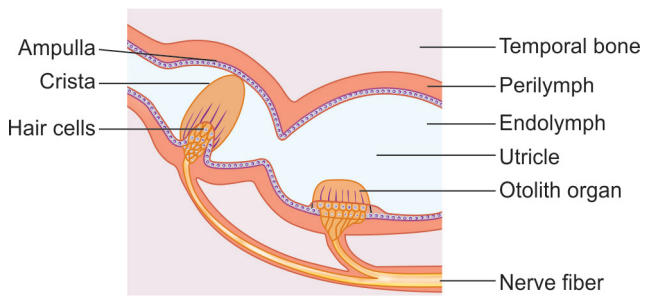


Figure 2.4 Structure of ampullary end of semicircular duct

PHYSIOLOGY OF EQUILIBRIUM

Equilibrium of body is maintained by coordination of reflexes from

- Vestibular apparatus (also called gyroscope of head)
- Eyes
- Proprioceptive reflexes from skin, muscles, joints and tendons (**Figure 2.3**).
  - Maculae (otolithic organ) of utricle saccule and cristae in the ampullae of three semicircular (SC) ducts are the sensory organs concerned with the equilibrium of body
  - The discharge rate of impulses from nerve endings, which supply the maculae changes with the gravitational pull on otolith organs. Remember, linear acceleration (gravity) stimulates the maculae, while angular acceleration (rotation) stimulates the cristae in SC ducts.
  - It is due to lagging behind of perilymph and endolymph thereby deflecting the cupula and stimulating the hair cells (**Figure 2.4**).

Functions of Vestibular Apparatus

- Vestibular apparatus helps in the maintenance of the muscle tone, posture and equilibrium
- It also maintains the erect position of head to that of trunk and limbs.
- Sends impulses to cortex, giving information about the position and rotation of head through otolithic organs.

How These Functions are Performed?

Cristae ampullaris

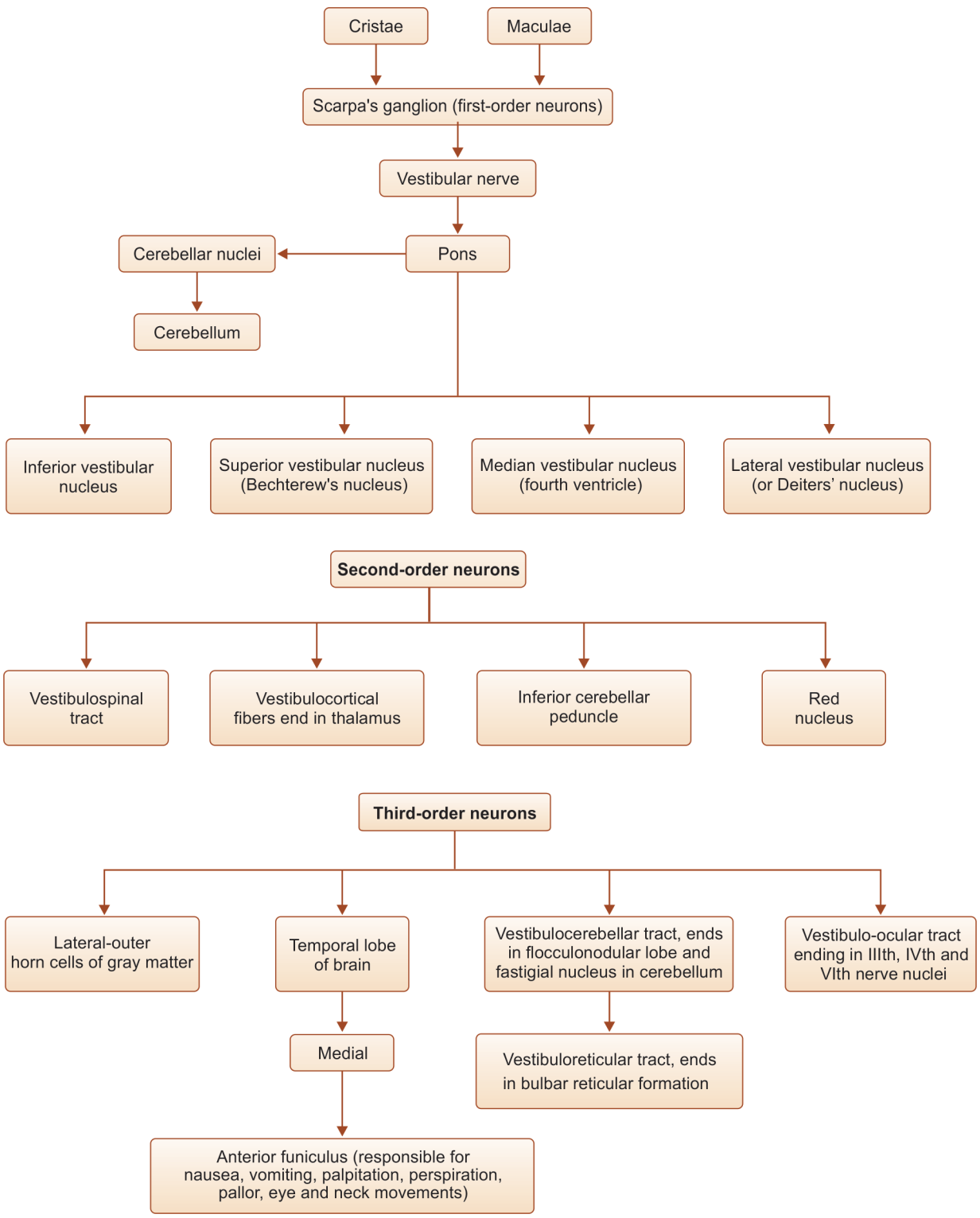
1. It is a ridge of neuroepithelium, which has type I (flask shaped) and type II (cylindrical) cells.
2. When movements of endolymph occur towards kinocilium, the discharge increases, while it occurs towards stereocilia, the discharge decreases. That is, normally the ear of one side tends to push in the opposite direction.
3. Because of this, sensory nerve endings are stimulated and send impulses upwards to the brain giving information about the movements of head.
4. If the person is rotated to the left, both his/her eyes move slowly to the right due to vestibular activity and this is further followed by quick movement of eyes to the left due to central correcting mechanism.
5. During rest with normal vestibular apparatus, the eyes remain in the center due to cancellation effect of right and left vestibular apparatus.
6. Now, if left vestibular apparatus is destroyed, the normal tone exerted by right vestibular apparatus pushes the eyes to the left side. This is corrected to the central position with a quick movement and nystagmus to right side appears.
7. Thus, semicircular canals give information about the direction, degree and plane of movements of head. These canals are stimulated by angular acceleration, which can be given by Barany's chair or by caloric test.

Coriolis effect is the specific type of angular acceleration that causes motion sickness in spacecraft due to rotation of earth.

Otolithic Organs of Maculae and Saccule

1. They act as stretch receptors and gravity acts as the stimulus.
2. Macular epithelium resembles that of cristae with additional feature of presence of otoconia or calcareous granules embedded in otolithic membrane.
3. When otolith rests on the hair cells, the stimulation is minimal; while these hang down vertically, exert a pulling action on hair cells, thus producing maximal stimulation.
4. These organs give information about the static position of head and not of movements.
5. Saccule gives information about the position of head in a lateral plane, while utricle in anteroposterior plane (**Flowchart 2.2**).

Flowchart 2.2 Pathways of vestibular impulses



Key Points

1. **Decibel (1/10 of a Bel)** is a log of the ratio of intensity of that sound and standard sound.
2. **Pressure exerted at oval window** is
   Hydraulic ratio —14 times × 1.3, i.e. lever ratio—(Length of handle of malleus versus length of long process of incus) = 18.3 times (Middle ear transformer mechanism) and total gain is 28 dB under ideal conditions.
3. It is because of **electrical potentials** that acoustic impulses are transmitted as neural impulses.
4. **Macula of utricle and saccule** and cristae in ampullae of semicircular canals (SCCs) are concerned with equilibrium of the body.
5. **Linear acceleration** (gravity) stimulates maculae, while angular acceleration (rotation) stimulates cristae.
6. **Ewald's law states** that the slow component of nystagmus is always toward flow of endolymph.
7. **Cone of light** is seen in the anteroinferior quadrant of the TM, because it lies at right angle to the meatus and hence, the light is reflected back.
8. **Ampullopetal flow of fluid** causes stimulation of horizontal semicircular canal (HSCC), while ampullofugal flow stimulates superior and posterior SCC.
9. **Utricle and saccule** (otolithic organs) responds to head movement's, i.e. linear acceleration and gravity.
10. **Semicircular canal** responds to rotatory movements, i.e. angular movements.
11. **Horizontal semicircular canal** may be made vertical by bending head 30 degree forward from supine position.
12. **Tympanic membrane** and ossicles efficiently transmit sounds of frequency between 500 to 3000 Hz because of key point 13.
13. **Natural resonance of middle ear** is 800 Hz and of external ear is 3,000 Hz.
14. **Movements of tympanic membrane** are more at the periphery than at the center.
15. **Axis of ossicular rotation passes** between anterior process of malleus to short process of incus.
16. **Frenzel maneuver** is used to open eustachian tube by contracting muscles of floor of mouth, pharynx, while nose, mouth and glottis are closed.
17. **External ear** gives a gain of 20 dB at 2,500 cps.
18. **In intact drum with ossicular interruption** ossicular coupling is lost and in such cases, sound input to cochlea occurs due to acoustic coupling which is 60 dB less than ossicular coupling.
19. **Identical perforations** in both tympanic membranes can have different hearing loss in both ears due to middle ear space volume difference
20. **Conductive hearing loss** in secretory otitis media is due to loss of ossicular coupling.
21. **Volume of middle ear space** is important in hearing levels and less than 0.4 cc is critical.

Chapter 3 History Taking and Physical Examination of Ear

What Students Must Know!

- **History Taking of Ear patient**
  - Chief Complaints
  - Common Causes of Ear Complaints
  - Method of Local Examination of Ear
  - Important Points for Examination of the Ear
- **Retraction of TM**
  - Classification of Retracted TM
  - Investigations in an ENT Case
  - Common Causes of Otalgia

INTRODUCTION

- Remember, the patient is the central axis around which all our research revolves
- A good and concise history taking is important as 80 percent of diagnosis is based on it
- A good taken history makes diagnosis of disease often easy.

HISTORY TAKING OF EAR PATIENT

1. History taking of an ear patient is like history taking in any other discipline of medicine. The scheme is similar and includes the following points such as
   - Chief complaints with duration
   - History of present illness
   - Past history
   - Personal history
   - Family history.
2. General physical examination includes lymph nodes of neck.
   - Cardiovascular system (CVS)
   - Central nervous system (CNS) with cranial nerves (VIIth and VIIIth)
   - Examination of respiratory system.
3. Local examination of ear, nose and throat.

Chief Complaints

Always begin by asking the patient—what has brought you here?

All complaints should be mentioned in chronological order, i.e. the older complaint, first.

Main chief complaints of ear disease are as follows:

Discharge from Ear

Enquire whether discharge is continuous or intermittent, serous, mucopurulent, purulent, blood stained, foul smelling or any aggravating factors and effects of treatment taken for the discharge.

Types of ear discharge and its cause:

Discharge from external auditory meatus

- Scanty and watery—Otitis externa (OE)
- Brownish—Liquefied wax
- Blackish—Otomycosis
- Watery and clear—cerebrospinal fluid (CSF) leak.
- Blood stained—Malignant OE, trauma, external auditory canal (EAC) tumor, acute suppurative otitis media (ASOM)

Discharge from middle ear

- Serous discharge—nonsuppurative otitis media.
- Mucoidal discharge—secretory otitis media, chronic suppurative otitis media (CSOM) (without active infection)
- Mucopurulent—suppurative otitis media
- Purulent foul smelling—atticoantral or unsafe ear
- Blood stained—atticoantral or unsafe ear
- Pulsatile discharge—ASOM with pinhole perforation or coexisting vascular tumor.

Hearing Loss

Onset and duration, progress, whether mild, moderate or severe in degree, autophony, fluctuating. Any aggravation/relief because of drugs, trauma including noise trauma, viral fever or discharge.

Vertigo

Onset, frequency and duration of attack, nausea, vomiting, effect of posture, history of trauma, drug usage, feeling of rotation (seen in true vertigo) or incoordination of movements.

Noises in the Ear

Character, unilateral or bilateral, continuous or intermittent, high pitched or low pitched, any relation with trauma, drugs or tensions.

Earache

Unilateral or bilateral, duration, aggravating factors, history of trauma, any orodental problem, severity, character or distribution of pain.

Otalgia

- Referred pain may be due to many causes such as diseases of teeth, oral cavity, tympanic membrane (TM) Joint, nose, paranasal sinus (PNS) and nasopharynx (through Vth nerve)
- Herpes zoster oticus (VIIth nerve)
- Tonsils, oropharynx (IX nerve)
- Larynx, pyriform sinus and cricopharynx (Vagus nerve)
- Cervical spondylosis (through C2 and C3 nerves).

Common causes of otalgia

- Dental causes
- Quinsy
- TM joint arthritis
- After tonsillectomy operation
- Malignancy of oral cavity, oropharynx, pyriform sinus and larynx.

Diplacusis

When the same tone is heard as notes of different pitch in either ear. It is a feature of Ménière's disease or after stapedectomy.

Other Symptoms of Complications

Headache, fever, facial deformity or swelling behind the ear or aphasia.

METHOD OF LOCAL EXAMINATION OF EAR

Important Points for Examination of the Ear

- Look for any previous injury or operative scars/sinus
- Examine the pinna and outer meatus by head mirror
- Remove any wax or debris by syringing or by a cotton tipped probe
- Pull the pinna gently backward and upward (downward and backward in infants) to straighten out the S-shaped meatus
- Insert the otoscope gently into the meatus holding it like a pen
- Inspect the external canal for any abnormal finding like sagging
- Inspect all parts of the TM by varying the angle of the speculum
- Do not stop until you have seen the membrane completely.
- The normal appearance of the membrane varies and can only be learnt by repeated practice in Outpatient Department (OPD).

Examination of Ear

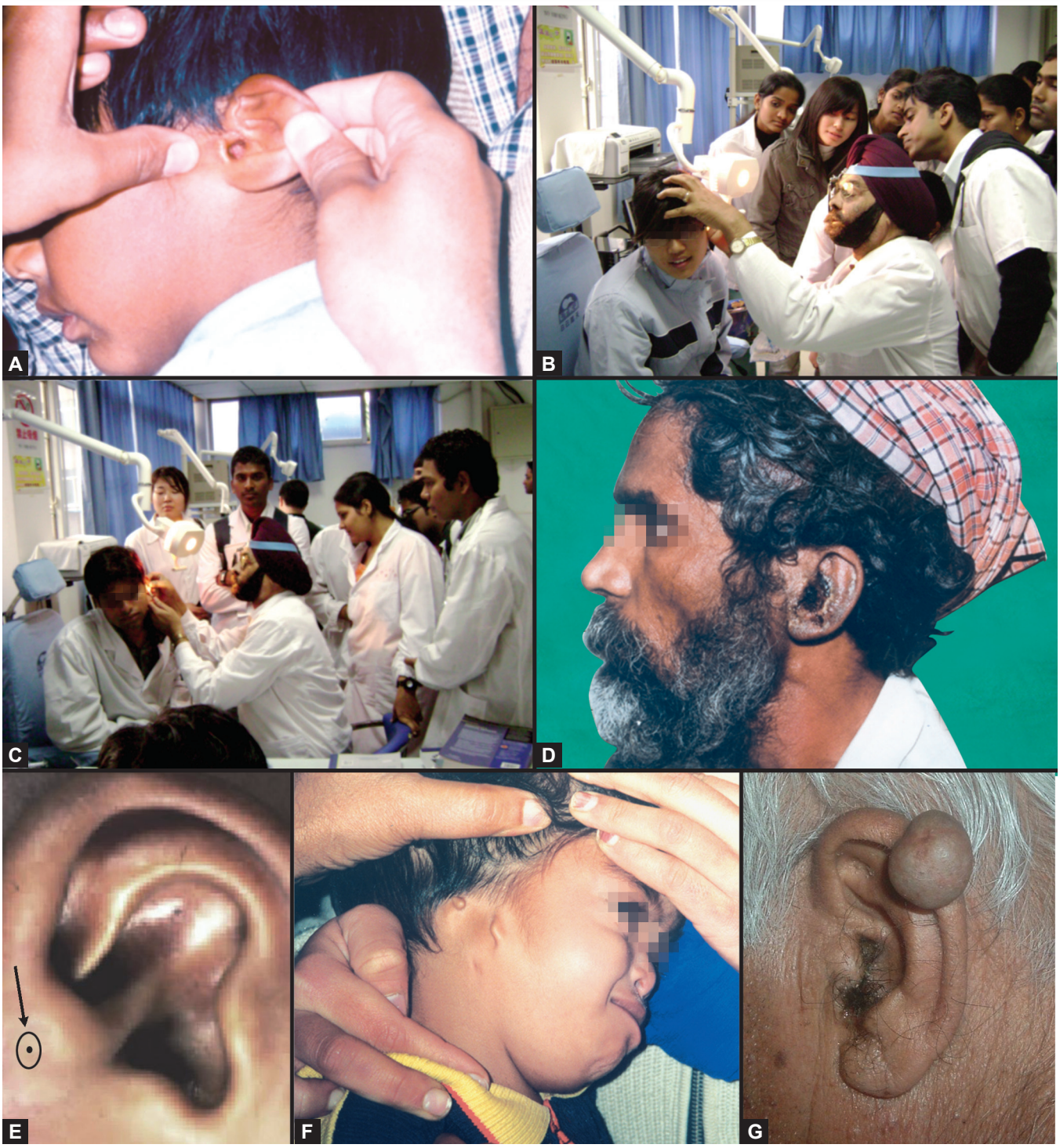
- ***Pinna:*** On inspection and palpation, the pinna is examined for any deformity, scar mark (of any previous surgery for preauricular sinus, Lemperts endaural incision), sinus opening, swelling, tenderness, painful movement, tragus sign and circumduction sign (**Figures 3.1A to G**).
- ***Preauricular and postauricular region:*** Look for any swelling, sinus, fistula, scar mark (postaural Wilde's incision), tenderness or edema.
- ***External auditory meatus:*** It is examined for any wax, fungus, foreign body, debris, discharge, polyp and swelling and most importantly for sagging of posterosuperior wall of meatus.

  Sagging of posterosuperior meatal wall indicates periostitis due to cholesteatoma in the mastoid antrum.
- ***Tympanic membrane:*** It is pearly gray in color and all the standard landmarks on it have to be identified such as Handle of malleus (HOM), short process of malleus, anterior and posterior malleolar folds, umbo and cone of light (**Figure 3.2A**).

  Cone of light is seen in anteroinferior quadrant of TM, which lies at right angle to beam of light.

  Examination of ear can also be done with the help of oto-endoscopes (**Figures 3.2B and C**) with the advantage of being quick and the findings can be recorded.

Then describe any perforation by starting with the following points (**Figures 3.3A to D**):



Figures 3.1A to G (A to C) Examination of ear without speculum; (D) vesicular eruptions pinna and meatus; (E) preauricular sinus; (F) malformation of pinna; (G) keloid on the pinna

Figure 3.2A Examination of ear with speculum

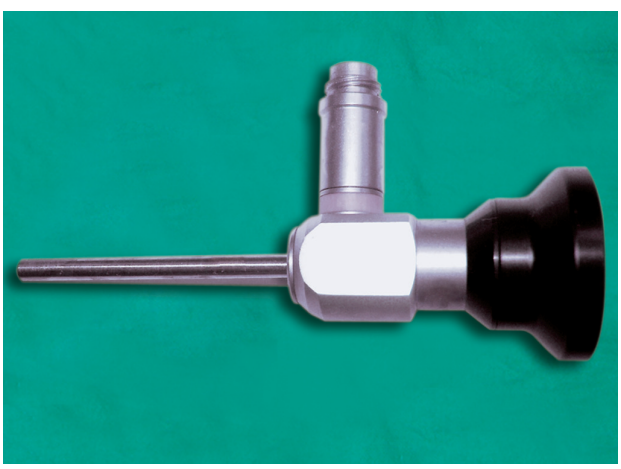


Figure 3.2B Otoendoscope

- Site, size and shape of perforation
- Dry/wet, single or multiple
- Margins of perforation (edematous indicates active infection, stellate means traumatic)
- A minute perforation of TM looks like a black spot as the middle ear is not lit up through it
  - Condition of rest of the tympanic membrane for the presence of any retraction, bulge, congestion or tympanosclerotic patches
  - Granulation tissue, cholesteatoma flakes or polypi
  - Condition of middle ear mucosa, ossicles, promontory, eustachian tube opening and round window niche if seen through a large perforation
  - Mobility with Siegel's speculum in **Figure 3.4** (in case of large perforation, there is no mobility of tympanic Membrane)
  - In case of polyp, a probe test is done with a cotton-tipped probe to see, pain, peduncle, blood staining (seen in infected polyp or granulations), facial twitching (if arises from facial nerve) and vertigo (if arises close to stapes).
- ***Tuning fork tests:*** Rinne's test, Weber's test and absolute bone conduction (ABC) test must be done.
- ***Examination of eustachian tube patency:*** Besides a bedside test of putting some dye or ear drops, such as Chloromycetin in the ear and feeling its bitter taste in the mouth in case of a perforation.

Other tests are:

1. Valsalva maneuver.
2. Eustachian tube catheterization.
3. ***Toynbee maneuver:*** During otoscopy, patient is asked to swallow with closed nose and mouth, thus creating negative pressure causing retraction of TM if the tube is patent.
4. ***Politzer's method:*** Politzer's bag with nozzle (**Figure 3.5**) is inserted into one nostril and both nostrils are compressed.

Figure 3.2C Examination of ear with otoendoscopes

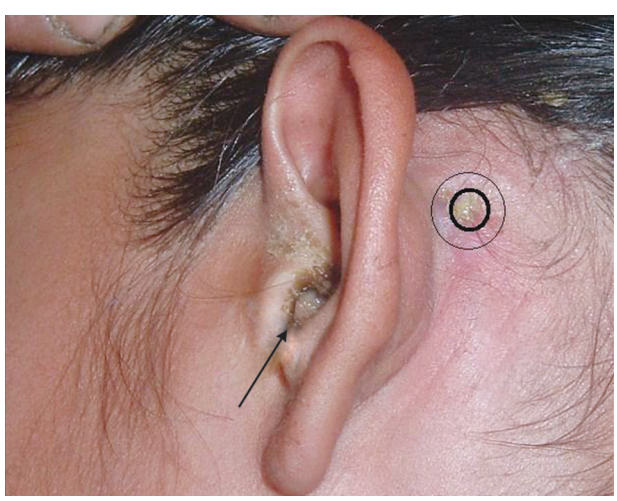


Figure 3.3A A post-aural fistula

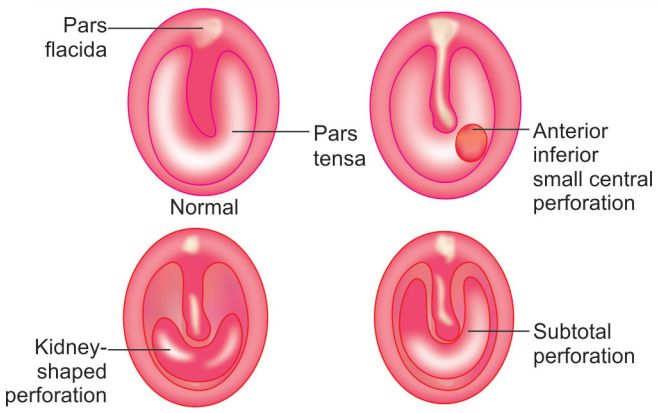


Figure 3.3B Different sites and types of central perforations

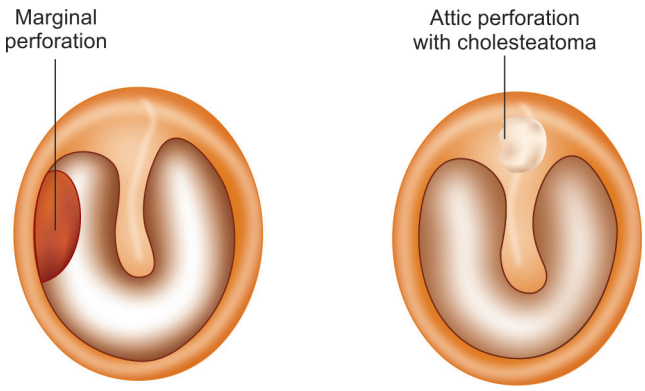


Figure 3.3C Different types of unsafe perforations: (i) marginal (ii) attic perforation

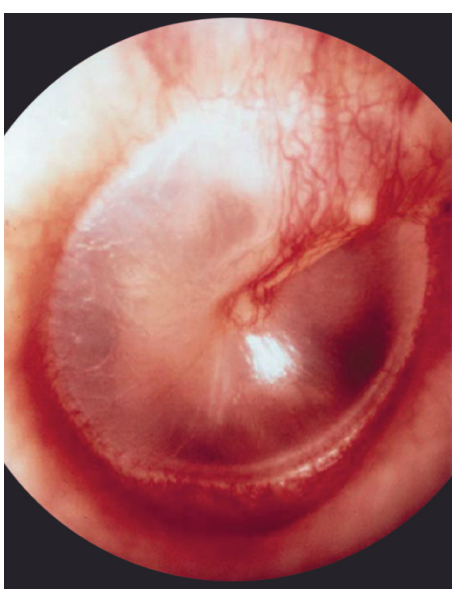


Figure 3.3D Acute suppurative otitis media

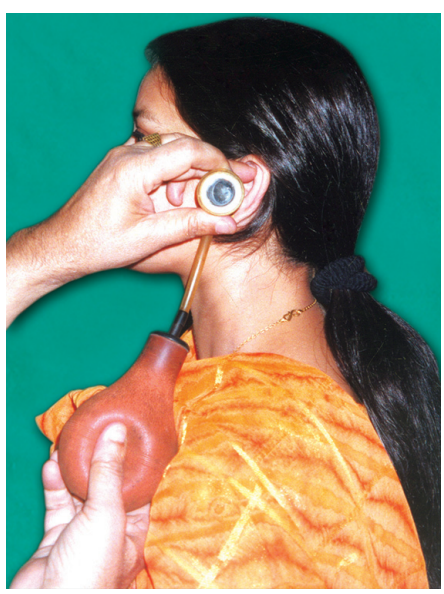


Figure 3.4 Examination of ear with Siegel's speculum

The patient takes a sip of water in his mouth and is asked to swallow. As he swallows, the bag is pressed and air enters the middle ear with a feeling of propping up sensation. Other methods to test patency of eustachian tube are

a. Siegalization.
b. By injecting radiopaque dye and X-rays.
c. Eustachian tube endoscopy.
d. Sonotubometery.
e. Frenzei maneuver in which after closing mouth and nose, patient moves his tongue up the palate. One can hear the click and movements of TM can be appreciated, if eustachian tube is patent.
f. Impedance audiometry.
g. Computerized tomography (CT) scan.
h. Magnetic resonance imaging (MRI).

- ***Examination of facial nerve:*** If it is involved, describe the various effects on face, such as wrinkling of forehead, closure of eyes, creases on the nose, deviation of angle of mouth, blowing or whistling from the mouth and watering from eyes and taste sensation of anterior two-third of the tongue.
- It is a good practice to tabulate the findings into right and left side. Describe the affected side first.

Figure 3.5 Politzer's bag

Retraction of tympanic membrane

Retraction of TM is indicated by:
- Absent cone of light
- Prominent anterior and posterior malleolar folds
- Handle of malleus is foreshortened and rotated and is drawn backwards, which in turn brings umbo in upper half of membrane, thus, displacing the light reflex
- Lateral process of malleus becomes prominent
- Mobility of TM is restricted.

Classification of Retracted Tympanic Membrane

- Stage I—Retraction present, but TM not in contact with incus
- Stage II—TM in contact with long process of incus
- Stage III—TM in contact with promontory, but still mobile on siegalization
- Stage IV—TM adherent with promontory (Adhesive otitis media)

INVESTIGATIONS

1. Blood for hemoglobin (Hb), blood transfusion (BT), and clotting time (CT).
2. Urine for sugar, albumin and pus cells.
3. Culture and sensitivity of ear discharge.
4. Pure tone audiometry (PTA). Impedance/BERA.
5. Radiological assessment:
   - X-ray paranasal sinus (PNS) occipitomental view
   - X-ray both mastoids lateral oblique view
   - CT scan in case of suspected complications.

X-ray PNS: To rule out any causative factor for chronic suppurative otitis media (CSOM) (safe or unsafe type).

X-ray both mastoids: It is taken to
- Compare the cellularity pattern of diseased and undiseased mastoid with each other
- It also indicates any sclerosis, cavitations, erosion and position of sigmoid sinus and dura mater for keeping in mind while doing surgical exploration.

CT scan: Done only if we suspect any complications of CSOM, such as sinus thrombosis, brain abscess, facial nerve involvement and also to see condition of ossicles, etc. which will be clearly demonstrated on CT scan.

Key Points

1. **Blood-stained discharge** may be due to granulations, polypoidal masses, macerations during cleaning, in malignancy or in malignant otitis externa.
2. **Foul-smelling discharge** is due to saprophytic bacteria and osteitis caused by cholesteatoma, indicating unsafe pathology. Other causes of foul smelling discharge are granulomatous conditions, myiasis, foreign body and malignancy with secondary infection.
3. **Constant pain, swelling, vertigo and facial nerve palsy** always point towards complications following atticoantral pathology.
4. Remember, there is no perforation in secretory or adhesive otitis media. Perforation indicates CSOM.
5. **X-ray both mastoids** (lateral oblique view) is done in CSOM to see and compare cellularity pattern of both mastoids. It also gives information about the presence of sclerosis, cavitations, erosion of bone and position of sigmoid sinus and dura, which are important during mastoid exploration.
6. **CT scan** is important in cases with complications following CSOM. It tells us about the extent of cholesteatoma, bony erosion, condition of ossicles, facial nerve, sigmoid sinus and dura.
7. **Cone of** light is seen in anteroinferior quadrant of TM because of concavity of TM and reflection back of light**.**
8. **Most important feature of retracted TM** is absent cone of light and HOM is drawn backwards assuming a horizontal position and prominent lateral process of malleus and malleolar folds
9. **Bed side test for testing patency of eustachian tube** is by putting Chloromycetin ear drops and feeling its bitter taste (in perforation cases only).
10. **Sagging** of posterior bony meatal wall of meatus is pathognomic of cholesteatoma or acute mastoiditis.

Chapter 4

Functional Assessment of Hearing and Vestibular Function Tests

What Students Must Know!

- **Tuning Fork Tests**
  - Rinne's Test
  - Weber's Test
  - Absolute Bone Conduction Test
  - Gelle's Test
- **Special Tests of Hearing**
  - Pure Tone Audiometry
  - Speech Audiometry
  - ABLB Test of Fowler for Recruitment
  - Impedance Audiometry
  - Evoked Response Audiometry
  - Otoacoustic Emission
- **Vestibular Function Tests**
  - Caloric Test
  - Electronystagmography
- **Fistula Test**

TESTS OF HEARING

It is important to measure the degree, type of hearing loss, site of hearing loss and its impact on speech development and rehabilitation. The tests of hearing should preferably be done in a sound-proof room.

VARIOUS TESTS

Finger Friction and Watch Tests

These are simple tests used for rough screening of deafness, but these tests are not standardized.

Whisper and Conversation Tests

- The drawback with this test is lack of standardization.
- Whisper is given with the residual air after full expiration. Normally, a whisper should be heard up to 12 feet and the conversational voice up to 20 to 40 feet.
- *Whispered voice heard at 2 feet:* Patient is likely to have normal hearing.
- *Whispered voice heard at 6 feet or conversation heard at 2 feet:* The loss is likely 30 to 70 dB.
- *Loud conversation heard at 2 feet:* The loss is more than 70 dB.

Tuning Fork Tests

Tuning fork was invented by John Shore in 1711.

- These tests are qualitative tests as these indicate the type of hearing loss.
- Tuning forks emit pure tones and allow comparison of air conduction with bone conduction.
- Tests are done with various tuning forks, but 512 Hz is the most commonly used as its rate of tone decay is not rapid and sound is quite distinct from ambient noise. Higher frequencies decay faster and with lower frequencies, patient perceives the vibrations more than the sound.
- The tuning fork should be held firmly by the stem and struck lightly against resilient surface such as elbow, heel of the hand or the 'padded' edge of a table.
- Forceful striking should be avoided as it produces overtones.
- Air conduction (AC) is tested by placing the tuning fork 1/2 to 1 inch in front of and parallel to the external acoustic meatus. It indicates the integrity of tympano-ossicular chain. **AC is better termed as Ossicular conduction**.
- **Bone conduction (BC)** is tested by placing the base of tuning fork on mastoid bone or on the forehead.
  a. BC signifies sound conduction through cochlea, auditory nerve and its central connections and hence provides information about the integrity of inner ear.

b. Sound through BC is transmitted by vibration of skull bones or through one is own voice

- Two different types of vibration occur, i.e.
  a. *Inertial type* (below 800) when skull vibrates as one unit and lagging behind of ossicles, mandible and cochlear fluid occurs due to inertia.
  b. *Compression type* (for frequency above 800) in this the vibrations act on the fluids of inner ear and cause its movements.

VARIOUS TUNING FORK TESTS

Rinne's Test (Sir Adolf Rinne, 1853)

Rinne's test tells about middle ear function and not about cochlear function.

Procedure

In this test, AC is compared with BC of the patient (**Figures 4.1A and B**).

- Tuning fork is struck and placed on the mastoid process.
- When the patient stops hearing, move it in front of external auditory meatus, vertically, in line with the external auditory canal (EAC). Do not dangle the tuning fork. Ask the patient if he/she still hears and then reverse the process.
- Another method is to place the tuning fork alternately on the mastoid and in front of the EAC and ask which sound is heard louder (Modified Rinne).
- The object of the test is to find out whether the patient hears longer or better by air or bone conduction.
- Rinne test will be negative in conductive deafness of more than 15 to 20 dB. (**Figures 4.2A to C**).
- Interpretation is as follows:
  - Normally, AC is 2 times better than BC **(+ve Rinne)**.
  - Conductive deafness, AC lesser than BC **(–ve Rinne)**.
  - Sensorineural (SN) deafness, AC greater than BC [but, duration is reduced] (**low +ve Rinne)**.
  d. Severe unilateral SN deafness, BC greater than AC [due to transcranial transmission of sounds to the normal ear. [**Figure 4.3**] **(false –ve Rinne).**
  e. Rinne equivocal when AC and BC are equal and it signifies mild conductive hearing loss.

By using different frequencies of tuning forks a rough estimate of hearing loss can be made.

- Rinne's test is negative with 256 Hz, but positive with 512 Hz indicates air bone gap of 20 to 30 dB.
- Similarly Rinne's test is negative with 512 HZ, but positive with 1,024 Hz, the loss will be 30 to 45 dB.

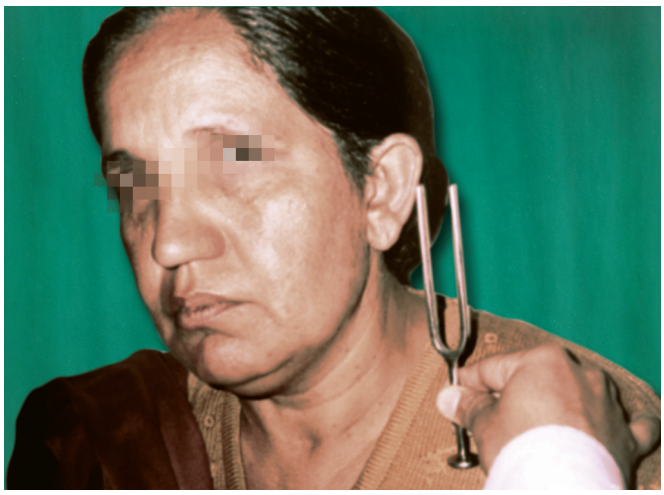


Figure 4.1A Rinne's tuning fork test—air conduction

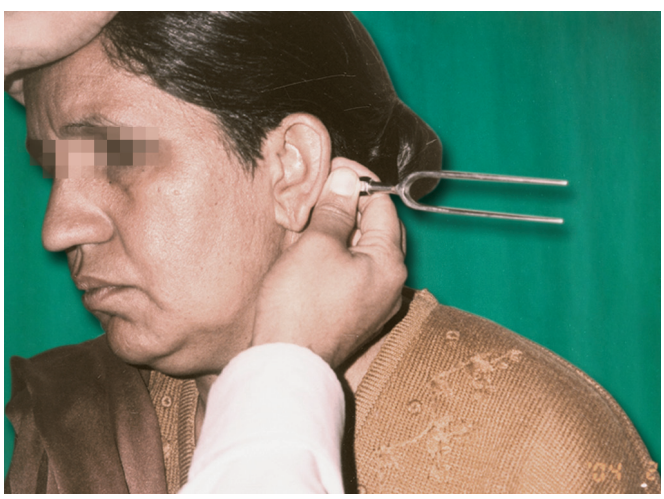


Figure 4.1B Rinne's tuning fork test—bone conduction

Weber's Test

Procedure

- In this test, the BC of both the ears in the same subject are compared with one another. The vibrating tuning fork is placed in the middle of forehead (or even on chin or upper incisor teeth) and the patient is asked about the lateralization of sound to left or right ear or in which ear the sound is heard better (**Figure 4.4**).
- It is a very sensitive test and even less than 5 dB difference in 2 ears hearing level will be indicated by this test.

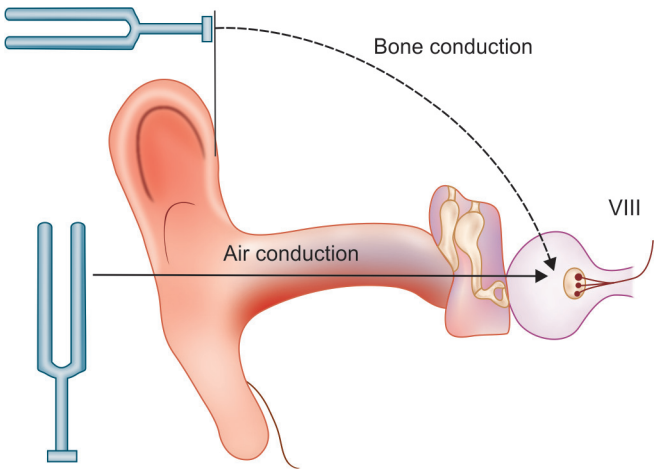


Figure 4.2A Rinne's test in a normal person

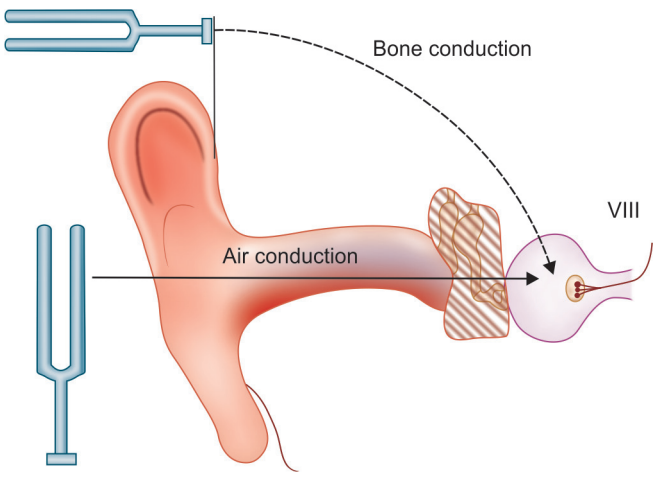


Figure 4.2B Rinne's test with conductive hearing loss

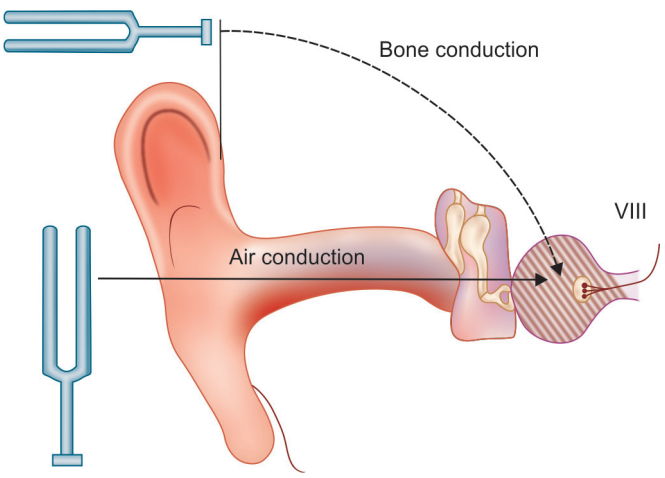


Figure 4.2C Rinne's test with perceptive hearing loss

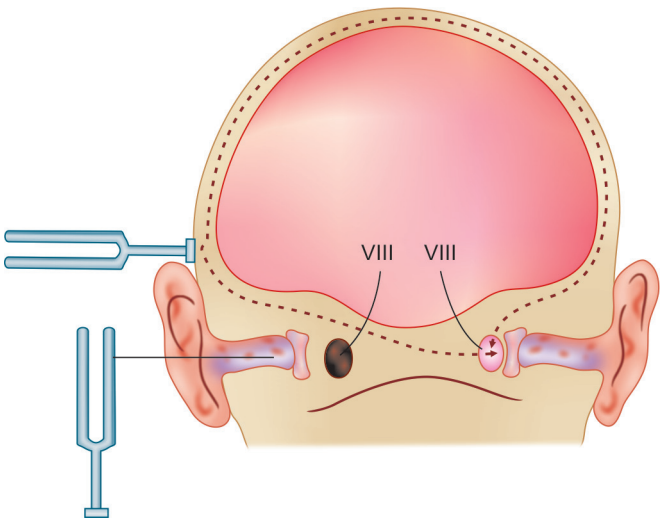


Figure 4.3 Rinne's test showing false negative Rinne

Interpretation

- In conductive deafness, the sound is lateralized to deaf ear and in bilateral conductive loss to the deafer ear or it is centrally heard if both ears are equally deaf. It is because ambient noise does not disturb the diseased ear as much as the normal ear.
- In sensorineural hearing loss (SNHL), sound is lateralized to better hearing ear or is heard centrally if both ears are equally bad.
- In normal ear, no lateralization of sound occurs.
- When we get a false -ve Rinne, then Weber's test is done. If lateralization occurs to the healthy side, it indicates severe SNHL.

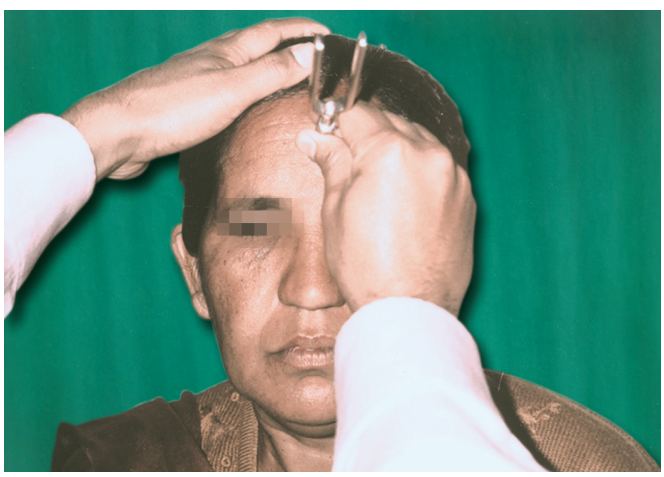


Figure 4.4 Weber's test

Schwabach's Test

Bone conduction of the patient and examiner is compared, but the meatus is not occluded.

Remember

- Schwabach's is shortened in SNHL.
- Schwabach's is lengthened in conductive hearing loss.

Absolute Bone Conduction Test

Procedure

Absolute bone conduction (ABC) is a modified version of Schwabach's test which is not used these days. In this test, BC of the patient is tested after occluding the external auditory meatus (thus making the test absolute) and then compared with the BC of the examiner provided the patient has a normal hearing.

Conclusion

- If both the patient and examiner hear equally, ABC normal, seen in either normal or conductive deafness.
- If patient ceases to hear before examiner ABC is reduced, seen in SNHL.

Gelle's Test

- This test is done to confirm the presence of otospongiosis.
- In this test, BC is tested and at the same time Siegle's speculum is used to compress the air in the external auditory meatus. This increases the pressure in the middle ear and so restricts the movements of ossicles, causing reduced hearing.
- If hearing is reduced on increasing the air pressure in the meatus, it is normal.
- In stapes fixation, or ossicular discontinuity bone conduction sound is not affected (Gelle's negative).
- In normal persons and in patients having SNHL Gelle's test is positive.

Bing Test

In this test, tuning fork is struck and placed on the mastoid, while the examiner closes and opens the ear canal by pressing the tragus. A person with SNHL or having normal hearing will hear louder when meatus is occluded (Bing positive). Patient with conductive hearing loss will appreciate no change on occlusion of meatus (Bing negative).

Other Tuning Fork Tests

- Stenger's test
- Teel's test
- Lombard's test.

These tests are done for those patients who feign deafness, but actually are normal subjects.

SPECIAL TESTS OF HEARING

- Subjective where response depends upon the patients such as pure tone and speech audiometry.
- Objective where response is automatically recorded such as impedance and BERA.

Pure Tone Audiometry

Advantages

1. Pure tone audiometry is a reliable method of testing the hearing acuity and gives information about the quantity and quality of hearing loss (**Figure 4.5**).
2. In some cases, pattern of curve points towards a disease such as otospongiosis, acoustic trauma, Ménière's disease and presbycusis.
3. Test record is good for future reference.
4. To know the degree of hearing handicap and for prescribing a hearing aid.
5. Also helps to find out speech reception threshold.

Procedure

- In this test, pure tones are given at various frequencies by increasing the intensity at 5 dB steps; and when the patient just hears the sound, it is recorded.

Figure 4.5 Photograph, while performing audiometry

- Hearing threshold at both air and bone are tested at different frequencies and a graph called audiogram is plotted (**Figures 4.6A to D**)
- Frequencies between 500 Hz and 3,000 Hz are important as these are the speech frequencies.
- Average hearing threshold at 500, 1,000 and 2,000 Hz is called Fletcher index.

Signs used are:

O AC right ear	X AC left ear
Δ AC masked	□ AC masked
< BC right ear	> BC left ear

Conclusion

- In normal persons, normal hearing threshold values with air and bone remain between 0 and 10 dB (graph A).
- Conductive deafness is shown by bone-air gap of more than 15 dB, which means a patient can hear by bone testing under 10 to 20 dB; while with air testing, hearing is usually much below level depending upon the severity (graph B).
- Type of audiograms in conductive hearing loss
  - Left sloping—loss in lower frequencies is seen in otospongiosis.
  - Right sloping—loss of higher frequencies and is a feature of secretory otitis media.
  - A large air bone gap indicates ossicular chain disruption.
- Bone dip at 2 kHz is seen in otospongiosis in some cases (33%) called 'Carhart's notch' and it may be because the middle ear contribution to BC is reduced by the mass of focus on the footplate.
- Masking of the non-testing ear with Barany's noise box (90 dB) or by rubbing a paper is must, in case difference of both ears is significant.
- In SNHL, both bone and air conduction values drop down and may even overlap each other (graph C). BC greater than 20 dB and air bone gap is greater than 15 dB.
  - **Ascending type** of audiogram is seen in endolymphatic hydrops.
  - **Descending type** in ototoxicity.
  - **Trough shape** is a feature of congenital SNHL.
- *Mixed deafness:* If these both values drop, but air-bone gap still persists, it may be indicative of mixed hearing loss (graph D) for example BC greater than 20 dB and air bone gap is greater than 15 dB.
- In acoustic trauma, there is a sudden dip at 4,000 Hz both in air and bone values.
- In normal persons, hearing threshold values both with bone and air remain between 0 and 10 dB.
- Percentage of hearing impairment as recommended by Department of Personnel, Government of India.
  a. Category I 26 to 40 dB (average hearing threshold), mild hearing loss.
  b. Category II 41 to 55 dB, moderate hearing loss.

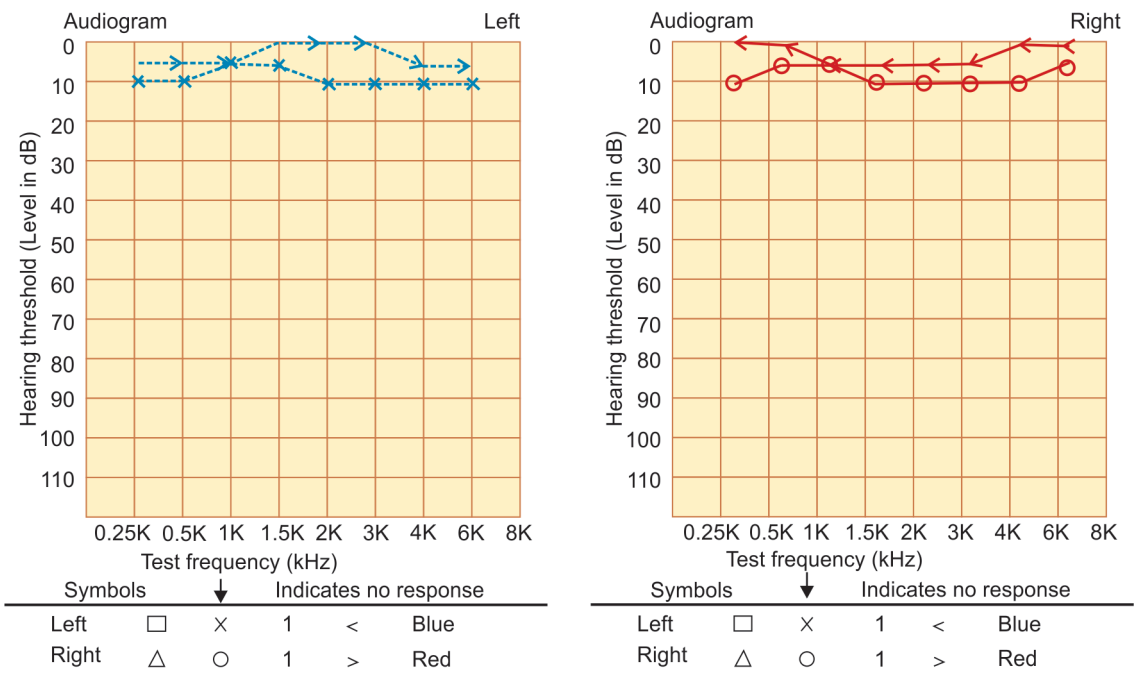


Figure 4.6A Normal audiogram

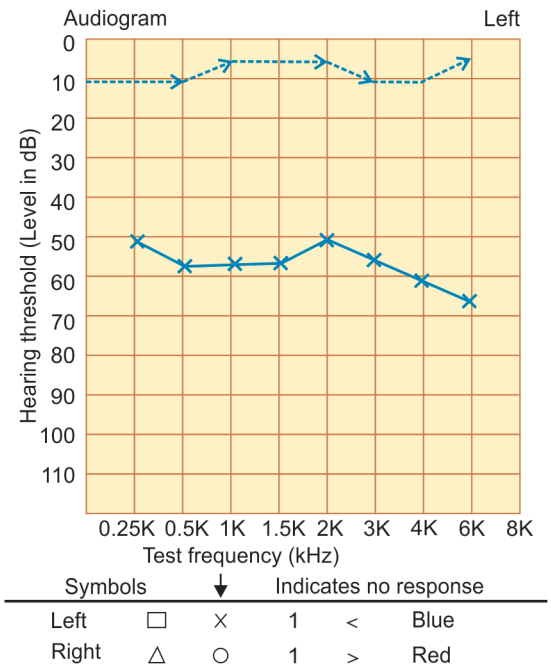


Figure 4.6B Audiogram showing conductive hearing loss

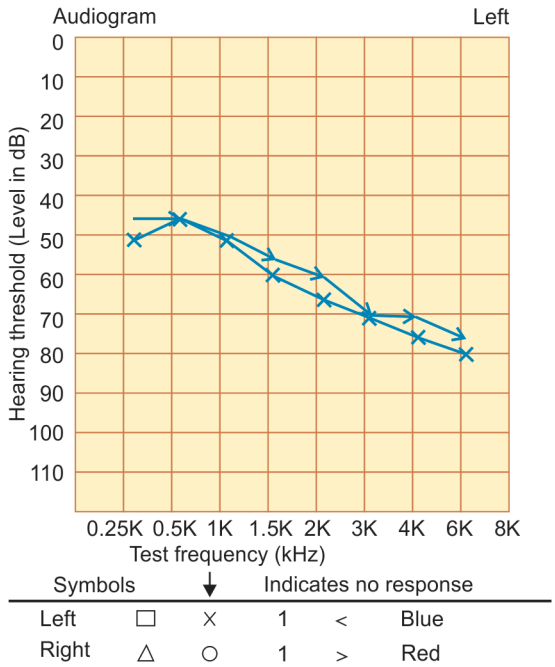


Figure 4.6C Audiogram showing sensorineural hearing loss

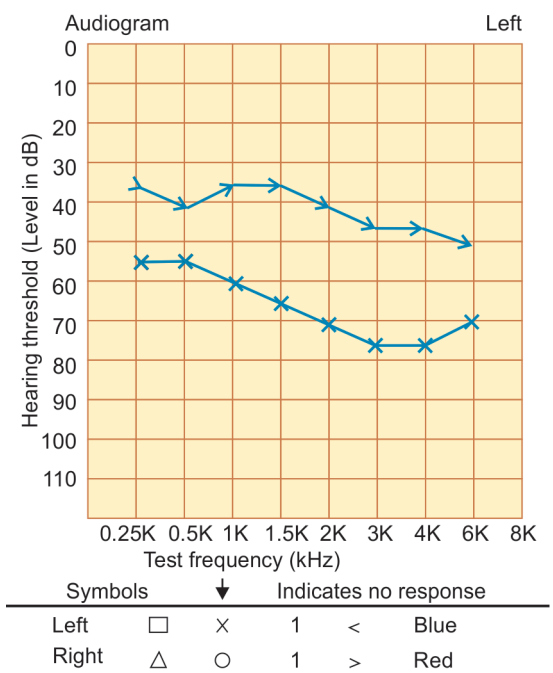


Figure 4.6D Audiogram showing mixed hearing loss

c. Category III 56 to 70 dB, severe hearing loss.
d. Category IV 71 to 90 dB, profound hearing loss.
e. Above 91 dB, near total hearing loss.
f. No hearing, total loss.

Speech Audiometry

- In this audiometry, recorded spondee words are presented to the ear at various sound pressures
- The patient is asked to write the words and which are then cross checked with the list.

Advantages

- D/D of organic and functional hearing loss
- D/D of cochlear and retrocochlear hearing loss
- Helps in fitting of proper hearing aid.

Speech Reception Threshold

Speech reception threshold (SRT) of a person is the minimum intensity level (in dB) at which 50 percent of the spondee words can be repeated correctly.

- Spondee words are 2 syllable words such as black night, football, daydream, sunlight or 5 × 2. Generally, SRT is ± 10 dB of average of 3 speech frequencies.

Speech Discrimination Score or Optimum Discrimination Score

Speech discrimination score (SDS) or optimum discrimination score (ODS) is the maximum percentage of correct score when phonetically balanced (single syllable) words such as pin, day, bus, fun and rum are used.

Results

a. In normal subjects or conductive hearing loss (HL), SDS is 95 to 100%.
b. In cochlear lesion, SDS is low.
c. In retrocochlear lesions, SDS is very poor and '**roll over phenomenon**' is present (which means with an increase of intensity, a drop of score occurs).

As poor discrimination score of less than 80 percent affects the ability to understand speech, hence this test is useful to find out if hearing aid will be useful or not.

Bekesy's Audiometry

Bekesy's audiometry is a device in which the patient himself/herself presses or releases the button depending upon hearing or ceasing to hear pulsed or continuous tone. It is not used these days.

Various types of graphs are recorded (**Figures 4.7A to D**).

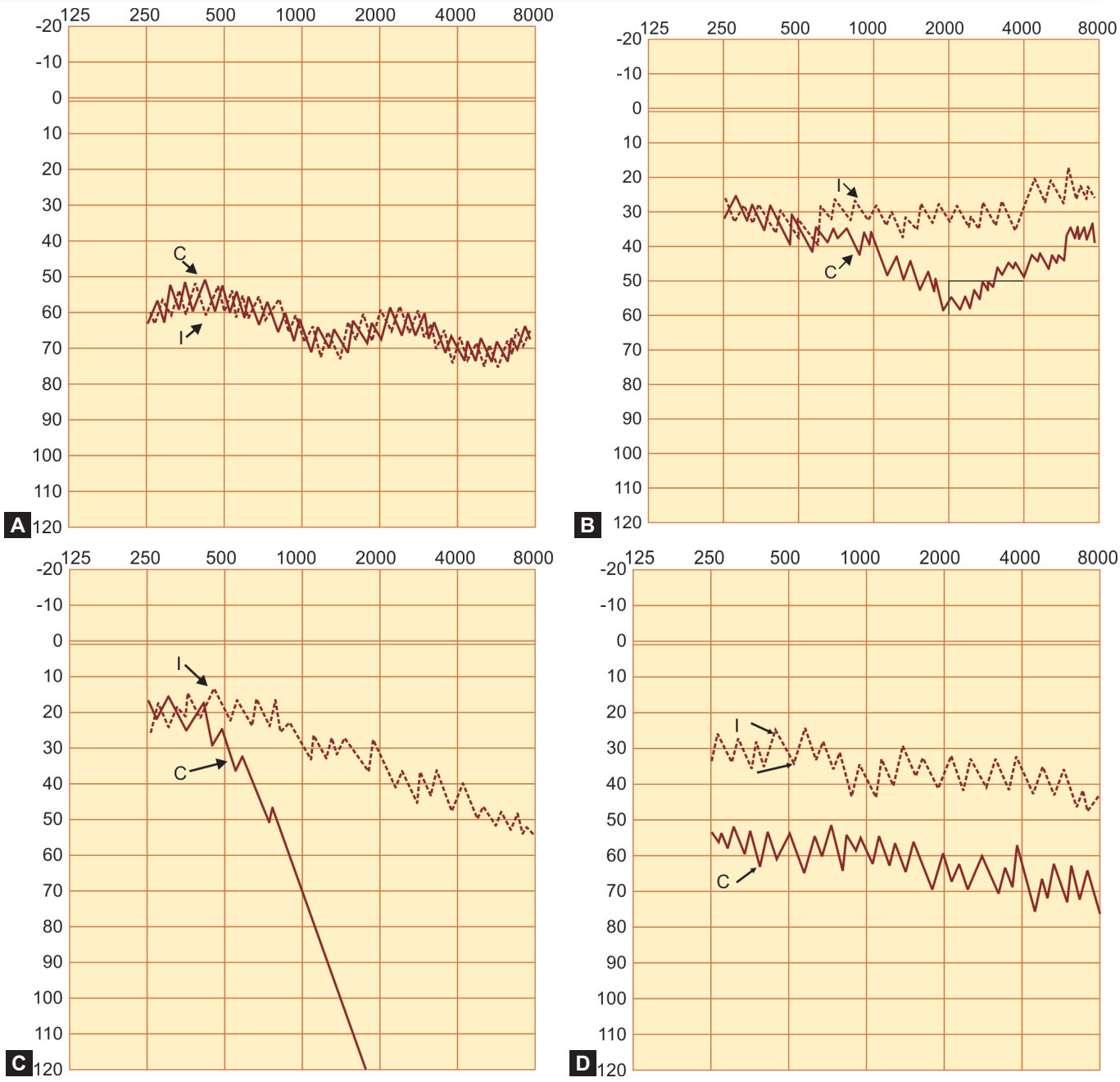
- Type I is seen in normal persons, both C and I tracings overlap in all frequencies
- Type II is seen in cochlear lesions, I and C tracings overlap up to 1,000 Hz after which C tracings drop down by about 15 to 20 dB
- Type III is seen in retrocochlear lesions, C tracings drop by more than 20 dB
- In type IV, the two tracings never overlap and C tracings are weak
- Type V is seen in malingerers, two tracings are widely separated from each other and C tracings are better than I tracings.

Tests for Recruitment

- **Recruitment** is an abnormally rapid increase in loudness with increasing sound intensity. Ear which does not hear low intensity sounds will hear greater intensity sounds as loud or even louder than normal ear.
- Although there are many hypotheses explaining the cause of recruitment, the most recent development says, that there are active and passive processes of hearing in the inner ear.
  The active process contributes to excitation of cochlea at low thresholds and passive process at high thresholds. It is the impairment of active process, which results in recruitment.
- This phenomenon of recruitment is seen in cochlear type of SNHL, i.e. Meniere's disease and presbycusis.
- In normal and conductive hearing loss, the test is negative.
- **Derecruitment** denotes an abnormal slow growth of loudness and is indicative of retrocochlear lesion.
- Various tests for recruitment are:
  - ABLB test.
  - SISI test.
  - Monaural loudness balance test.
  - Differential limen test.

ABLB Test of Fowler for Recruitment

- Test of Fowler for recruitment is also called alternate binaural loudness balance (ABLB) test (**Figure 4.8**)
- In this test, a tone is played alternatively into normal and deaf ear, the intensity is gradually increased in the affected ear until the sound is heard equally in both ears
- In positive recruitment, ladder pattern becomes horizontal at higher intensity
- Acoustic reflex is not present in
  - Ossicular discontinuity
  - Retrocochlear lesion
  - Severe cochlear lesion
  - Late stapedial fixation.



Figures 4.7A to D Various tracings in Bekesy's audiometry. (A) Type I tracing seen in normal persons; (B) Type II tracing seen in cochlear lesions; (C) Type III tracing seen in retrocochlear lesions; (D) Type IV tracing seen in acoustic nerve lesions. C means continuous pulse and I means intermittent

Short Increment Sensitivity Index Test

- In short increment sensitivity index (SISI) test, the ability to recognize short increase of 1 dB every 5 second is recorded at 20 dB above threshold levels
- A 20 dB such increments of 1 dB each are given and the number of times the increment is recognized correctly is noted and it is multiplied by 5 to get the percent
- Test is good for differentiating a cochlear and a retrocochlear lesion

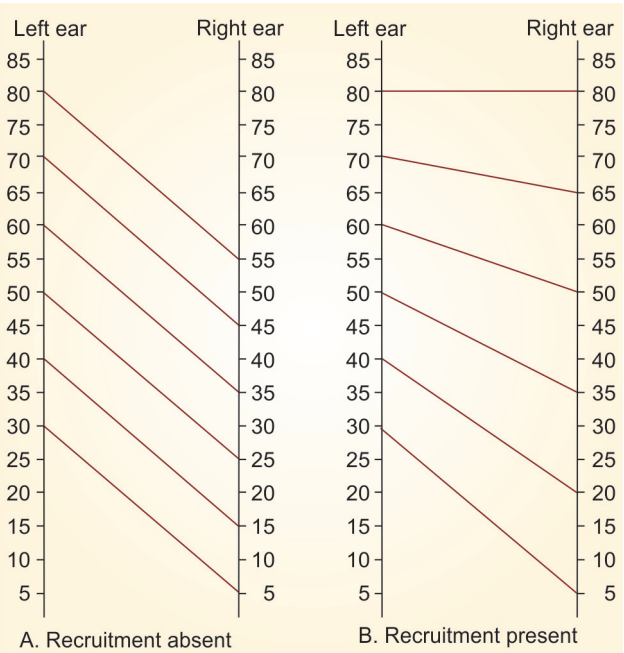


Figure 4.8 Alternate binaural loudness balance test (Fowler's)

- A score above 60 percent (70–100%) indicates cochlear lesion and is termed as positive SISI
- A score of 15 percent is seen in retrocochlear or conductive hearing loss.

Carhart's Tone Decay Test (Nerve Fatigue Test)

- It is the measure of rapidity of deterioration in the threshold of hearing when a continuous sustained sound is presented to the ear.
- A continuous tone 5 dB above threshold in 4,000 Hz is given to the ear and the person should be able to hear it for 60 second, if he/she has a normal hearing. If he stops hearing earlier intensity is increased by 5 dB. The procedure is continued till the patient is able to hear the sound for full 60 seconds.
- Difference between the initial response and the final response is the 'tone decay'.
- The result is expressed as dB by which intensity has to be increased so that the patient can hear the sound for 60 second.
- If tone decay of more than 30 dB or more is seen, it points towards retrocochlear lesion, i.e. acoustic neuroma.
- **How is the test done?**
  - Patient is given a sound 25 dB above threshold and say he/she can hear it for 10 seconds only
  - Next sound given at 30 dB and now he/she hears it for 30 seconds
  - Next sound at 35 dB and hears it for 40 seconds
  - Last sound at 40 dB—hears it for 60 seconds
  - So initial sound is 25 dB and final sound is 40 dB. Difference comes to be 15 dB.

Interpretation of the Test

- Normal difference is 0 to 15 dB.
- Cochlear lesion 15 to 25 dB is seen.
- Retrocochlear lesions more than 30 dB is seen.

Impedance Audiometry

The test measures the impedance of middle ear system at the level of tympanic membrane due to changes in air pressure in external auditory meatus.

It consists of: Tympanometry and acoustic reflex audiometry.

Tympanometry

- Tympanometry is an objective audiometry and measures the impedance (means resistance) offered by the middle ear conducting apparatus such as tympanic membrane (TM) and ossicular chain and also the compliance (suppleness) to sound pressure transmission.
- It consists of the following (**Figures 4.9A and B**):
  - A probe fitted into external auditory meatus connected to an oscillator, which gives sound at 220 Hz
  - An air pressure pump, which is used to alter the pressure in the meatus
  - A microphone.
- Thus, we can measure the resistance of TM and middle ear and also compliance of TM and ossicular chain to sound pressure transmission.
- Tympanogram is the graphic representation of compliance and impedance of tympano-ossicular system with air pressure changes.

Six types of graphs are obtained (Figure 4.10):

- *Type A:* Normal graph with compliance of 1.6 cc
- *Type A_S:* In otosclerosis, compliance is less than normal (0.25 cc). It is also seen in fixed malleus syndrome, tympanosclerosis or tumors in middle ear.
- *Type B:* Flat or dome-shaped curve, no change in compliance with pressure changes. It is seen in secretory otitis media or thick TM, adhesive otitis media, grommets in ear or in TM perforation.
- *Type C:* Maximum compliance at negative pressure and is seen in eustachian tube dysfunction or retracted TM.
- *Type A_D:* There is increased compliance at normal pressure and is seen in ossicular chain disruption, lax TM or post-stapedectomy.
- *Type E:* A broad deep notch seen in partial or complete ossicular discontinuity.

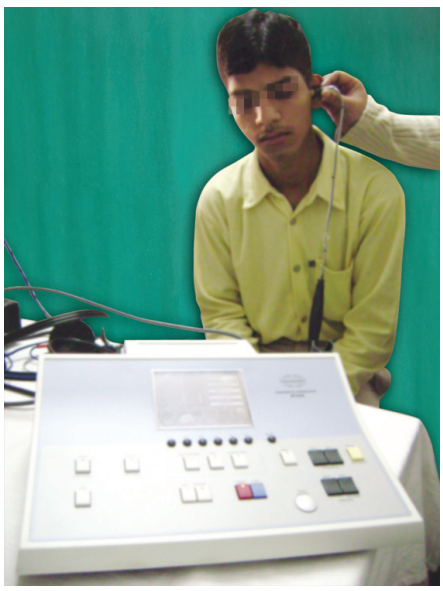


Figure 4.9A Impedance audiometer

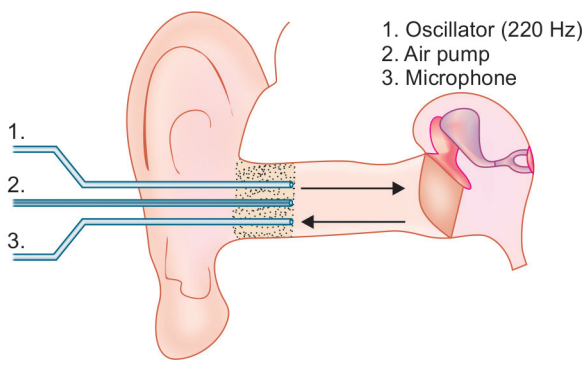


Figure 4.9B Principle of impedance audiometry

Advantages of Impedance Audiometry

1. Differential diagnosis of conductive and SNHL.
2. To find out the differential diagnosis of conductive hearing loss.
3. To know the site of lesion in facial nerve palsy.
4. To test hearing acuity in infants and children.
5. To find out malingers.
6. To find out lesions of brainstem.

Stapedial Reflex or Acoustic Reflex

- In impedance audiometry, if the other ear is presented with a sound of 80 to 90 dB above threshold level, an acoustic reflex due to stimulation of stapedius muscle can be elicited because contraction of stapedius muscle causes stiffness of ossicular chain
- The reflex is elicited due to integrity of VIIIth and VIIth nerve
- **Afferents pass through VIII nerve and efferents through VII.**

Stapedial reflex helps in:

- Estimation of hearing acuity
- Localization of lesion of VIIth nerve and progress of recovery
- Demonstration of recruitment if stapedial reflex is elicited at 40 dB or so instead of 70 dB
- Identifying malingerers
- Hearing acuity in infants and children.

Stapedial reflex is absent in:

- Moderate to severe conductive hearing loss, i.e. otosclerosis
- Ossicular chain discontinuity
- Atelectasis
- Severe SNHL such as acoustic neuroma
- Facial nerve palsy and Ramsay Hunt syndrome.

Evoked Response Audiometry

Evoked response audiometry is a recent development in which the diagnosis of cochlear and retrocochlear pathology can be made without the active cooperation of the patient since it is an objective test.

It, being a noninvasive test can be done in all age groups including infants, children and mentally challenged patients.

It is of following types:

1. **Brainstem evoked response audiometry (BERA) (Figure 4.11):** It records electrical responses originating from cochlear nuclei and its central connections in the brainstem. Five types of waves (I-V) are commonly recorded (**Figures 4.12A and B**).
   - Ist, IIIrd and Vth wave are prominent and important waves.
   - Remember, EECOLI for origin of waves;
     - Ist wave arises from eighth nerve (cochlear end)
     - IInd wave arises from eighth nerve (near brainstem)
     - IIIrd wave from cochlear nucleus
     - IVth wave from olivary nucleus
     - Vth wave from lateral lemniscus and
     - VIth and VIIth waves from inferior colliculus.
   - Advantages of BERA
     - To test hearing acuity in children
     - Diagnose cerebellopentine angle tumors
     - Identify malingerers.
   - It is important to record latency, interwave latency and amplitude of waves. Any alteration suggests pathology.
2. **Cortical evoked response audiometry (CERA):** It records electrical responses arising from cerebral cortex.
3. **Electrocochleography:** In this, we place the electrode on the promontory through TM and record cochlear,

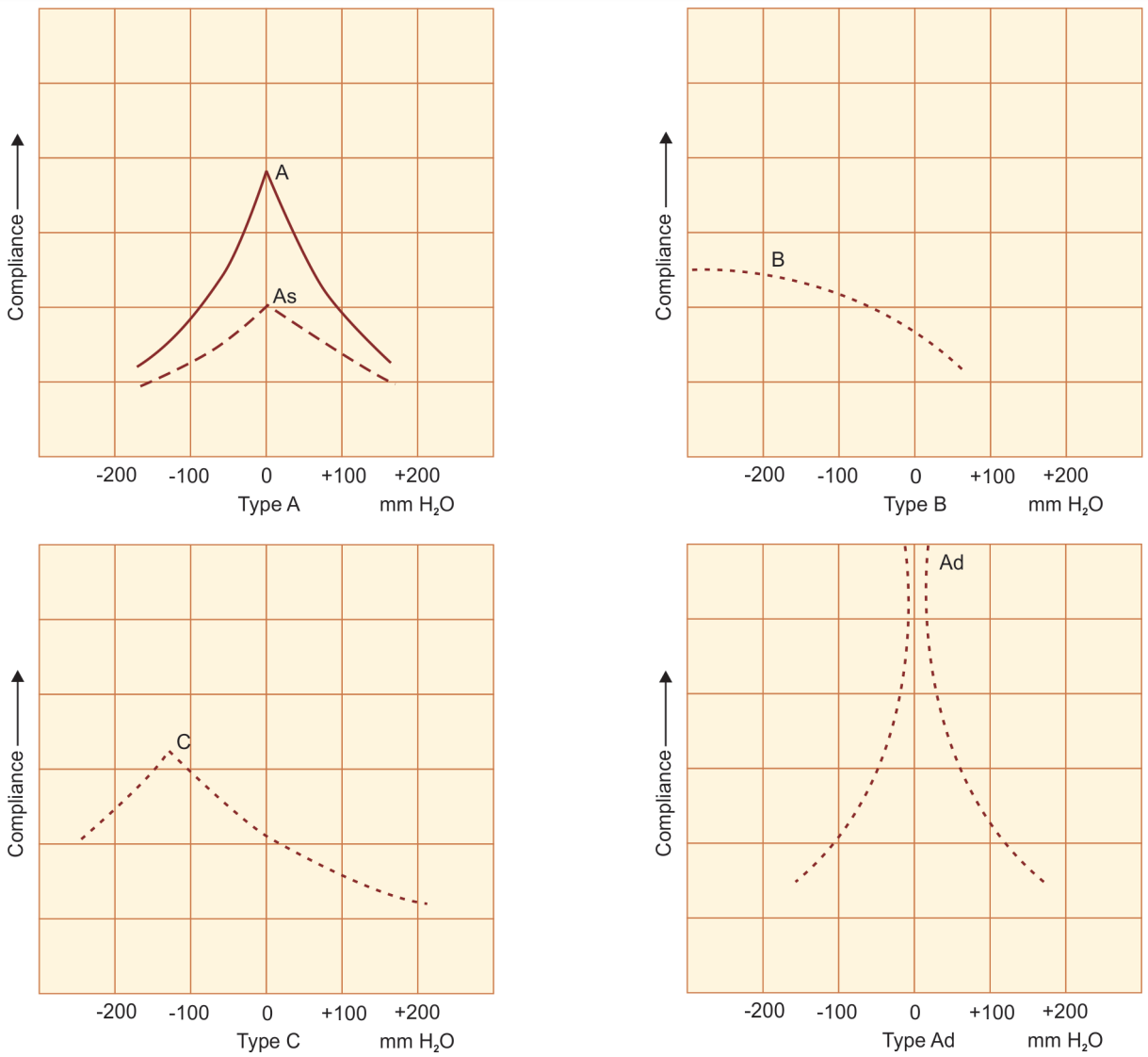


Figure 4.10 Tympanograms Type A: Normal As type is seen in otosclerosis; B: Flat or dome-shaped audiogram (middle ear fluid); C: Maximum compliance at -100 mm of H_2O (E tube dysfunction); Ad: Increased compliance at ambient pressure (ossicular disruption)

summating and action potentials of cochlea and its connections.

4. **Psychogalvanic skin response audiometry:** It is not used as it involves a skin prick and so is not popular.

Otoacoustic Emission

- Otoacoustic emission's (OAEs) were first described by David Kemp in 1978. Also called cochlear echoes or Kemp echoes.
- Otoacoustic emissions are low intensity sounds produced by the cochlea in response to an acoustic stimulus. In response to sound, the outer hair cells move, generating a mechanical energy inside the cochlea that is propagated out via the middle ear conducting apparatus to the external auditory canal, generating a signal.
- Vibrations of outer hair cells can be detected in external auditory meatus by using a microphone and computerized techniques. The measurement indicates objective measurement of cochlear function.
- These are not seen in patients having hearing loss of more than 40 to 55 dB.

Figure 4.11 Photograph while performing brainstem evoked response audiometry

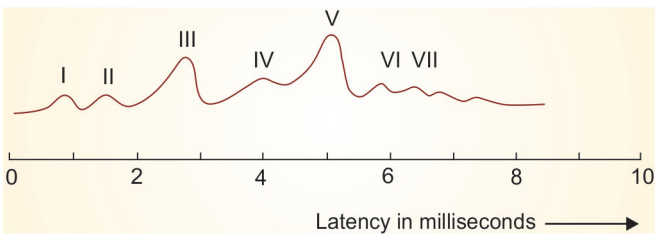


Figure 4.12A Various waves seen in brainstem evoked response audiometry

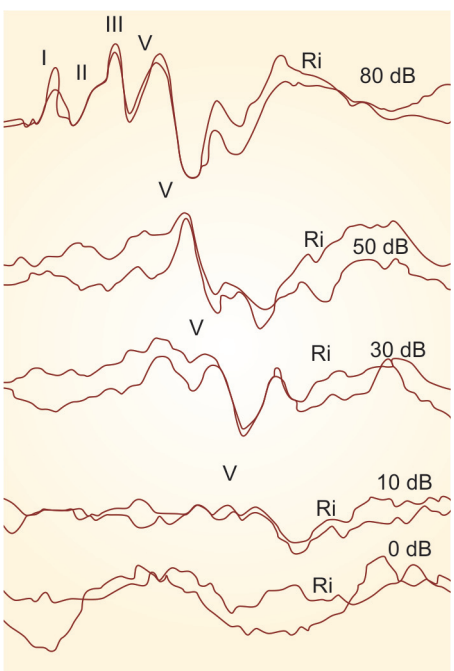


Figure 4.12B Normal auditory brainstem response

Types of OAE

1. Spontaneous OAEs—arise from outer hair cells, inhibited by ototoxic drugs.
2. Stimulus frequency OAEs—technically difficult to record.
3. Transient evoked OAEs—elicited in response to transient clicks.
4. Distortion product OAEs—in response to simultaneous tones.

Uses of OAE

1. These are very useful in **'screening of neonates and high risk infants'** for hearing loss.
2. Diagnosing central processing auditory disorders, particularly auditory neuropathy.
3. Differentiate cochlear from retrocochlear pathology.
4. Detect early changes in ototoxicity and noise induced hearing loss.
5. To monitor Ménière's disease.
6. Malingerers.
7. Provides objective confirmation of cochlear dysfunction in tinnitus.

Advantages

- Noninvasive
- Objective, so more accurate
- Takes less than 3 minutes, time saving
- Needs no preparation.

Disadvantages

- Not very useful in mild hearing loss and central auditory pathology
- Cannot quantify hearing loss
- Not useful in serous otitis media.

VESTIBULAR FUNCTION TESTS

Derangement of vestibular system is indicated by vertigo and nystagmus, which is defined as involuntary, rhythmical, oscillatory movements of eyes away from the direction of gaze.

Nystagmus of vestibular origin has 2 components, i.e.

- Slow component and quick (fast/corrective) component and by convention, nystagmus is named after quick component
- Quick component of nystagmus is eliminated when the patient is put under anesthesia.

Degrees of Nystagmus

- First degree is a weak nystagmus and it is present when the patient looks in the direction of quick component.

- Second degree nystagmus appears when the patient is looking straight ahead.
- Third degree nystagmus (severe) appears when the patient is looking towards slow component.

Types of Nystagmus

Central

It is coarse, irregular and does not fatigue. It can be in any direction. Vertigo is usually not present. Symptoms and signs of intracranial disease are present.

Ocular

Ocular is of congenital type and is pendular. Paralysis of external rectus may simulate nystagmus.

Vestibular

Vestibular is rhythmic, has a slow and fast component, fatigues easily, vertigo is present, duration is of less than 1 minute and latency is 2 to 20 second. It can be spontaneous, positional or induced.

Spontaneous nystagmus
It is horizontal, rotatory or mixed type and does not last for more than 3 weeks and vertigo is also present.

Positional nystagmus
- It appears and reappears when the head is put in the same position
- Vertigo is not much and it may be because of vestibular or central causes
- A nystagmus, which is fatigable and short lasting is usually of peripheral origin and the one not fatigable and with changing direction is of central type.

Induced nystagmus
This type of nystagmus can be induced by rotation in a chair, thermal stimuli (caloric test) or by visual stimulation such as looking at a series of objects moving from one side to other.

VARIOUS TESTS

Galvanic Stimulation Test

- In this test, a person stands with arms outstretched and feet together
- Current of 1 mA is passed to one ear
- A normal person sways to the side of current passed
- This test helps to differentiate between end organ and vestibular nerve lesions.

Barany's Rotational Test

- Subject is rotated 10 times in 20 second and postrotatory nystagmus is measured.
- Main objection of this test is excessive stimulation, which may damage the cupula and, therefore, cupulometry has been designed.

Caloric Test

Fitzgerald and Hallpike Technique

Bithermal caloric test
- It tests the integrity of horizontal semicircular canal (HSCC).
- The patient lies in a supine position looking at the roof with head flexed 30° forwards to make the lateral SCC vertical. External canal of ear is irrigated with 30°C or 44°C (7° above and below normal body temperature) of 200 to 300 cc water for 40 seconds.
- In a healthy person, the patient has a feeling of vertigo and nystagmus appears. The response is measured in seconds between start of irrigation and cessation of nystagmus. About 5 minutes gap is given between cold and hot caloric test and the result is recorded in a calorigram (**Figure 4.13**).

The main advantage of caloric test is that each labyrinth can be tested separately.
- Frenzel's glasses (+20 D) are used to highlight the nystagmus
- Remember, COWS meaning cold to opposite and warm to the same side.

Interpretation of the test
Normal nystagmus lasts for 2 to 3 minutes and response of cold is to the opposite side and warm to the same side (COWS).

Canal paresis in this, the duration of nystagmus is reduced for both hot and cold like left hot and left cold (**Figure 4.13**) and is seen in peripheral vestibular lesions.

Directional preponderance: It is seen in both peripheral and central lesions, and in this, the response is greater in one direction both for hot and cold caloric testing (left hot and right cold).

Contraindications
- Perforation of TM
- Open mastoid cavity
- Severe vertigo.

Dundas Grant Method of Cold Air Caloric Test

If the drum is perforated or in mastoid operations or fenestration, normal caloric test cannot be done, hence, cold air jet is given by spraying ethyl chloride spray on the tube. If

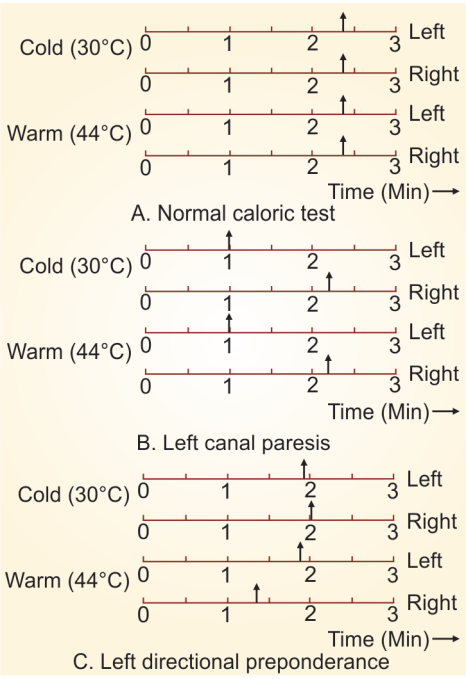


Figure 4.13 Calorigram

no nystagmus is seen in 30 to 60 second, it indicates inactive labyrinth.

Kobrak's Cold Caloric Test

Kobrak's cold caloric test is a rough office test in which 5 mL of ice cold water is put for 30 second in the ear canal.

If no response, 10 mL or 20 mL of water is irrigated. If there is still no response, the labyrinth is considered dead.

Fistula Test

- The test is done for detecting the presence of fistula in the bony walls of labyrinth, which may be caused by cholesteatoma, surgical like syphilitic osteitis, neoplasms, glomus tumor and barotraumas.
- In this test, air is compressed in external auditory canal by pressing the tragus or by a Siegle's speculum.
- This produces nystagmus to the diseased side due to stimulation of lateral SCC caused due to its erosion by some pathology (fistula test is positive).
- In reversed fistula sign the slow component of nystagmus is towards the diseased side and is seen in cases having undue mobility of stapes.
- Prerequisite for this test is a functional labyrinth.

Interpretation

- Positive fistula test indicates fistulous communication between middle ear and labyrinth.
- **False +ve** fistula test also called **Hennebert's sign** is a +ve fistula test without any fistula in the labyrinth. It is seen in late congenital syphilis and 20 percent patients of Meniere's disease and is considered to be due to adhesion between vestibule and stapes foot plate or abnormally mobile foot plate of stapes or erosion of bony labyrinth causing osteitis leading to formation of third window.
- Negative fistula test indicates either there is no fistula or if fistula is present, then the labyrinth is dead or fistula covered by granulation tissue or cholesteatoma (false -ve fistula).
- Fistula of HSCC produces a horizontal nystagmus, fistula of PSCC produces a vertical nystagmus and in a fistula of both horizontal and vertical canal, there is rotatory nystagmus.

Romberg's Test

The patient is made to stand erect with eyes closed and direction of falling or swaying is noted. In sharpened Romberg's test, heel is in front of toes and arms are on the chest.

In this test, with labyrinthine lesion, the patient tends to fall to the side of lesion (direction of slow component of nystagmus) and in central lesions, the swaying is symmetrical, not affected by closing of the eyes.

Unterberger's Test

The patient is asked to stand erect with his arms outstretched; the eyes closed and instructed to march on the spot. In the presence of a paralytic labyrinthine lesion, the patient will rotate to the side of the lesion.

Gait Test

The patient is asked to walk tandem in a straight line between two points and then quickly told to return on the same line. Patient with labyrinthine lesion will deviate to the side of lesion, while in cerebellar disease there will be marked imbalance.

Hallpike Maneuver Test

In this test, patient is sitting on a couch, examiner turns the head of patient to 45° right side and puts him in supine with head hanging 30° below horizontal. Nystagmus is seen. Test is repeated with head turned to left side and parameters of nystagmus are seen like duration, latency, direction and fatigability. In BPPV, the test is very useful and also helps to find out if the lesion is peripheral or central. In central lesions nystagmus is produced immediately without any latency period.

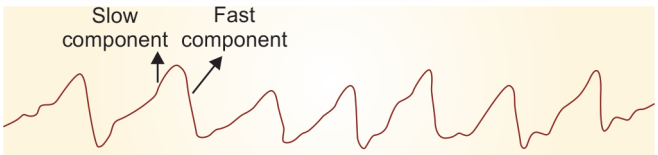


Figure 4.14 Electronystagmography

Electronystagmography

In electronystagmography (ENG) test, the eye movements are graphically recorded, after stimulating the vestibular system, by various techniques.

Electrode is placed on the outer canthus of one eye and other electrode on the frontal region. The potential difference is thus picked up between cornea and retina and the movements of eyes are recorded.

In ENG, irrigation is done for 30 second and eyes are closed or the room is darkened. The graph is recorded and steeper the angle of slow phase greater is the nystagmus (**Figure 4.14**).

ENG shows:

- Spontaneous nystagmus.
- Whether the lesion is central or peripheral. In central lesion nystagmus is irregular and is abolished by eyes closure. In peripheral lesions nystagmus is regular and not abolished by eyes closure (**Table 4.1**).
- It provides documentary evidence of nystagmus and also nystagmus of first degree is easily seen.

Drawback of ENG is that it tests only HSCC and results may fluctuate**.**

Optokinetic Nystagmus

In this test, black strips pasted on white drum are rotated in both directions and nystagmus is recorded. A central lesion will show an asymmetrical response.

Craniocorpography

Craniocorpography tests the spinovestibular system used for examination of children and group scrutiny. The patient is made to walk on a spot for 60 seconds with eyes closed and lateral balancing is recorded.

Table 4.1: Differential diagnosis of peripheral and central vertigo

	Peripheral lesion	*Central lesion*
1. Latency	2–20 seconds	No latency
2. Duration	Less than one minute	More than minute
3. Direction of nystagmus	Direction fixed towards the undermost ear and is regular	Direction changing and irregular
4. Fatigue	Present	Not fatigable
5. Vertigo	Severe degree	None or slight degree
6. Eyes closure	Not abolished by eyes closure	Abolished by eyes closure

Key Points

1. **512 Hz Tuning Fork** is preferred because it has longer tone decay and the sound is quite distinct from ambient noise.
2. **False –ve Rinne** is seen in unilateral severe sensorineural deafness and Weber's test decides the issue.
3. **Carhart's notch** seen as a dip in bone conduction at 2 kHz is due to mass effect of focus on foot plate of stapes thus reducing bone conduction.
4. **Normal speech reception threshold** is ± 10 dB of average of 3 speech frequencies while **SDS** (%) is 95 to 100 %.
5. **Recruitment** is seen in cochlear type of deafness such as Ménière's disease and presbycusis.
6. **In retrocochlear lesions** low SISI score (15%) and tone decay (positive) of more than 30 dB is seen.
7. **Stapedial reflex** is due to integrity of VIIIth nerve and VIIth nerve.
8. For origin of waves 1 to 5 in BERA remember **EECOLI**
9. **In caloric test—**lateral SCC is stimulated:
   - **Canal paresis** means reduced response both by hot and cold
   - **Directional preponderance**, in this the response is greater in one direction both for hot and cold (left hot and right cold).
10. **Hennebert's sign** indicates false +ve fistula test and is seen in late congenital syphilis due to abnormal mobility of foot plate of stapes.
11. **Poor speech discrimination score** and acoustic tone decay is suggestive of retrocochlear hearing loss.
12. **Superior canal** can be tested by rapid heads movements in the plane of superior SCC.
13. **Third mobile window** in ear is created in case of dehiscence of SCC causing **Tullio's phenomenon** like picture.
14. Caloric test was performed in 1906 by **Robert Barany and awarded Nobel Prize in 1914**.
15. **Fitzgerald and Hallpike** refined caloric test in 1942.
16. **Ipsilateral canal paresis** may be seen in acoustic neuroma.
17. Acoustic reflex decay test is positive in 8th nerve lesion.
18. In **Bing test** on occlusion of external auditory meatus there is a change in intensity of sound indicating SNHL.
19. In **acoustic reflex**, there is bilateral contraction of stapedius muscle, which occurs 70 to 80 dB above the threshold of hearing.
20. **Psychoacoustics** is a branch of psychophysics that studies the relationship between physical properties of a stimulus and the behavior response.
21. **Cookie bite curve** in audiometry is typical of cochlear otosclerosis, while dish pattern is seen in congenital hearing loss.

Chapter 5 Diseases of External Ear

What Students Must Know!

- **Congenital Conditions**
  - Preauricular Sinus
  - Treacher Collins Syndrome
- **Acquired Conditions**
  - Malignant Otitis Externa
  - Herpes Zoster Oticus
  - Otomycosis
- **Miscellaneous Conditions**
  - Wax Ear
  - Foreign Bodies of Ear
  - Keratosis Obturans
  - Primary Cholesteatoma of External Auditory Canal
  - Exostosis

CLASSIFICATION

Diseases of external ear may be classified as following.

Congenital Conditions

Congenital deformities occur because of genetic defect, from a virus or toxic effect of drugs during pregnancy. Since, the time of development of external, middle and inner ear vary, the deformities of one part may not be associated with congenital deformity of others.

Preauricular Sinus

1. These are blind tracks in front of ear lined by squamous epithelium.
2. Occur due to incomplete fusion of tubercles of 1st and 2nd branchial arch during development of external ear (**Figure 5.1**).
3. These cause symptoms only when infected, i.e. pain, increase in temperature, swelling and discharge.

Treatment
After treating the acute symptoms, the track is outlined by a dye and is excised, avoiding injury to facial nerve. The healing is by secondary intention and scar formation.

Congenital Swellings of Pinna

Dermoid, hemangiomas and lymphangiomas may occur in relation to pinna and treatment is by excision.

Collaural Fistula

Collaural fistula is an anomaly of first branchial cleft. In this, there is one opening in the floor of external auditory meatus and another behind the angle of mandible close to anterior border of sternocleidomastoid. Tract of fistula passes through parotid in close proximity to the facial nerve.

Treatment
Treatment is excision of the tract.

Congenital Anomalies of Pinna

1. Anotia is complete absence of pinna and is treated by plastic reconstruction or by prosthesis (**Figure 5.2A**).

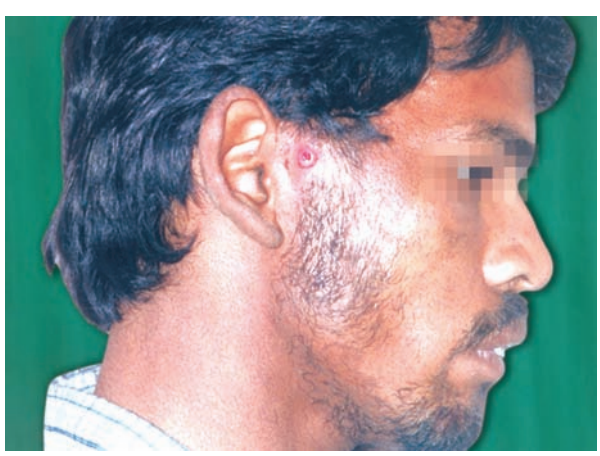


Figure 5.1 Preauricular sinus

2. Microtia is very small deformed pinna and may be associated with other anomalies of ear (**Figures 5.2 B to E**).
3. Melotia is displacement of pinna caudoventrally.
4. Polyotia means that there are multiple tags of skin and cartilage around the pinna and can be seen on a line drawn from tragus to the angle of mouth (**Figure 5.3A**).
5. Synotia a condition, where auricular tags lie behind and below the mandible and may be associated with anomalies of mandible and tongue.
6. Bat ears are abnormal anteriorly placed pinna (**Figure 5.3B**) and are best treated by surgery at 6 years of age.
7. Lop ear is a severe variant of bat ear.
   - Gradenigo ear there is tripartition of antihelix.
   - Pixie's ear or undue tension of skin of lobule (Devil's ear)
   - Harbula hirci is presence of excessive hair in the tragus.
8. *Darwin's tubercle*—It is a small elevation on the posterosuperior part of helix and is an inherited condition (**Figure 5.3C**).
9. *Wildermuth's ear (Mozart's ear)*—Here the antihelix is more prominent than helix; lobule may be absent or adherent to the skin of neck (**Figure 5.4**).
   - Winkler's disease is also called chondrodermatitis nodularis chronicus helicis in which small painful nodules are seen in the upper part of pinna.

Treacher Collins Syndrome

Also called mandibulofacial dysostosis. It is an autosomal dominant condition involving 1st and 2nd branchial arch. The following anomalies are presents (**Figures 5.5A and B**):

1. Microtia with congenital atresia of external auditory canal.

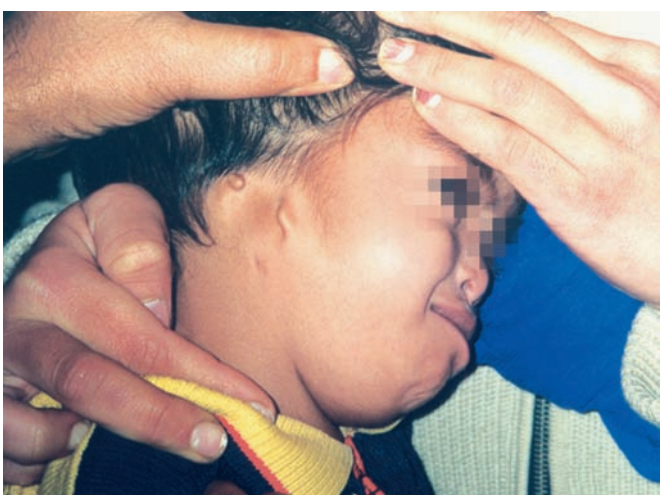


Figure 5.2A Anotia

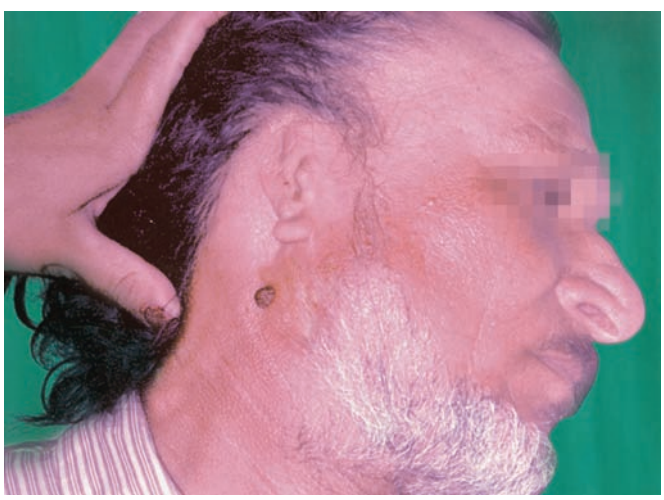
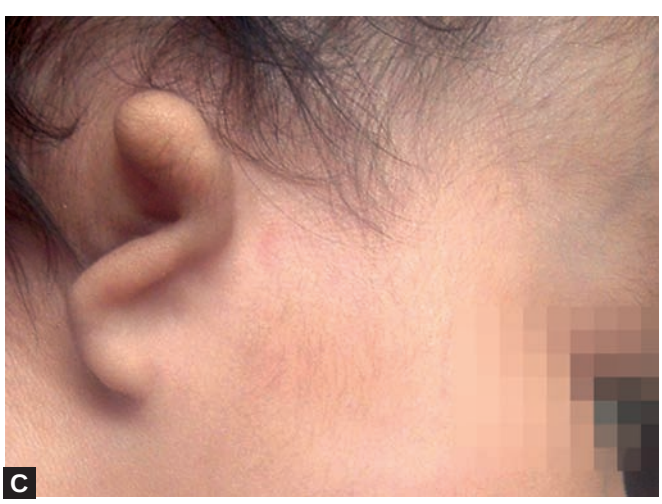
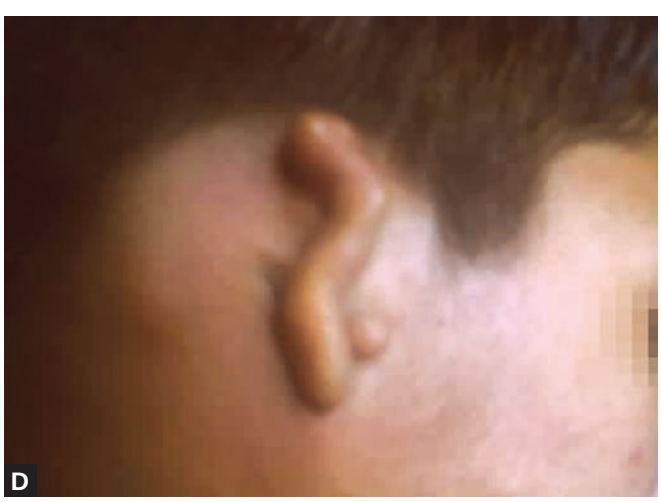


Figure 5.2B Anomalous pinna





Figures 5.2C and D Anomalous pinna and absent meatus

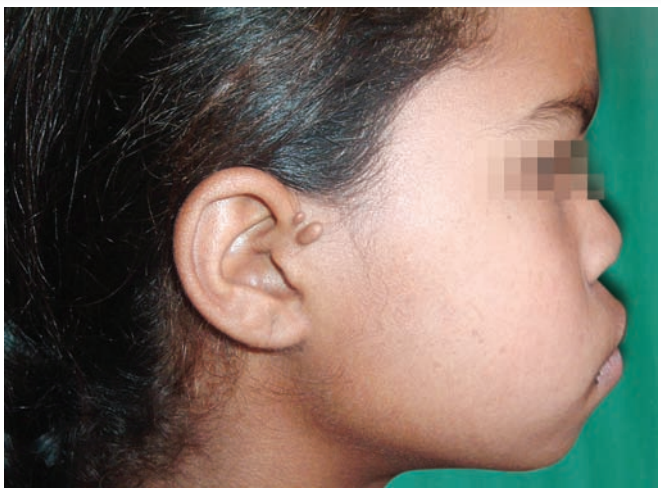


Figure 5.2E A 12-year-old girl with multiple anomalies of pinna, nose and hands

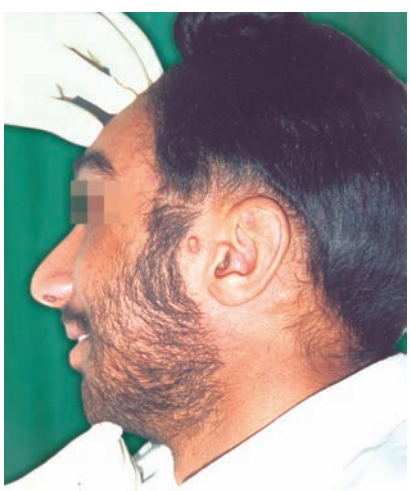


Figure 5.3A Accessory pinna (polyotia)

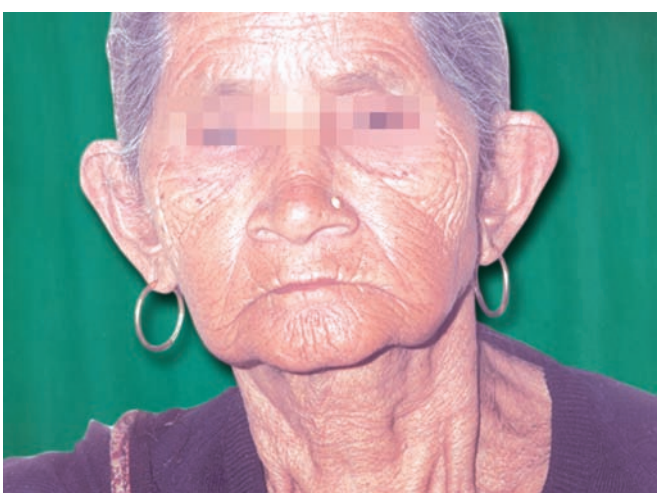


Figure 5.3B Bat ears

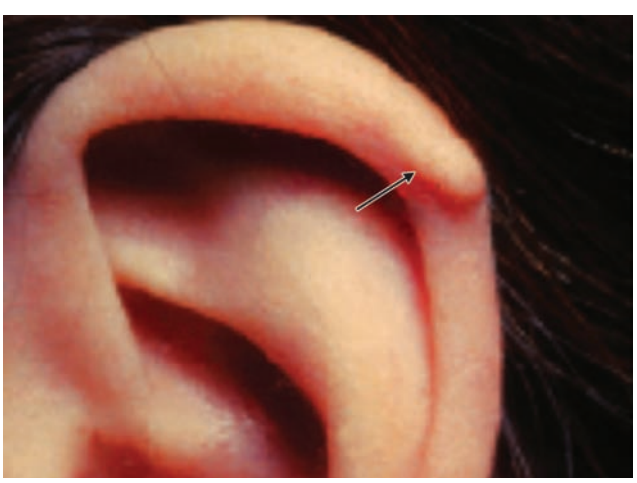


Figure 5.3C Darwin's tubercle

2. Hypoplasia of mandible and middle-third of face and malar prominence.
3. Antimongoloid palpebral fissures.
4. Notching of lower eyelid (coloboma) and atrophic lid margins.
5. Conductive type of deafness.

Treatment

Treatment is by plastic surgery reconstructive procedures.

Sometime various anamolies of pinna can be seen due to wearing of heavy ornaments in the ears (**Figure 5.6**).

Atresia of External Auditory Meatus

Atresia of external auditory meatus may be:

- Acquired
- Congenital atresia.

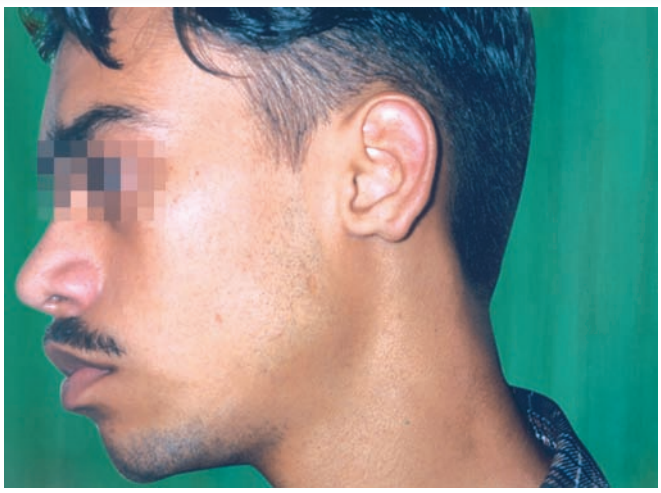
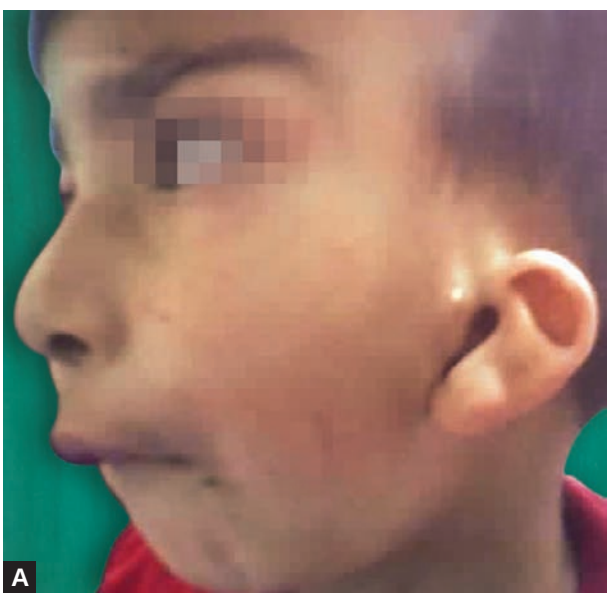
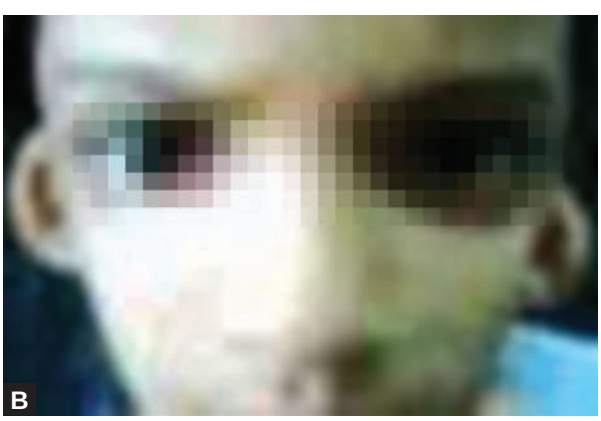


Figure 5.4 Absent lobule





Figures 5.5A and B Multiple congenital anomalies (Treacher Collins syndrome)

Acquired Atresia

Acquired atresia is usually due to trauma or after a long standing chronic infection of skin or burns or corrosives of external auditory meatus. Trauma may be accidental or iatrogenic following a surgical procedure like mastoidectomy. Usually, the history is quite informative and patient presents with conductive hearing loss due to impacted wax or a foreign body. Treatment is canaloplasty with skin grafting.

Congenital Atresia

The canal is canalized at 24th week of intrauterine life and may be seen with normal middle and external ear, because these develop in first trimester of pregnancy. It is due to the failure of canalization of ectodermal core that fills the distal part of first branchial cleft. Outer meatus may be filled with fibrous tissue or bone (**Figure 5.7**).

Treatment
Treatment is excision of the tissue and recanalization with split skin graft.

Congenital Tumors of External Auditory Meatus

Such as hemangiomas or lymphangiomas may be seen, although rarely.

Treatment

Treatment is excision of the tumor.

Inflammatory Conditions of the Pinna

Erysipelas

Also called Saint Anthony's fire. It is a *streptococcal haemolyticus* infection of skin of pinna, which produces raised red, edematous eruptions with sharply defined edges associated

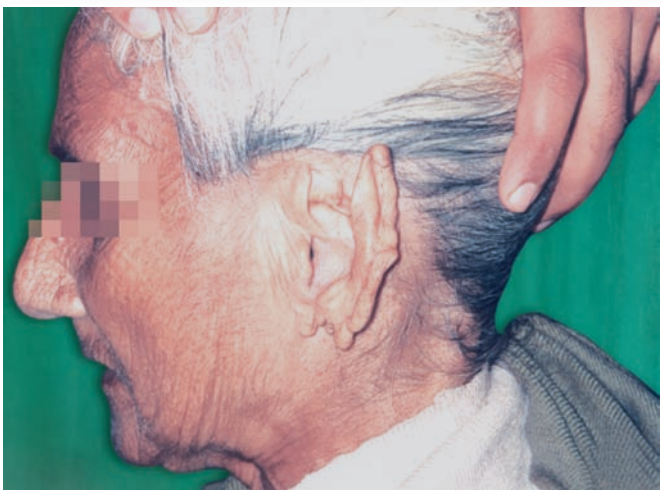


Figure 5.6 Ornamental split ear

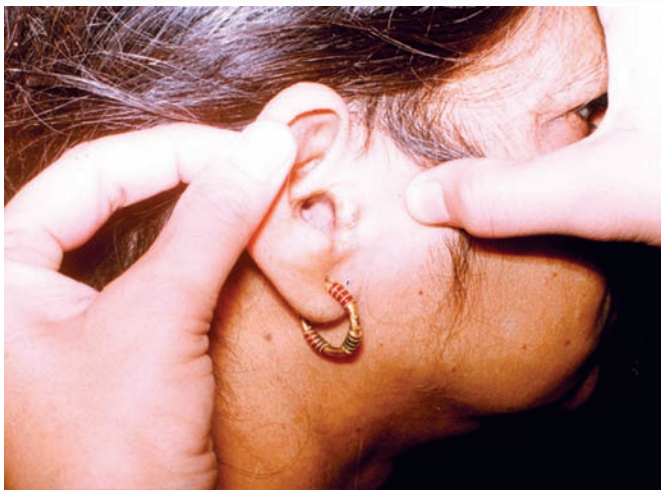


Figure 5.7 Stenosis of external auditory meatus

with severe degree of malaise and temperature. It is treated by large doses of penicillin and anti-inflammatory drugs.

Perichondritis

Perichondritis is inflammation of the perichondrium covering the cartilage of the pinna and may follow trauma leading to hematoma and infection or may also follow otitis externa or a furuncle of the pinna or follow operations such as cutting the cartilage in the presence of infection (**Figure 5.8**).

Signs/symptoms

There is uniform enlargement of pinna, surface is red and shiny. There is severe pain along with constitutional disturbances such as fever, malaise and body aches. Recurrent infection may result in cauliflower ear or Boxer ear.

Treatment

1. Broadspectrum antibiotics such as amoxicillin, ciprofloxac with or without tinidazole or injection gentamicin 80 mg IM two times a day.
2. Anti-inflammatory drugs such as ibuprofen or paracetamol.
3. Local application of magnesium sulfate dressing or ichthyol in glycerin.
4. Once abscess is formed I and D has to be done.

Infective Conditions of External Auditory Meatus

Furunculosis

Furunculosis is a *staphylococcal* infection of hair follicles, which are present in cartilaginous part of the external auditory meatus.

Clinical features

1. Severe pain spreading to jaw or head, but hearing is almost normal.
2. Swelling of canal and Tragus sign positive, i.e. tenderness on pressing the tragus (**Figure 5.9**).
3. Examination shows swelling with a bursting point in the canal, tympanic membrane is normal.
4. Postauricular sulcus is obliterated if infection spreads posteriorly. Regional lymph nodes are tender and enlarged.

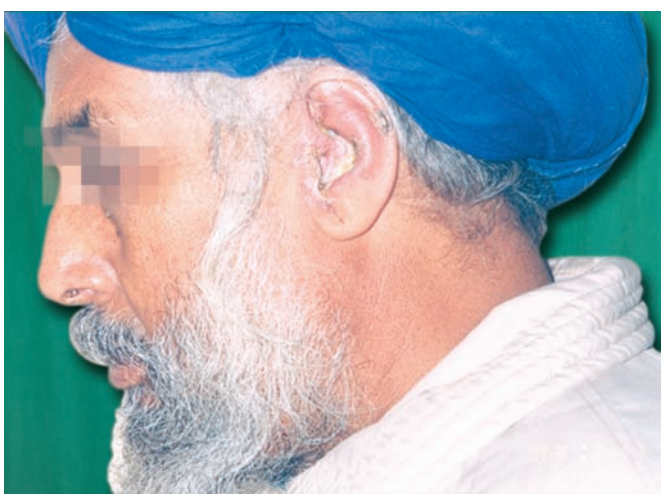


Figure 5.8 Perichondritis

Treatment

1. In recurrent cases diabetes should be ruled out.
2. Antibiotics (broad spectrum) and anti-inflammatory drugs.
3. Meatus is packed with a wick soaked in antibiotic steroid cream, which acts as a splint and prevents movements of cartilaginous part and also helps in relieving tension by counter pressure.
4. Hot fomentation locally is soothing and incision is usually not required.

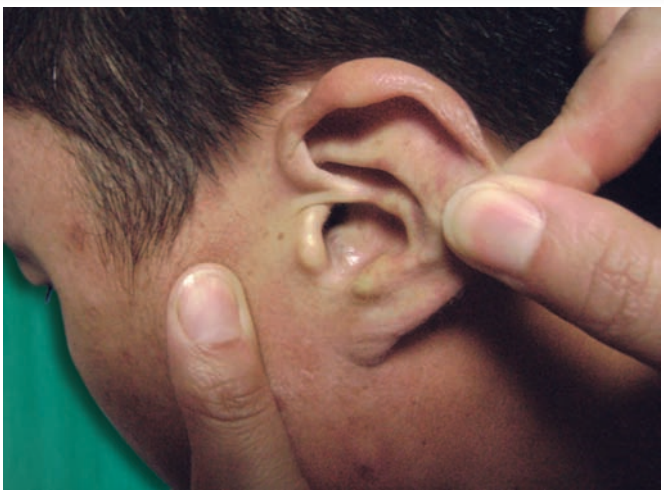


Figure 5.9 Furuncle in ear canal

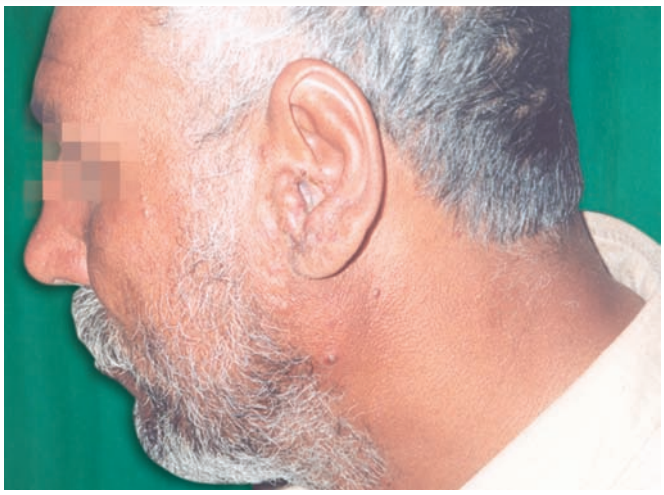


Figure 5.10 Otitis externa

Otitis Externa

Otitis externa is a generalized infection of skin of the external auditory canal and may be acute or chronic. It is also called Swimmer ear (**Figure 5.10**).

Etiology

1. Predisposing factors are hot and humid climate (Singapore ear).
2. Scratching with dirty nails or objects.
3. Bathing and swimming in dirty pools.
4. Allergic diathesis.
5. Excessive sweating changes pH of the canal from acid to alkaline, which favors growth of organisms.

Bacteriology

Staphylococci, Streptococcus haemolyticus, Pseudomonas pyoc-yanea (Ps. pyocyanea), B. proteus and *Escherichia coli* (*E. coli)*.

Clinical features

1. Pain or discomfort, tenderness, discharge, which is serous with debris filled in canal.
2. No hearing loss.
3. Edema, redness and tenderness on circumduction sign, i.e. pinna when moved in all directions causes pain.

Treatment

Systemic antibiotics, anti-inflammatory drugs, local treatment such as removal of debris and wick soaked in antibiotic steroid cream, avoidance of any predisposing factors.

Malignant Otitis Externa or Necrotizing Otitis Externa

1. Malignant otitis externa was described by Meltzer and Kelemen in 1959.
2. It is a fulminating severe form of otitis externa caused by *pseudomonas* seen in elderly diabetic patients.
3. It may also be seen in those patients suffering from acquired immune deficiency syndrome (AIDS) or malignancy and are on immunosuppressive drugs like azathioprine, methotrexate, cyclophosphamide and cyclosporine.
4. Patients using steroids or having hypogammaglobulinemia may also be affected by this disease.
5. The disease has also been called as skull base osteomyelitis.

Clinical Features

1. It is called malignant as it behaves like a malignant process by causing destruction of tissues of canal, pre- and postauricular region by various enzymes such as lecithinase and hemolysin.
2. Posteroinferior wall of external auditory meatus shows granulations and lower cranial nerves involvement such as VII, IX, X, XI. Facial nerve may be paralyzed more frequently than other nerves.
3. Severe pain in the ear is present (**Figure 5.11**).
4. Infection may spread to parotid, skull base and jugular foramen through various foramina causing multiple cranial nerve palsies.

Common Pathogens

- Pseudomonas aeruginosa
- Staphylococcus aureus
- *Aspergillus* and rarely *Proteus*.

Differential Diagnosis

- Paget's disease
- Carcinoma of external auditory meatus
- Granulomatous disorders.

Diagnostic Work Up Includes

- Hemoglobin (Hb), total leukocyte count (TLC), differential leukocyte (DLC)
- Imaging studies such as computerized tomography (CT) scan, bone scan to rule out osteomyelitis
- Serial Gallium-67 scans, which indicates active inflammation at the site.

Treatment

1. Heavy doses of antibiotics such as gentamicin/ tobramycin/ cefotaxime 1 gm IM/IV and ciprofloxacin 750 mg twice daily for a period of 6 to 8 weeks.
2. Hyperbaric oxygen therapy is very effective and helps by improving phagocytic action due to higher tissue oxygen tension levels.
3. Local debridement of necrotic tissues and bone.
4. Packing of a wick soaked in antibiotic cream.
5. Strict control of diabetes is most important.
6. Wide surgical excision of infected tissue and bone may be required sometime.
7. Mortality is 67 percent in patients with facial nerve palsy, while it is 80 percent in patients with multiple cranial nerve involvement.

Primary Cholesteatoma of External Auditory Canal

1. It has also been reported, which is due to erosion of bony meatus by squamous epithelium due to some defect in the bone itself making it susceptible to invasion.
2. Patient has all the features of otitis externa with granulations.
3. It should be diffentiated from malignant otitis externa and carcinoma of meatus.
4. Treatment is complete removal of the necrotic bone and diseased mucosal lining.

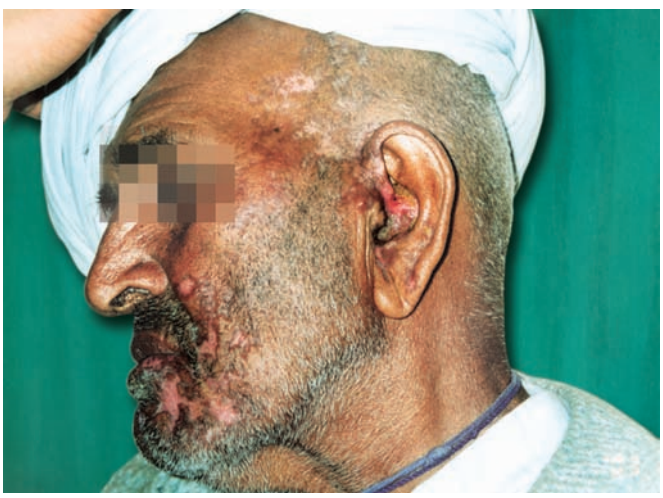


Figure 5.11 Malignant otitis externa

Otomycosis

Otomycosis is a fungal infection of external auditory canal usually caused by *Aspergillus fumigatus, Aspergillus niger* or *Candida albicans*.

Clinical Features

1. Seen during hot and humid atmosphere.
2. Irritation, itching, dull pain and discharge.
3. Sense of blockade with mild conductive loss.
4. Wet blotting paper like debris in canal, upon which mycelia can be seen is the characteristics of otomycosis.

Diagnosis

It is confirmed by microscopic examination (**Figure 5.12**)

Treatment

- Keeping the ears dry
- Removal of fungal mass from canal
- Spirit cleaning 2 to 3 times
- Antifungal drops such as clotrimazole or 2 percent salicylic acid in alcohol
- Local application of gentian violet
- Use of amphotericin B is sometimes done in resistant cases.

Viral Infections

Herpes Zoster Oticus

1. Also called Ramsay Hunt syndrome after it was described in 1907 by Hunt James.
2. In this disease, vesicles appear in or around the ear canal along with VII nerve weakness and pain in the area (**Figures 5.13A and B**).
3. In its severe form, there may be sensorineural hearing loss (SNHL) and disturbed vestibular function and even signs and symptoms of viral encephalitis.
4. Cranial nerves V, IX and X may also be involved. It is caused by chickenpox causing virus *Varicella*, which affects geniculate ganglion.

Treatment

- Antibiotics to prevent secondary infection
- Antiviral drugs such as acyclovir in the form of tablets (800 mg 4-5 times a day) and cream
- Anti-inflammatory drugs
- Corticosteroids in the form of tablets and local cream
- Facial nerve palsy is managed in the usual way.

Bullous Myringitis Hemorrhagica

It is a viral infection seen during influenza epidemics and is characterized by severe earache with a few constitutional symptoms. On examination, hemorrhagic blebs are seen

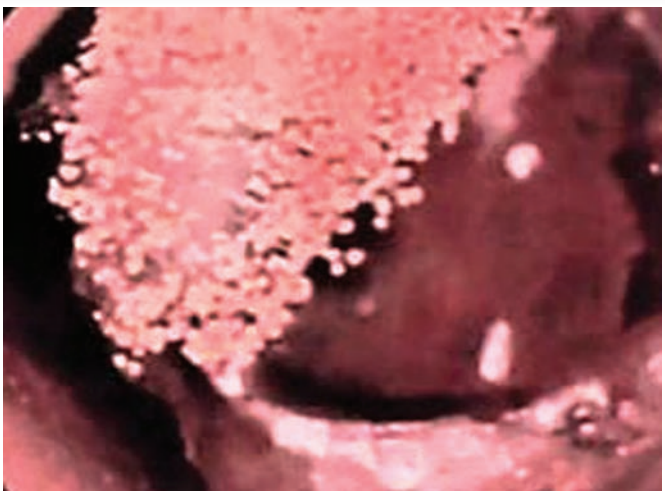


Figure 5.12 Fungal otitis externa

on drum and sometimes in the canal wall. Mild conductive hearing loss may be seen. It should be differentiated from acute otitis media, which shows marked systemic features.

Treatment
It is treated by analgesics, antibiotics and local steroid drops.

Retracted Tympanic Membrane

Tympanic membrane acts as a mirror of middle ear and a careful look indicates the pathology of middle ear and retracted drum is mostly because of eustachian tube dysfunction. Patient usually presents with history of URC followed by mild fullness of ear and diminished hearing and its features are:

1. Drum looses its normal lustre and shine.
2. Mobility of tympanic membrane (TM) is restricted.
3. Anterior and posterior malleolar folds become prominent.
4. Handle of malleus appears to be foreshortened and drawn backwards assuming a horizontal position.
5. Lateral process of malleus becomes prominent.
6. Cone of light is absent or is reduced to a fragment at a different position.

Treatment

Treatment is treating the underlying cause whatsoever.

Reactive Conditions

Eczematous Otitis Externa

Eczematous otitis externa is an allergic dermatitis of external ear, which may be due to jewelry, cosmetics or use of antibiotics or chemicals.

There is present lot of irritation, edema, swelling and scaling and even stenosis of canal may be present.

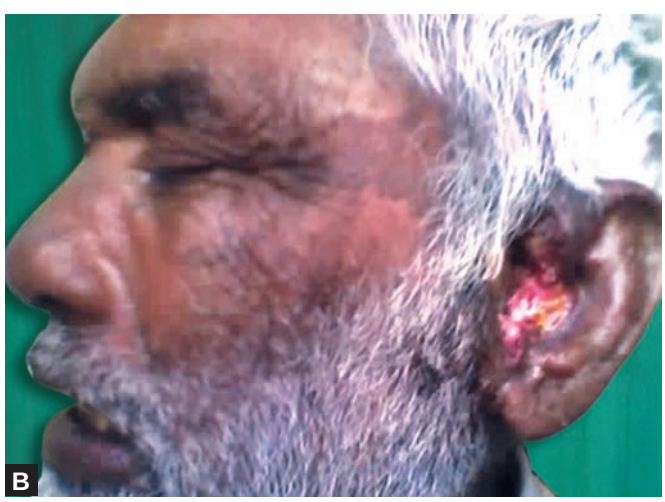
Treatment is by avoiding the irritating factors, use of antihistaminics with steroid cream and prophylactic antibiotics.

Neurodermatitis

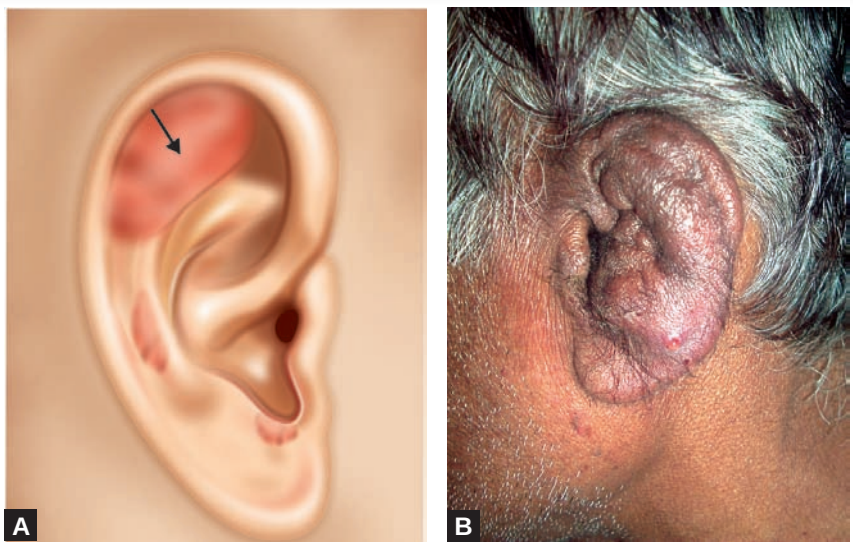
Neurodermatitis is compulsory itching due to psychological factors and is treated by psychotherapy and bandage to ear to avoid compulsive itching.

Seborrheic Otitis Externa

Seborrheic otitis externa is scaly dermatitis of external auditory canal, which is associated with seborrheic capitis and is treated by treating the scalp condition.



Figures 5.13A and B Ramsay Hunt syndrome showing vesicles, facial palsy



Figures 5.14A and B Hematoma pinna

Traumatic Conditions

Hematoma of Pinna

Hematoma of pinna is usually seen in fights where due to trauma a fluctuant swelling (**Figures 5.14A and B**) appears under the skin. Usually, there are no constitutional symptoms unless an infection supervenes. Its persistence deprives blood supply to perichondrium, leading to infection and necrosis. If not treated may lead to cauliflower ear also called Boxer's ear.

Treatment is by incision and drainage and proper compression of the wound to prevent accumulation of blood or fluid. This can be done by applying quilting sutures and/or a tight bandage. Antibiotics to prevent secondary infection and anti-inflammatory are also given.

Frostbite

Frostbite is commonly seen in extremely cold weather and as the skin lining the lateral surface of pinna is firmly adhered to the cartilage with minimal subcutaneous tissue making it more prone to frostbite. Best treatment is prevention besides the role of vasodilators, rewarming at 38° to 42°C, the application of 0.5 percent silver nitrate and systemic antibiotics.

Pseudocyst Pinna

A soft cystic swelling appears on the pinna beneath the skin and is usually because of trauma.

Treatment
Treatment is aspiration or incision and drainage under aseptic conditions.

Tumors of External Ear

Benign

Exostosis
Exostosis occur in bony meatus and are usually multiple, while osteomas are single and occur at the junction of bony and cartilaginous meatus. So exostosis is a bony outgrowth from bony meatus, which may be single pedunculated or multiple of sessile type. It may be bilateral. Etiology is not known, but may be due to cold water bathing or trauma and infections.

Clinical features
Asymptomatic when small, but if large may occlude the meatus causing irritation and deafness.

Treatment
No treatment if asymptomatic, but if large, electric drill is used to remove it avoiding injury to VII nerve.

Adenoma
1. Sebaceous adenoma arises from sebaceous glands of cartilaginous meatus and is treated by excision.
2. Ceruminoma (Hydradenoma) arises from ceruminous glands and is a rare tumor resembling sweat gland tumors and may become malignant.

Treatment
Treatment is excision: 'Keloid' on the pinna are also commonly seen in females after ear piercing procedures (**Figure 5.15**) and are difficult to treat due to tendency to recurrence.

Malignant Tumors

Basal cell carcinoma (rodent ulcer)
Basal cell carcinoma arises from basal layer of epidermis and starts as a nodule on pinna (**Figure 5.16**). Margins of ulcer are not everted and no lymph node metastasis is seen.

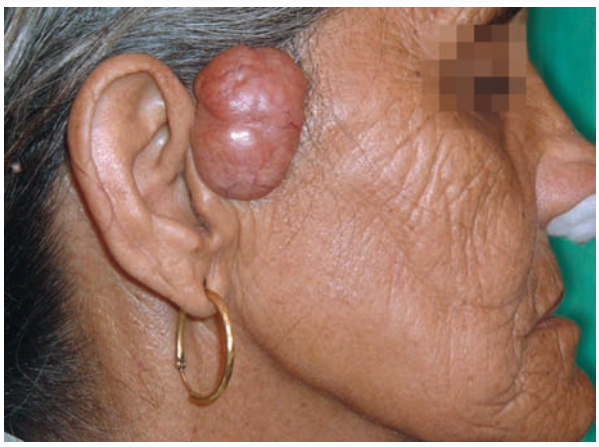


Figure 5.15 Keloid

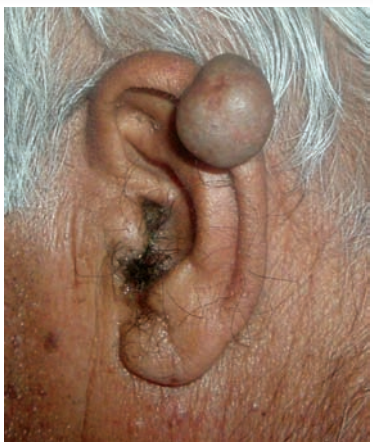


Figure 5.16 Basal cell carcinoma

Treatment

Resection of tumor if small and localized, but if extensive, complete excision followed by plastic reconstruction. Radiotherapy is for inoperable tumors only.

Squamous cell carcinoma

Squamous cell carcinoma can occur on pinna or in external auditory canal. Chronic otorrhea may be a predisposing factor (**Figures 5.17A and B**).

Clinical features

Elderly patient, bleeding from ear or blood-stained discharge, bleeding polyp or granulation and enlarged lymph nodes. Facial nerve may be involved. Margins of the ulcer are everted.

Treatment

Cancer of pinna requires radical excision (i.e. total auriculectomy) and cancer of external auditory canal (EAC) needs wide excision of tumor by extended radical mastoid operation followed by radiotherapy.

Miscellaneous Conditions of External Ear

Wax

Wax is secreted by ceruminous and sebaceous glands in the cartilaginous part of external auditory canal. To these secretions are added desquamated keratin, debris and dust to form the wax. Ceruminous glands produce watery secretions, while sebaceous glands produce fatty secretions. Due to oxidative processes, it becomes brown in color.

The wax is excreted out due to movements of jaw, while eating or talking. It collects in excessive amount in dry hot humid or dusty occupation or if there is excessive desquamation from canal. Wax performs antibacterial function and it is a nature's way for removal of dust and foreign material.

Clinical features

Sense of blockage, itchiness, hearing is diminished, earache, tinnitus and vertigo.

Treatment

If hard, it should be softened by wax solvents, i.e. soda glycerin, etc. and then removed by syringing with sterile normal saline water at body temperature or may be with wax hook.

Keratosis Obturans

1. Keratosis obturans is also called cholesteatoma of external auditory canal.
2. It is a condition seen in 5 to 20 years of age, in which there is a firm mass consisting of wax, desquamated keratinized epithelium and cholesterol granules.
3. Exact etiology is not known, but hyperemia of canal skin and irritability of epidermis may contribute.
4. The mass causes erosion and widening of bony canal. Failure of epithelial migration may lead to accumulation of epithelial debris.

Clinical features

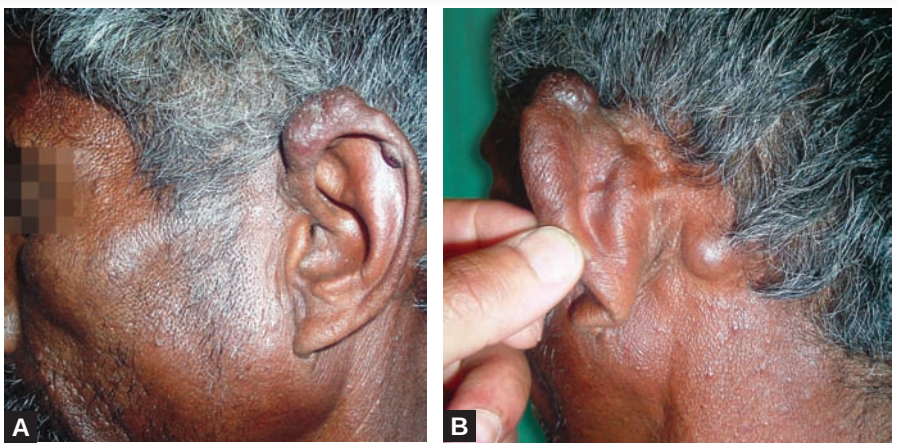
Pain, deafness, granulation tissue formation, symptoms and signs of chronic sinusitis and bronchiectasis. On examination, pearly white mass of keratin material is seen.

Treatment

Mass is softened by soda glycerin solution and removed periodically under anesthesia.

Foreign Bodies of Ear

Foreign bodies may be animate, such as insects, flies, maggots or cockroaches or may be inanimate, such as organic, i.e. seeds, peas or beans and inorganic, i.e. beads, buttons, rubber, etc.



Figures 5.17A and B Squamous cell carcinoma with secondaries neck

Clinical features
Intense irritation, earache and diminished hearing.

Treatment
Usually removed under local or general anesthesia. Animate foreign body, if living is first killed by putting some oily drops and removed by forceps or syringing.

Inanimate foreign bodies are removed under general anesthesia by ring curette or syringing. If foreign body is impacted, it is removed under general anesthesia by endaural or postaural route.

Complications
- Injury to tympanic membrane, ossicles and labyrinth.
- Otitis externa/otitis media.
- Foreign body granuloma.
- Tetanus may occur from sharp infected foreign bodies.

Key Points

1. **Malignant otitis externa** is caused by *Pseudomonas* and is seen in early diabetic patients.
2. **Herpes zoster oticus** also called Ramsay Hunt syndrome is caused by chickenpox virus *Varicella* affecting geniculate ganglion.
3. **Osteomas** usually single arise at bony sutures and cartilaginous junction of external auditory canal, while exostoses are multiple bony outgrowths from bony meatus.
4. **Cholesteatoma of external auditory meatus** is also called keratosis obturans caused by hyperemia and irritability of canal skin.
5. **Singapore ear** also known as telephonist ear or tropical ear is a type of diffuse otitis externa due to hot and humid climate.
6. **Button-sized nickel cadmium** batteries as foreign bodies are very dangerous because of releasing of toxic compounds causing systemic toxicity.
7. **Exostosis** is the most common benign tumor of the external auditory meatus.
8. **Winkler's nodule** (Chondrodermatitis nodularis chronica helicis) occurs on rim of helix in old age. Most common fungal infection of ear is caused by *Aspergillus niger*.
9. **Cough response,** while cleaning auditory canal is mediated through auricular branch of vagus (Alderman nerve).
10. **Features of retracted tympanic membrane are:**
    Cone of light is absent or distorted;
    Malleolar folds become prominent;
    Lateral process of Malleus is prominent;
    Mobility is restricted.
11. The **capacity of aural syringe** is 4 oz, while capacity of Higginson syringe is 3 oz.
12. **Causes of otalgia—remember mneumonic: 9T's:** T: **T**M Joint; T: **T**onsil; T: **T**eeth; T: **T**ongue; T: **T**hroat ulcers; T: **T**rachea; T: **T**hyroid; T: **T**ube eustachian; T: **T**ics-glossopharyngeal.

Chapter 6 Acute Otitis Media

What Students Must Know!

- **Acute Suppurative Otitis Media**
  - Causes of Acute Otitis Media
  - Bacteriology
  - Clinical Features
  - Management
  - Complications of Acute Otitis Media
  - Acute Necrotizing Otitis Media
- **Acute Mastoiditis**
  - Latent Mastoiditis
- **Petrositis (Gradenigo's Syndrome)**

ACUTE SUPPURATIVE OTITIS MEDIA

Definition

- Acute suppurative otitis media (ASOM) is an acute inflammation of the mucosa of middle ear, eustachian tube, and mastoid antrum which is collectively called middle ear cleft.
- The condition is commonly seen in children and infants due to short and wide eustachian tube and also because of more susceptibility to infection due to less body resistance.
- It is less seen in adults due to more efficient eustachian tube function.

Etiology

Etiology of ASOM is sequelae of upper respiratory tract infections. Infection reaches the middle ear through eustachian tube, which if blocked, creates a negative pressure and sucks the infected mucus in the middle ear.

- It is also likely that viral diseases (like measles, whooping cough and diphtheria) prepare the ground for secondary invasion of middle ear by bacteria.
- Deviated nasal septum (DNS), polypi and sinusitis.
- Cleft palate, adenoids and allergy also predispose.
- Postnasal packing.
- Barotrauma.
- Babies fed in supine position, particularly bottle fed babies, become more prone to ASOM.

Causes of Acute Otitis Media

- Acute tonsillitis/adenoiditis, cleft palate.
- Influenza/common cold.
- Coryza of measles, scarlet fever, whooping cough.
- Sinusitis, DNS and polypi.
- Hemotympanum/trauma to the tympanic membrane (TM).
- Barotrauma/diving.
- Temporal bone fracture.

Routes of Infection

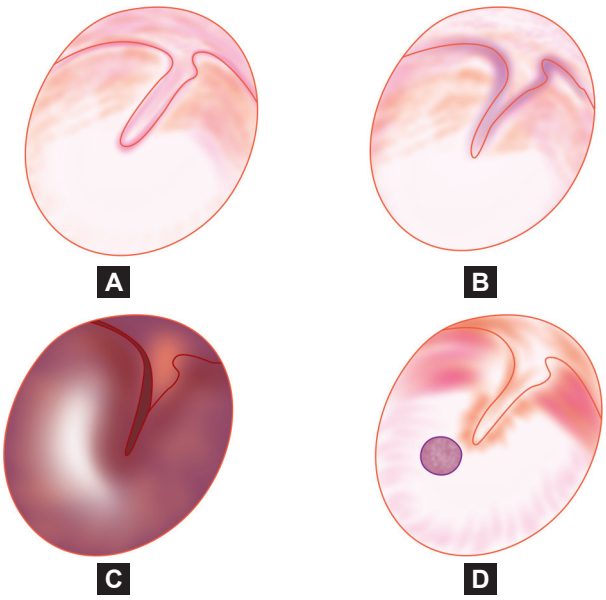
- Through eustachian tube opening
- Ruptured TM
- Hematogenous (sometimes only).

Bacteriology

- *Streptococcus pneumoniae* (most common)
- *Haemophilus influenzae* (Pfeiffer's bacillus)
- *Moraxella catarrhalis*
- *Staphylococcus pyogenes*
- *Streptococcus pyogenes*
- *Branhamella catarrhalis*.

Pathology

Various stages of ASOM are as follows (**Figures 6.1A to D**):



Figures 6.1A to D Stages of acute suppurative otitis media. (A) Stage of tubal catarrh; (B) Stage of presuppuration;(C) Stage of suppuration; (D) Stage of resolution with perforation

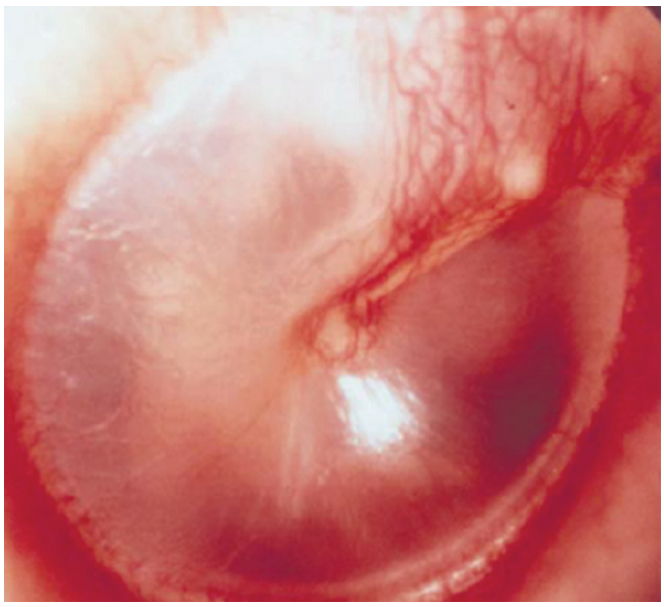


Figure 6.1E Acute congestion of tympanic membrane

Stage of Tubal Catarrh or Congestion

Eustachian tube is blocked due to edema and congestion, which leads to absorption of air in the middle ear causing negative pressure, hence retraction of TM and some effusion in the middle ear.

Clinical features

- Earache, popping in ear and
- Mild conductive deafness, but no fever
- Examination of TM shows retracted TM such as absent cone of light; malleolar folds prominent; handle of malleus drawn backwards; lateral process of malleus looks prominent, mobility of drum is restricted.

Stage of Exudation

In stage of exudation pyogenic organisms invade the middle ear and cause congestion of the middle ear mucosa with formation of mucoidal exudate.

Clinical features

- Marked pain in the ear, which may be of throbbing nature
- Deafness and tinnitus
- Child has high fever and is restless
- Examination of TM shows marked congestion (**Figure 6.1E**) along the handle of malleus and periphery giving a cart wheel appearance and fullness of posterior part of drum.

Stage of Suppuration

In this suppuration stage, there is formation of pus in the middle ear.

Clinical feature

- Pain in the ear becomes severe and throbbing
- Temperature is 102 to 103°F
- Conductive deafness.

On examination, the TM is red and bulging and may show a yellow spot of future perforation (nipple-like protrusion).

Light house sign

It may be seen when there is pulsating discharge seen on otoscopy showing reflecting light intermittently.

Mastoid tenderness may be present in the suprameatal triangle.

Stage of Resolution

- In this stage, the TM ruptures with release of pus, with or without a little blood and the symptoms subside.

- Fever comes down and the earache is relieved.
- On examination, discharge is seen coming through the perforation of the TM which is usually in its anteroinferior part. In due course of time, perforation may heal up or may persist.

Stage of Complications

- These may occur, if treatment is inadequate or due to high virulence of organisms or if the patient has poor resistance.
- The disease may spread beyond the middle ear cleft leading to acute mastoiditis, facial nerve palsy, abscess formation, labyrinthitis, petrositis, meningitis, lateral sinus thrombosis or brain abscess.

Diagnosis

Diagnosis of AOSM is based on:

- History of the upper respiratory catarrh or trauma to the ear of the patients.
- Examination of tympanic membrane.
- Tuning fork (TF) tests and pure tone audiometry (PTA).

Differential Diagnosis

- Referred otalgia
- Furunculosis
- TM joint arthritis
- Acute parotitis.

Management

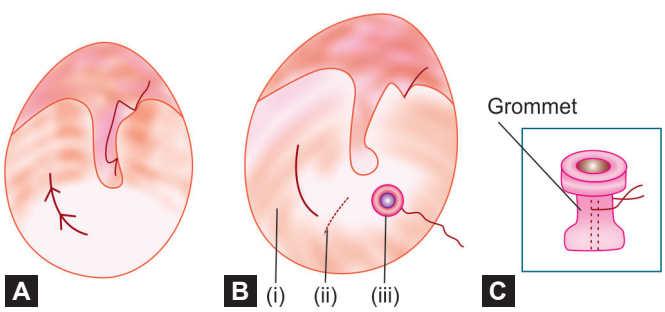
- Antibiotics for 5 days (ampicillin 50 mg/kg in 6th hourly doses or amoxicillin 25 mg/kg in 8th hourly doses).
- Nasal and systemic decongestants in the form of nasal drops such as xylometazoline or oxymetazoline every 4 to 6 hours. These help in natural drainage of discharge.
- Analgesics and anti-inflammatory drugs as such or in combination with decongestants have to be given to relieve the pain. Analgesics are now considered the drug of choice for the initial management of ASOM.
- Myringotomy is the treatment of choice if the patient presents with a red bulging drum. Incision is made with a myringotomy knife in anteroinferior quadrant from below upward under general anesthesia. It relieves the pain immediately and drum heals quickly once the infection subsides (**Figures 6.2A to C**). 'Myringotomy' is indicated in following situations such as:
  - Markedly congested and bulging drum, which does not respond to conservative management in 48 hours
  - Acute pain persisting in the child in spite of the best conservative treatment
  - If discharge is not adequate through a tiny perforation
  - If recovery is delayed and conductive deafness persists
  - Early features of complications of suppurative otitis media (SOM) appear.
- Cortical mastoidectomy is performed in cases, where there is masked mastoiditis or recovery is delayed.
- Ear drops are of no value if drum is intact. Once perforation has occurred, aural toilet followed by antibiotic drops.

Complications of Acute Otitis Media

- Mastoiditis
- Facial nerve palsy
- Petrositis
- Lateral sinus thrombosis
- Intracranial complications.

ACUTE NECROTIZING OTITIS MEDIA

- Acute necrotizing otitis media (ANOM) is a virulent type of ASOM seen in infants and children suffering from measles, influenza or scarlet fever. Bacteria usually are the *Streptococcus haemolyticus*.
- The disease is characterized by profuse, purulent, foul-smelling discharge with necrosis of TM, ossicles, mastoid air cells and scutum. The VIIth nerve palsy may also be seen. Tympanic membrane shows a big subtotal or kidney-shaped perforation occurring over a very short period.
- Treatment is by antibiotics such as penicillin in heavy doses or by cephalosporins. If no response is seen, then cortical mastoidectomy is done.



Figures 6.2A to C Different types of myringotomy incisions. (A) Incision in acute suppurative otitis media; (B) (i) Curvilinear incision, (ii) Radial incision in secretory otitis media, (iii) Radial incision with grommet in place; (C) Magnified view of a grommet

MASTOIDITIS

Masked or Latent Mastoiditis

- Masked mastoiditis results from inadequately treated cases of ASOM or those cases that were resistant to drugs; therefore it is a good practice to do culture sensitivity of the ear or nasal discharge.
- It is a slow process of destruction of mastoid air cells without acute features. There exists unextinguished infection in the mastoid.
- Clinical features are no pain, no fever; there is persistent discharge of mucus and deafness in a treated case of ASOM, feeling of being unwell, malaise, headache and mastoid tenderness with mild conductive hearing loss. X-ray both mastoids shows coalescence of air cells and cloudiness.
- Treatment is cortical mastoidectomy with full doses of antibiotics depending upon culture report to avoid intracranial complications.

Coalescent Mastoiditis

In this condition, cells of mastoid coalesce into larger cavities filled with pus under pressure. Septa of cells demineralize and disappear leading to large pockets of pus in mastoid antrum. Condition is treated as any other mastoiditis.

Acute Mastoiditis

- Acute mastoiditis occurs when the infection from mucosa of middle ear cleft spreads to bony walls of mastoid antrum.
- Usually, it occurs in a well-pneumatized mastoid bone.
- Beta-hemolytic streptococci are the usual organisms.

Pathology

- Due to extension of inflammatory process to the mucoperiosteal lining of air cells, there is increased pus formation associated with limited drainage through a small perforation (**Figures 6.3A and B**).
- Hence, there is collection of the pus under tension. Besides this, there is hyperemic decalcification of walls of mastoid antrum.
- Both these processes cause destruction and coalescence of mastoid air cells.
- Ultimately, pus may break the mastoid cortex leading to subperiosteal abscess formation.

Clinical Features

Symptoms

- Recurrence of pain after ASOM, is important
- Fever is of low grade and of intermittent type
- Discharge persisting beyond 3 weeks after ASOM points towards acute mastoiditis
- Positive reservoir sign which means meatus fills up immediately after cleaning.

Signs

- Patient looks ill, toxic and pulse rate is increased.
- Ear discharge is of pulsatile in nature
- Sagging of posterosuperior bony meatal wall due to periosteitis of bony wall between antrum and deep bony meatus and mastoid tenderness is present elicited by pressing with a finger over the cymba concha giving rise to maximum tenderness as compared to pressure on the posterior border or tip of mastoid (three finger test)
- Swelling on the mastoid with tenderness and accentuation of postaurical sulcus
- A small perforation of TM is seen usually along with conductive deafness.

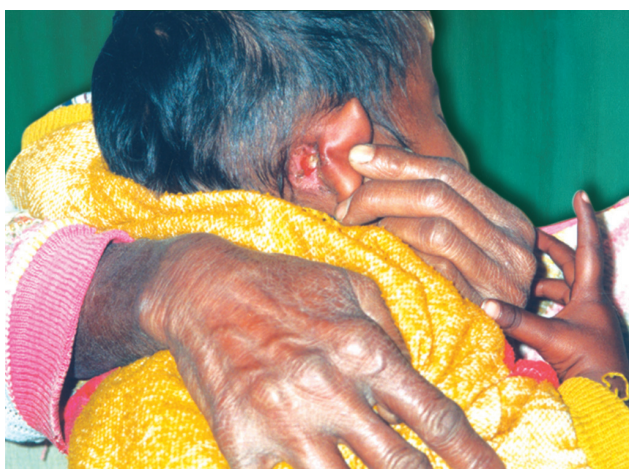


Figure 6.3A Mastoid fistula on right side in a 5-year-old child

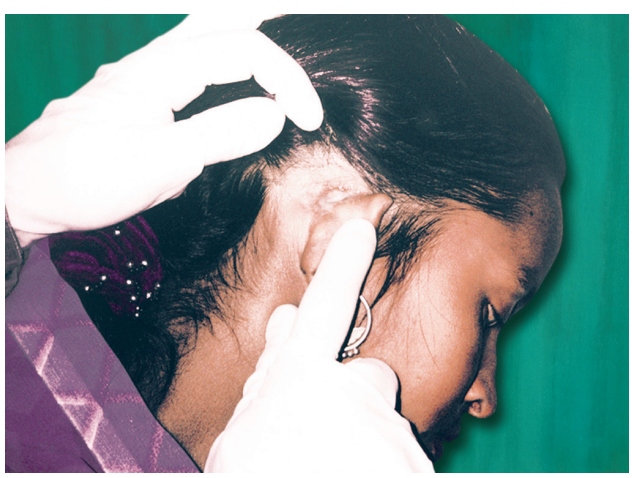


Figure 6.3B Mastoid fistula in an adult patient

Management

- Antibiotics—penicillin 5 to 10 lac 6th hourly or cephalosporins, i.e. Cefotaxime 1 gm IV or IM twice daily for 7 to 10 days.
- Anti-inflammatory drugs.
- Myringotomy for drainage of pus from the middle ear.
- Cortical mastoidectomy or Schwartz operation, if conservative treatment fails in 48 hours.

Complications of Acute Mastoiditis

- Subperiosteal abscess
- Facial nerve palsy
- Labyrinthitis
- Petrositis
- Intracranial abscess.
- Meningitis
- Lateral sinus thrombosis.

Differential Diagnosis

Differential diagnosis between furunculosis and acute mastoiditis are shown in the **Table 6.1**.

Abscesses in Relation to Mastoid

- Postaural subperiosteal abscess.
- **Zygomatic abscess**—posterior root of zygoma is involved and swelling lies above and in front of pinna and pus lies superficial or deep to the temporalis muscle (**Figures 6.4A and B**).
- **Bezold's abscess**—pus passes through the tip of mastoid into sternomastoid muscle in the upper part of neck.
- **Citelli's abscess**—pus passes through inner table into digastric triangle along the posterior belly of digastric muscle.
- **Luc's abscess**—it is a subtemporalis abscess by tracking under the periosteum of roof of bony meatus.
- **Meatal abscess**—when pus points in the posterior wall of external auditory meatus.

PETROSITIS

- Petrous apex is divided into anterior compartment and posterior compartment by internal auditory meatus.
- Anterior compartment is further subdivided into peritubal and apical region.
- Petrous apex may be pneumatized in 30 percent cases.
- Cell tracts may be perilabyrinthine or periapical cells.
- Petrositis results when the infection from the middle ear or mastoid spreads to pneumatized petrous apex through various tracts.
- Infection may be acute, chronic or complicated with intracranial complications.

Table 6.1: Differential diagnosis

	Furunculosis	*Acute mastoiditis*
•	History of trauma present	Absent
•	No history of otorrhea	History of otitis media present
•	Earache is very severe	It is less
•	No hearing loss	Usually present
•	Tragus sign present	Absent
•	Canal appears to be narrow due to swelling	Sagging of posterosuperior bony wall may be present
•	Tympanic membrane is normal	May show perforation with discharge
•	Discharge is serous type	Discharge is mucoid or mucopurulent
•	No tenderness on mastoid	Tenderness over mastoid present
•	Postaural groove obliterated	It is accentuated
•	X-ray show mastoids normal	X-ray shows clouding of mastoid

Clinical Features

- History of otitis media present.
- Complaint of raised temperature.
- Deep-seated ear pain. Anterior petrositis results in retro-orbital pain while posterior petrositis results in sub-occipital pain.
- Temporal headache.
- Diplopia (due to the VIth nerve palsy and palsy of external rectus).

Symptoms

The triad of symptoms called **Gradenigo's syndrome** described in 1904 consists of:

a. Diplopia (VIth nerve palsy).
b. Otorrhea and mastoiditis.
c. Retro-orbital pain and temporal pain (due to Vth nerve involvement).

Diagnosis

Diagnosis of petrositis is based on:

- History of the patient.
- Clinical features.
- Clouding of apical cells on X-rays.
- Finding of fistulous tracts while doing mastoid surgery.
- Patient not responding to medical or surgical treatment.

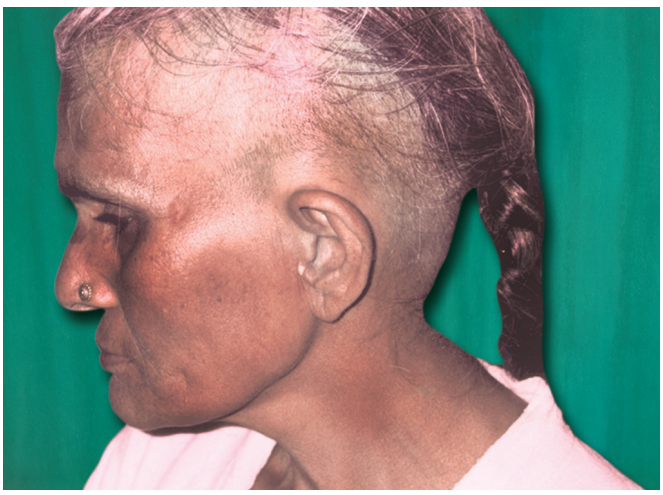


Figure 6.4A Zygomatic abscess (lateral view)

Figure 6.4B Zygomatic abscess (posterior view)

Treatment

Antibiotics followed by surgical exploration of the tracts leading to petrous apex close to eustachian tube or in front of cochlea in radical mastoidectomy operation. It is extrapetrosal drainage.

Other approaches for petrous apex are (**Remember—FEAR**):

- **Frenckner's operation**—approach through cells under the superior semicircular canal (SCC).
- **Eagleton's operation**—middle fossa dural approach.
- **Almoor's operation**—drainage through a triangle bounded by carotid artery, cochlea and tegmen tympani above.
- **Ramadier's operation**—petrous approached through posterior wall of bony carotid canal.

Key Points

1. **Lighthouse sign** is seen due to intermittent reflection of light on otoscopy when there is pulsating discharge in acute suppurative otitis media (SOM).
2. **Myringotomy** is done in anteroinferior quadrant and was first performed in 1801 by Astley Cooper for serous otitis media.
3. **Acute necrotizing otitis media** is caused by *Streptococcus haemolyticus* and is characterized by profuse purulent foul-smelling discharge.
4. **Postaural sulcus** is obliterated in furunculosis, while it is accentuated in acute mastoiditis.
5. **In Citelli's abscess** pus is seen in digastric triangle after passing through inner table of mastoid process and may reach up to mediastinum.
6. **Gradenigo's syndrome** is characterized by retro-orbital pain, otorrhea and diplopia. Sudden disappearance of symptoms suggests intracranial rupture.
7. **Most common bacteria** seen in acute SOM in infants and children are *Streptococcus pneumoniae*.
8. **In ASOM,** 85 percent cases show perforation in anteroinferior quadrant.
9. **Ist sign of acute mastoiditis** is ironing of mastoid.

Chapter 7 Chronic Suppurative Otitis Media

What Students Must Know!

- **Chronic Otitis Media**
- **Types of Tubo-Tympanic CSOM**
  - Common Causes of Chronic Otitis Media
  - Bacteriology
  - Clinical Features
  - Investigations
  - Management
  - Complications of Safe Type of CSOM
- **Atticoantral Type of CSOM**
  - Cholesteatoma
  - Etiology
  - Types of Cholesteatoma
  - Effects of Cholesteatoma
  - Pathogenesis of Atticoantral Disease
- **Surgical Goals for Treatment of Cholesteatoma**
- **Laparotomy (Exploration) of Mastoid**

DEFINITION

- Chronic suppurative otitis media (CSOM) means chronic or long-standing infection of the mucoperiosteal lining of the middle ear cleft, which is characterized by:
  - Discharge
  - Deafness
  - Perforation of the tympanic membrane (TM)
- Duration of disease is usually more than 12 weeks in CSOM
- Incidence of CSOM in India is 46/1,000 (rural population) and 16/1,000 (urban areas)
- It is one of the most common causes of deafness in our country because of its prevalence in poor socio-economic class.

Types

1. Tubotympanic or safe type
2. Atticoantral or unsafe type.

The development and behavior of CSOM depends upon the following factors:

- Disorders of ventilation
- Reaction of mucoperiosteal lining
- Infiltration by keratinizing epithelium
- Secondary infection by saprophytes and pyogenic organism
- Reaction of bone such as erosion or necrosis.

TUBOTYMPANIC TYPE OF CHRONIC SUPPURATIVE OTITIS MEDIA

- In this, the disease is confined to the mucosa of eustachian tube (E-tube) and anteroinferior part of middle ear.
- It is a safe type of disease as there is no danger to the life of patient hence is also called benign type of CSOM.
- About 10 percent of apparently safe looking ears may be dangerous.

Types of Tubotympanic Chronic Suppurative Otitis Media

1. *Permanent perforation syndrome (Lille type I):* Here, the margin of the perforation epithelializes so the perforation does not heal, even though there is no active discharge.
2. *Persistent mucosal disease (Lille type II):* Here, there is some source of infection or block as a result, the ear becomes chronically draining. It may occur due to an aditus block or infection through the eustachian tube.

Etiology

- Always a sequelae of acute suppurative otitis media (ASOM) which has not been treated adequately
- Once the permanent perforation takes place, entry of infection takes place through external auditory meatus or eustachian tube
- Occasionally, a traumatic perforation may get infected and CSOM ensues.

Common Causes of Chronic Otitis Media

- Inadequate/poorly selected antibiotic therapy in ASOM
- Late treatment of acute otitis media (AOM)
- Upper airway sepsis like allergy, adenoid and tonsil disease
- Lowered resistance, e.g. malnutrition, anemia
- Particularly virulent infection, e.g. measles.

Predisposing Factors

These may be:
- Infection from tonsils, adenoids and sinuses
- Allergy
- Eustachian tube dysfunction
- Malnutrition
- Hypogammaglobulinemia
- Bathing and swimming in dirty water.

Bacteriology

Pseudomonas, Proteus, Escherichia coli and anaerobes (Bacteroides fragilis and Peptostreptococcus).

Pathology

- In this type of CSOM, the disease remains confined to mucosa of anteroinferior part of middle ear and E-tube
- Due to infection, there occurs hyperplasia of mucosa leading to blockage of posterior part of tympanum leading to extravasation of blood, which may result in cholesterol granuloma or blue drum.

Pathological Changes

Pathological changes depend upon the stage. The stages are as follows:

Acute stage: When the ear is discharging and the mucosa of middle ear will appear to be hypertrophied, velvety and congested.

Inactive stage: There will be a dry perforation most commonly in the anteroinferior part of TM and mucosa of middle ear will be normal.

Quiescent stage: Perforation will be present, ear will be dry for quite some time and middle ear mucosa may be normal as in Lille type I or may be slightly hypertrophied and polypoidal in Lille type II.

Healed stage: Perforation has healed by a thin scar. Along with it, there may be tympanosclerotic patches seen as chalky deposits on tympanic membrane. Ossicular chain is usually intact and mobile, but may show some degree of necrosis of incus or malleus.

Clinical Features

Symptoms

- Discharge is mucopurulent, not foul smelling and is aggravated with upper respiratory catarrh (URC)
- Hearing loss is usually conductive type and of moderate intensity (35-40 dB). Hearing is better when ear is discharging due to shielding effect of round window or discharge covering the perforation
- History of URC allergy/tonsillitis, adenoiditis or sinusitis is most of the time related to the discharge
- Pain is not present unless CSOM is associated with acute otitis externa or complications.

Signs

- Examination of ear shows a perforation of tympanic membrane, which is central with variable shape and size, dry or wet
- Mucosa of the middle ear may be polypoidal, edematous or congested depending upon the stage of CSOM (**Figures 7.1A to C**).
- Polyp is usually pale in tubotympanic, while in atticoantral disease it is fleshy and pink.
- Kidney-shaped perforation is explained due to relatively poor blood supply of the involved area of the tympanic membrane.
- Eustachian tube opening, round window, ossicles may also be visible through the perforation (**Figure 7.1D**).
- Ossicular chain is usually normal, but may be necrosed particularly long process of incus due to its precarious blood supply
- Perforation of TM causes diminished hearing and degree of hearing loss depends upon the size and site of perforation; frequency of sound and middle ear space volume
- Remnants of tympanic membrane may show tympanosclerotic patches, which are calcareous chalky deposits that interfere in mobility of tympanic membrane.

Functional Examination

Tuning fork tests show negative Rinne, Weber lateralized to bad ear and absolute bone conduction (ABC) equal.

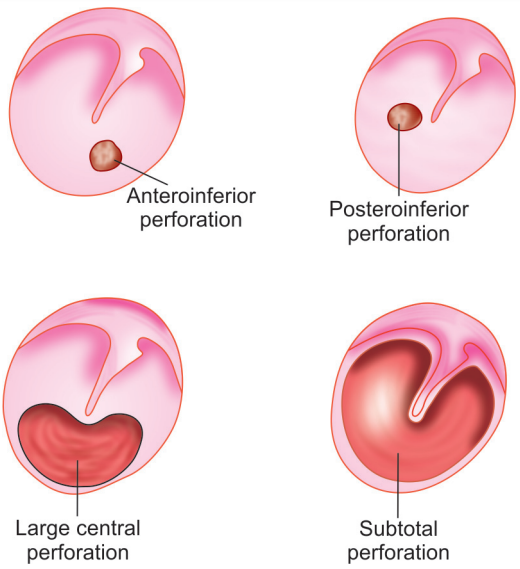


Figure 7.1A Different sites of safe perforations in CSOM

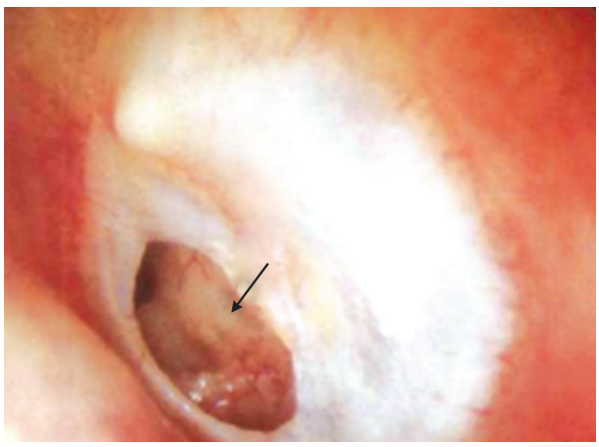


Figure 7.1B Anterior perforation

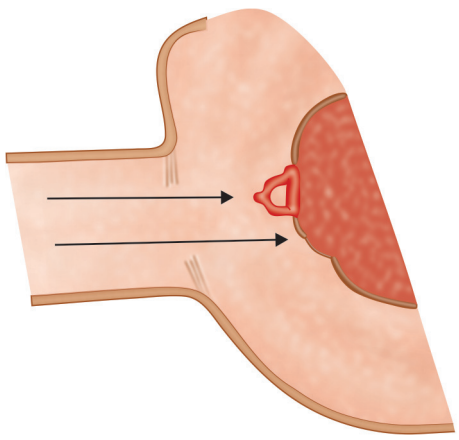


Figure 7.1C Loss of phase difference in perforated tympanic membrane

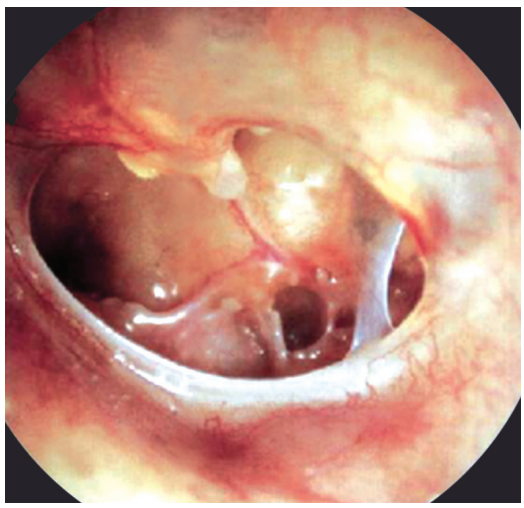


Figure 7.1D Subtotal perforation with various landmarks

Pure tone audiometry (PTA) shows bone air gap indicating conductive hearing loss.

> Sensory neural hearing loss can occur in safe type of CSOM because of:
> – Use of ototoxic topical and systemic antibiotics or
> – Due to absorption of bacterial toxins through the round window.

Investigations

- Blood for hemoglobin (Hb), total leukocyte count (TLC), differential leukocyte count (DLC), bleeding time (BT), clotting time (CT)
- Urine for routine examination
- Culture and sensitivity of ear discharge to select proper antibiotics
- X-ray paranasal sinuses (PNS) (to rule out sinusitis)
- X-ray both mastoids lateral oblique view (Schuller's view) shows clouding of cells, but no cavitation
- PTA to see the amount and type of hearing loss.
- **Examination under microscope is very helpful particularly in doubtful cases of type of CSOM.**

Management

Treatment of safe type is always conservative. It depends upon the stage of CSOM as follows:

Active Stage

1. **Aural toilet:**
   - By dry method such as by **dry mopping** with cotton swabs. Putting a cotton wool wisp in the ear canal for few minutes and replacing it till discharge does not appear

- **By wet method:** The idea is to take out the discharge from the meatus and middle ear. Hydrogen peroxide can be instilled for 1/2 to 1 minute followed by cleaning with warm boric solution. **Suction method is better,** but the drawback is noise trauma and continuous suction may cause vertigo also
- **Syringing with warm saline** or acetic acid 1.5 percent may be done by expert person.

2. **Antibiotics** play an important role and are given depending upon culture and sensitivity report of discharge. Usually, a combination of Amoxy-clox (1 TDS) or cipro tinidazole (1 BD) is effective. Ototoxic antibiotics should be avoided because even the drops may be absorbed causing sensorineural hearing loss.
3. **Role of decongestants and antiallergics:** Their role is in the form of tablets such as pseudoephedrine, tripolidine, cetrizine or in the form of nasal drops such as oxymetazoline or xylometazoline or saline nasal drops in infants. These help in decongesting and proper aeration and drainage through eustachian tube.
4. **After care** to prevent recurrence, it is advised to keep ears dry, avoid swimming and avoiding URC.
5. **Treatment of any predisposing factors** such as deviated nasal septum (DNS), sinusitis, polypi, allergy or adenotonsillar infection is very important to complete the cure and prevent recurrence.

Quiescent Stage

In this stage precautions, such as after care and treatment as above should be taken and the patient kept under observation so that he passes onto inactive stage.

Inactive Stage

Treatment in inactive stage depends upon the patient and the perforation.

- If the patient is aged and has mild loss, he may be advised to keep the ear dry and if the hearing loss is moderate and the patient is young and active, the following treatment is advised.
  - **Perforation less than 5 mm size**—cautery with trichloroacetic acid (50%) or silver nitrate (20%) is done repeatedly at an interval of 7 to 10 days to unlock or de-epithelialize the margins of perforation to promote their healing. Gel foam may be kept for support and area is kept moist with ear drops to promote fibroblast growth.
  - **Role of surgery:** If the perforation is larger, then **myringoplasty or tympanoplasty** operation has to be done to improve the conductive hearing loss.

Patch test helps to find out if ossicular chain is intact or necrosed. In this test a disc of paper or gel foam is kept on the perforation and the patient is asked, if there is any subjective improvement. If yes, it means that the ossicular chain is intact and simple myringoplasty will do, otherwise tympanoplasty has to be done for repair of ossicular chain and TM.

Complications of safe type of CSOM

1. Otitis externa
2. Erosion of ossicular chain
3. SNHL
4. Vertigo
5. Tympanosclerosis.
6. Adhesion in middle ear.

ATTICOANTRAL TYPE OF CSOM

- It is also called unsafe or dangerous type of CSOM, because dangerous intra-or-extracranial complications can occur, which may prove fatal for the patient
- In this the disease spreads to bony walls of epitympanum, aditus, antrum and adjoining mastoid cells.

Etiology

Mostly, the etiology of atticoantral disease is:

- Cholesteatoma, which is most commonly seen in acellular or sclerotic type of mastoid
- It may also be caused by localized osteitis in which granulations are seen in posterosuperior part or attic region
- Narow epitympanic space also predisposes to formation of cholesteatoma.

Pathogenesis of Atticoantral Disease

- Negative intratympanic pressure results in the formation of retraction pockets involving attic or posterosuperior tympanic segment
- If the Prussak's space is obstructed, then there is limited retraction of attic; but in case, both isthmi are obstructed, the vacuum produces a larger attic retraction pocket. (Isthmi allow ventilation beyond mesotympanum in acellular mastoid)
- If keratin collects in this pocket, becomes moist and swollen, it becomes an ideal media for the growth of proteolytic bacteria
- This causes ulceration of the epidermal lining of the pocket leading to osteitis with resorption of bone
- There is granulation tissue in the attic or sinus tympani. The long process of incus, crura and head of stapes are destroyed
- Once the cholesteatoma is established, its expansion in the middle ear is influenced by pneumatization of mastoid and distribution of mucosal folds and ligaments of middle ear cleft.

Cholesteatoma

It is a misnomer as it is neither a tumor nor do all cholesteatomas contain cholesterol crystals. Various names have been given to it such as:

- Cholesteatosis (Young)
- Epidermosis (1961, Tumarkin)
- Keratosis (1963, McGuckin)
- Keratoma (1974, Schuknecht), which is thought to be most appropriate.

Definition

- Skin at a wrong place is the simplest definition of cholesteatoma. It may be defined as a cystic structure lined by keratinized squamous epithelium resting on a fibrous stroma
- Presence of keratinising stratified squamous epithelium within the middle ear cleft constitutes cholesteatoma
- It literally means cholestea (meaning fat), oma (means tumor), which is not so
- Epithelial lining resting on fibrous tissue forms the matrix on which sheets of desquamated epithelium called keratin lie to form the bulk of cholesteatoma
- Black cholesteatoma is collection of old hemorrhage in it giving it a black appearance
- Macroscopically cholesteatoma looks like a soft pultaceous mass resembling tooth paste contained in a sac or cholesteatoma appears to be a rounded pearly white mass often surrounded by friable granulation tissue from infected bone
- Microscopically cholesteatoma is a benign keratinizing squamous cell cyst
- Epithelial matrix of acquired cholesteatoma has 10 to 15 layers, while congenital cholesteatoma has only 5 layers of matrix
- Most common site of origin of middle ear cholesteatoma is posterior epitympanum.

Types of Cholesteatoma

A. Congenital
B. Acquired
   - Primary
   - Secondary (Lille type III).

Congenital Cholesteatoma

- It arises from congenital embryonic cell rests in the middle ear or temporal bone
- Other theories of formation are due to ectodermal migration or middle ear mucosa metaplasia
- The patient is a child around 4 to 5 years and the male female ratio is 3:1
- It presents with whitish cholesteatoma mass behind an intact tympanic membrane.
  - This TM may perforate spontaneously and present as a case of CSOM.
  - Sites of congenital cholesteatoma are petrous apex, cerebellopontine angle, mesotympanum and TM.

Acquired Cholesteatoma

- **Primary acquired:** In this, there is no previous history of otitis media or perforation. Patients with cleft palate are said to be more prone to primary acquired cholesteatoma.
- **Secondary acquired:** In this cholesteatoma occurs in a pre-existing perforation in the pars tensa and the perforation is marginal in the posterosuperior quadrant of pars tensa.
- Sometime cholesteatoma may occur in a residual perforation after grommet gets extruded.

Theories of Pathogenesis of Cholesteatoma

Theories of pathogenesis of cholesteatoma are as follows:

1. **Congenital theory:** Cawthorne (1963) stated that cholesteatoma may originate as congenital embryonic cell rests, which eat away bone unless it breaks through the outer attic wall.
2. **Theory of immigration:** Ruedi, Tumarkin shared the view that a cholesteatoma is derived by immigration of squamous epithelium from deep meatus and tympanic epithelium into the middle ear cleft through a marginal perforation as seen after necrotising otitis media.
3. **Theory of invagination:** Persistent negative pressure in the attic causes invagination of pars flaccida resulting in pre-epidermosis. Cholesteatoma threat occurs only when keratin debris accumulate, which gets infected by *Pseudomonas, E. coli, B. proteus* resulting in clinical symptoms of CSOM.

   Habitual sniffing is known to cause high degree of negative middle ear pressure, which may play a crucial role in pathogenesis of cholesteatoma (Wittmack,1933).
4. **Theory of metaplasia:** Wendt (1873) stated that flattened epithelium of the attic undergoes metaplasia resulting in keratinizing squamous epithelium due to subclinical infection. Origin of cholesteatoma is shown in **Figure 7.2**.

Effects of Cholesteatoma

Cholesteatoma erodes bone by:

a. **Chemical theory:** Due to liberation of chemicals at the periphery of matrix.
b. **Ischemic theory:** By pressure ischemia leading to necrosis.
c. **Enzymatic:** Enzymes such as collagenases, proteolytic enzymes, acid phosphatases, etc. are secreted by perimatrix (a layer of granulation tissue that is in contact with the bone).

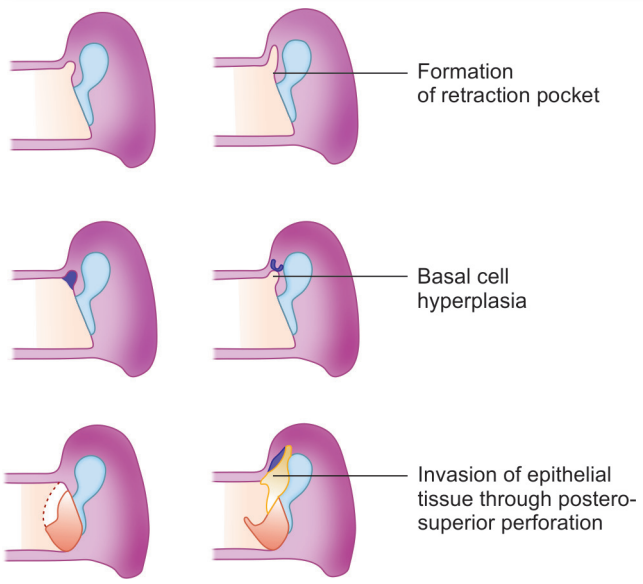


Figure 7.2 Origin of cholesteatoma

Bone resorption in cholesteatoma

Bone resorption in cholesteatoma may be due to:
1. *Mechanical factors:* Due to expanding cholesteatoma.
2. *Biochemical factors:* Due to bacterial endotoxins and products of granulation tissue such as cytokines, collagenase and acid hydrolase.
3. Cellular factors due to osteoclastic activity.
   An active infected cholesteatoma causes faster bone resorbtion.

Pathogenesis of Cholesteatomas

- **Primary acquired cholesteatomas**
  - Invagination theory
  - Basal cell hyperplasia theory
  - Otitis media with effusion theory
  - Epithelial invasion theory
- **Secondary acquired cholesteatoma**
  - Implantation theory
  - Metaplasia theory
  - Epithelial invasion theory

Clinical Features

- **Discharge:** Scanty, foul-smelling discharge like dead mouse or rotten fish due to saprophytic infection and osteitis and may be blood stained.
- Foul-smell is due to decomposition of desquamated epithelium and superadded infection by gram-negative anaerobes and saprophytic bacteria.
- Other causes of foul-smelling discharge are granulomatous conditions, myiasis, chronic foreign body and malignancy with secondary infection.
- **Hearing loss:** It is usually of conductive type and of moderate intensity (35-45 dB). It may be of mixed type in long-standing cases in which sensorineural hearing loss (SNHL) occurs due to absorption of toxins through round window or the use of ototoxic antibiotics over a long period. Sometimes the hearing may be normal because of bridging of gap by the cholesteatoma itself called cholesteatoma hearer.
- **Other features** may be earache, vomiting, fever and persistent headache in case of extradural abscess or acute otitis externa.
- Tinnitus, vertigo, facial nerve palsy, Gradenigo syndrome indicates complications of otitis media.

Examination

- There is present a scanty foul-smelling discharge due to bone destruction
- Sagging of posterosuperior bony meatal wall
- Attic or posterosuperior marginal perforation with granulation tissue or pearly white flakes of cholesteatoma (**Figures 7.3 to 7.5**)
  A fistula in the post-auricular region may be seen as a complication of CSOM (**Figure 7.5C**)
- Granulation tissue is newly formed highly vascularized connective tissue and appears as a part of the normal repair process.
- Aural polyp is progressively enlarging hyperemic middle ear mucosa and is pedunculated, which may arise from any part of middle ear such as promontory, ossicles or even facial nerve and is usually pale in color and insensitive to touch

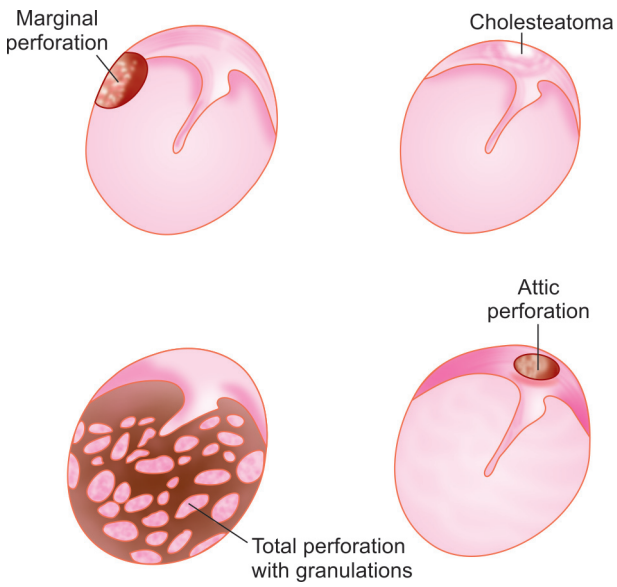


Figure 7.3 Different types of perforations in unsafe type of chronic suppurative otitis media

Figure 7.4 Ear polyp (right side)

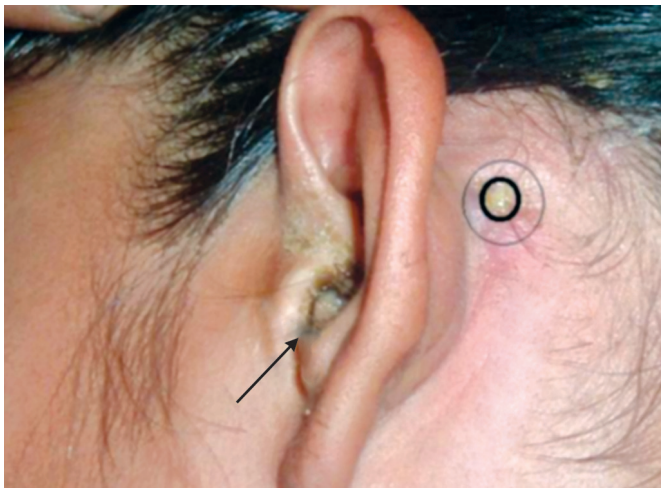


Figure 7.5B Fistula in mastoid

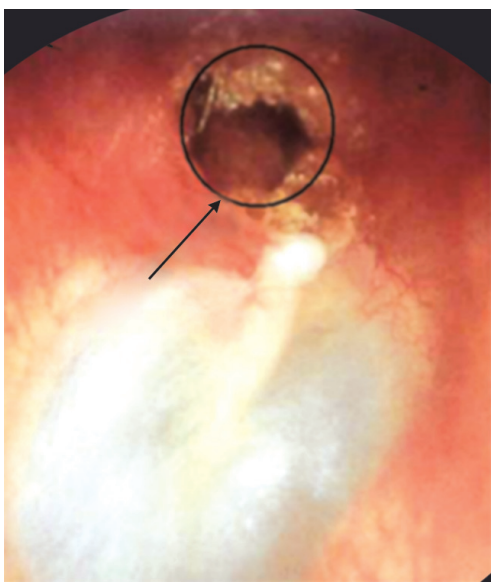


Figure 7.5A Attic perforation

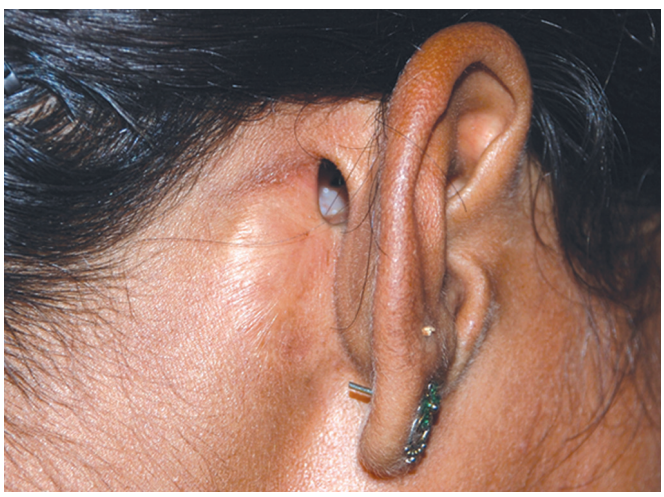


Figure 7.5C Natural fistula in mastoid

- Fistula test if positive points towards labyrinthine erosion usually of horizontal semicircular canal (HSCC)
- Examination under microscope is very helpful in finding out necrosed ossicles and condition of labyrinthine windows.

Investigation

1. Tuning fork tests show conductive hearing loss of moderate to severe degree, i.e. Rinne negative, Weber lateralized to the bad ear and ABC is equal.
2. PTA confirms the conductive or mixed type of hearing loss.
3. Hemoglobin (Hb), bleeding time (BT), and clotting time (CT).
4. Urine for routine examination.
5. Culture and sensitivity of discharge shows *S. aureus, Proteus, P. aeruginosa* or *E.coli*.
6. X-ray both mastoid lateral oblique view may show sclerosis, destruction or cavitations and widening in attic or mastoid antrum only when it is extensive disease.

   Edges of the cavity caused by cholesteatoma are irregular and shaggy, while that due to operated mastoid cavity are smooth and regular.
   The positions of sigmoid sinus and dural plate can also be seen besides the degree of pneumatization and temporomandibular joint.

7. CT scan is very useful to see the extent of the disease, especially facial nerve, condition of necrosed ossicles and to confirm the findings of X-ray mastoids.
   CT shows a non-enhancing mass with bony erosion and sharply defined smooth margins.

Differential diagnosis of cavity mastoid

- Cholesteatoma
- Large antrum
- Postoperative cavity
- Glomus tumor
- Cholesterol granuloma
- Tuberculosis
- Sarcoidosis
- Multiple myeloma
- High jugular bulb
- Big facial recess.

Treatment

- Treatment of atticoantral disease is only surgical (mastoidectomy operation). The aim of treatment should be to achieve a dry, safe and useful ear
- Conservative medical treatment is not of any help in unsafe ear
- Antibiotics can help in the suppression of secondary infection, but will not affect the osteitis or the control of cholesteatoma
- In the initial stages if there is a retraction pocket, repeated suction in OT will help to remove the infected debris.

Surgical Goals for Treatment of Cholesteatoma

- Remove total disease
- Achieve a dry ear
- Treatment and prevent complications
- Preserve normal anatomy
- Improve hearing.

Surgical Treatment of Cholesteatoma

Depends upon the type and extent of cholesteatoma in the middle ear cleft.

- Choice of procedure depends upon the extent of the disease in the middle ear and may be canal wall up or canal wall down procedures
- Various procedures done are:

Laparotomy (exploration) of mastoid

Laparotomy includes:

1. *Canal-wall-up*
   Complete mastoidectomy
   Facial recess approach
2. *Canal-wall-down*
   Modified radical mastoidectomy
   Radical mastoidectomy
3. *Others*
   Atticotomy
   Bondy procedure
   Canal-wall-reconstruction

- In canal-wall-up procedures posterior bony wall is left intact and disease is removed through external auditory meatus and mastoid thus avoiding open mastoid cavity. It also helps in reconstruction of hearing. Danger of leaving some cholesteatoma behind is high in these cases
- In canal-wall-down procedures posterior meatal wall is removed thus exteriorizing the diseased area, which can be easily cleaned as and when required.
- Modified radical mastoidectomy or radical mastoidectomy (both of these are canal-wall-down procedures)
- If the disease is limited to attic only, atticotomy may be sufficient
- Further extension of cholesteatoma into antrum will require atticoantrostomy
- Cholesteatoma matrix is completely removed from all areas except when it is adherent to the dura, facial nerve or superior semicircular canal (SCC) or ice covering the footplate of stapes.

These procedures will give the patient a dry and safe ear, but useful ear will only be achieved by tympanoplasty procedures, which includes putting a temporal fascia graft along with repair of ossicular chain.

Contraindications of Surgery in Unsafe Ear

1. Only hearing ear.
2. Very elderly patient.
3. Medically unfit

- Diagnostic features of safe and unsafe CSOM is given in **Table 7.1.**

Table 7.1: Diagnostic features of safe and unsafe chronic suppurative otitis media

S.no.	*Tubotympanic type (safe)*	S.no.	*Atticoantral type (unsafe)*
1.	Mostly seen in younger age group	1.	Seen in middle age group
2.	Discharge is copious, mucopurulent, non-foul smelling and not blood stained	2.	Discharge is scanty, foul smelling and may be blood stained
3.	History of upper respiratory catarrh, sinusitis, adenotonsillitis present	3.	Any such history usually not present
4.	Deafness is of conductive type and of mild to moderate degree	4.	Deafness may be conductive or mixed type and of moderate to severe degree
5.	On examination there is no sagging of bony meatal wall and TM shows a central perforation in pars tensa	5.	Sagging may be present and an attic or posterosuperior marginal perforation may be present
6.	Granulation tissue or cholesteatoma are not seen	6.	These are usually present
7.	Symptoms and signs of complications such as vertigo, facial nerve palsy, headache are usually not present	7.	These may be present in long-standing cases of unsafe ear
8.	X-ray mastoid may show some clouding, but no cavitation	8.	X-rays shows sclerosis, cavitation or evidence of destruction
9.	X-ray of para nasal sinuses (PNS) or nasopharynx may show evidence of sinusitis or a nasopharyngeal mass such as adenoids	9.	Such X-rays are not informative in atticoantral disease
10.	Treatment is mostly conservative along with repair of the perforation	10.	Treatment is always surgical in the form of canal wall up/down procedure

Key Points

1. **Hearing in CSOM** is better when the ear is discharging due to shielding effect of round window or discharge covering the perforation.
2. **Cause of SNHL** in a case of CSOM may be due to absorption of toxins through the round window or use of ototoxic antibiotics and drops.
3. Simple **patch test** helps to find out the integrity of ossicular chain, hence to decide whether myringoplasty or tympanoplasty needs to be done.
4. **Ciliated columnar epithelium** lines the E-tube, anterior mesotympanum and inferior hypotympanum, while cuboidal epithelium lines the attic, mastoid and posterior mesotympanum.
5. **Posterior perforation** tends to have more hearing loss due to loss of sound protection for round window. Larger the perforation, greater the loss of surface area on which sound pressure can act.
6. **Keratoma** (Schuknecht, 1974) is the most appropriate name for cholesteatoma.
7. **Cholesteatoma erodes bone** due to enzymes secreted by perimatrix, i.e. osteoclasts such as collagenases, proteolytic enzymes and acid phosphatases.
8. **A positive fistula** test may be seen in oval or round window fistula, post-stapedectomy perilymph leaks, horizontal canal fistula, Ménière disease, labyrinthitis or syphilis.
9. **Nystagmus** occurring with tragal compression or Valsalva maneuvre is due to superior SCC dehiscence syndrome.
10. **Only treatment of unsafe ear** is removal of disease by mastoidectomy to make the ear safe and to reconstruct the hearing, but not at the cost of disease.
11. **Most important diagnostic procedure** in confirming the presence of cholesteatoma is microscopic examination of the patient.
12. **Attic perforation with SNHL**—treatment of choice is MRM
13. **Malleus** is the most commonly deformed ossicle congenitally.
14. **Long process of incus** gets necrosed before stapedial crura in CSOM.
15. **Foul-smelling discharge** is due to saprophytic bacteria and osteitis caused by cholesteatoma, indicating unsafe pathology. **Other causes of foul-smelling discharge** are granulomatous conditions, myiasis, chronic foreign body and malignancy with secondary infection.
16. **Tubercular otitis media: clinical features—remember mneumonic:** 5 P's; Painless ear discharge; Perforations multiple; Profound hearing loss; Paralysis of face; Pale granulation
17. **Theories of origin of cholesteatoma—remember mneumonic: CRWSH: C**ongenital theory; **R**uedi's theory; **W**ittmacks's theory; **S**aade's theory; **H**abermann's theory.

Chapter 8 Complications of Suppurative Otitis Media

What Students Must Know!

- **Classification of Complications**
- **Extracranial Complications of SOM**
  - Acute Mastoiditis and Subperiosteal Abscess
  - Labyrinthitis
  - Petrositis
  - Facial Nerve Palsy
- **Intracranial Complications of SOM**
  - Extradural Abscess
  - Otogenic Meningitis
  - Otogenic Brain Abscess
- **Lateral Sinus Thrombosis**
  - Tobey Ayer Test

Why Complications Occur in Chronic Suppurative Otitis Media?

Although incidence of complications is declining, but these are still seen in India due to:

- Poor socioeconomic conditions
- Lack of education and awareness of health care
- Complications are commonly seen following acute suppurative otitis media (ASOM) or chronic SOM of atticoantral type.

CLASSIFICATION OF COMPLICATIONS

1. ***Extracranial (Intratemporal):***
   i. Acute mastoiditis
   ii. Subperiosteal abscesses.
   iii. Petrositis and Gradenigo's syndrome
   iv. Labyrinthitis
   v. Facial nerve palsy
   vi. Osteomyelitis of temporal bone
   vii. Septicemia or pyemia
   viii. Otogenic tetanus.
2. ***Intracranial:***
   i. Extradural abscess
   ii. Subdural abscess
   iii. Otogenic meningitis
   iv. Otogenic brain abscess
   v. Lateral sinus thrombosis
   vi. Otitic hydrocephalus.

FACTORS LEADING TO COMPLICATIONS

- Inadequate antibiotics.
- High virulence of bacteria.
- Poor resistance.
- Presence of diabetes mellitus, tuberculosis, leukemias.
- Antibiotic resistance of organisms.
- Preformed pathways.
- Immunocompromised patients.

How Infections Spread

Different routes of spread of infection are as follows (**Figure 8.1**):

- *Direct spread:*
  - In acute cases infection, spreads by hyperemic decalcification.
  - In chronic infections, by osteitic erosion because of cholesteatoma or granulation tissue.
- *By retrograde thrombophlebitis:*
  - This is the commonly seen mode of spread in acute infections
  - It is because of connection of veins of Haversian canal with dural venous sinuses through dural veins.
- *Preformed pathways such as:*
  - Congenital dehiscences such as that of fallopian canal or jugular bulb
  - Patent sutures such as petrosquamous suture
  - Accidental or surgically created bony defects

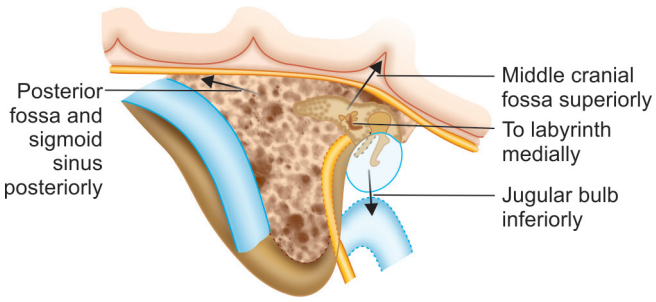


Figure 8.1 Different routes of spread of infection from middle ear and mastoid

– Through normal anatomical pathways such as oval/round window, aqueduct of vestibule and internal acoustic meatus or through foramina of blood vessels.

EXTRACRANIAL COMPLICATIONS OF SOM

Acute Mastoiditis and Subperiosteal Abscess

The acute mastoiditis and subperiosteal abscess have been described in Chapter 6 (**Figure 8.2**).

Labyrinthitis

Inflammation of the labyrinth is called labyrinthitis.
It result from the following:
- Acute suppurative otitis media
- After stapedectomy

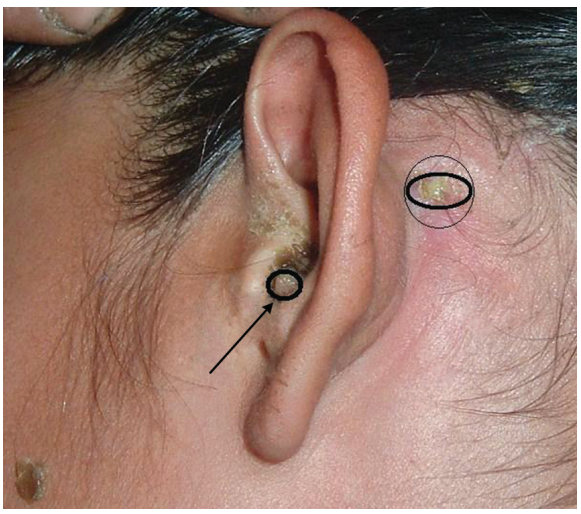


Figure 8.2 Mass in meatus and a mastoid fistula

- Through preformed pathways
- Fracture lines.

There are two types of labyrinthitis:
1. Localized or circumscribed.
2. Diffuse type:
   - Serous labyrinthitis
   - Suppurative labyrinthitis.

Localized Labyrinthitis

Localized labyrinthitis is a type of fistula of the labyrinth and is because of localized erosion of bony labyrinth exposing the membranous labyrinth.

Causes
- Cholesteatoma causing erosion of lateral semicircular canal (SCC) or foot plate of stapes.
- Middle ear neoplasms such as carcinoma or glomus tumors.
- Accidental or surgical injuries.
- Syphilis, tuberculosis, osteomyelitis.
- Auto immune–Cogan's disease.

Clinical features
- Vertigo
- Fistula test becomes positive due to exposure of membranous labyrinth
- Nystagmus towards the diseased or affected ear
- Features of CSOM are present.

Treatment
- Antibiotics such as ampicillin or 3rd generation cephalosporins
- Antivertiginous drugs such as cinnarizine 25 mg three times a day or betahistine (vertin) 16 mg three times a day
- Mastoid exploration is done to remove the underlying disease
- After control of acute phase vestibular head exercises are given.

Diffuse Serous Labyrinthitis

It is a diffuse inflammation of the labyrinth without pus formation and is a reversible condition.

Causes
- May follow localized labyrinthitis.
- After acute inflammation of middle ear.
- May be seen after stapedectomy or fenestration operation.

Clinical features
Nausea, vomiting, vertigo, spontaneous nystagmus towards opposite ear and rarely towards involved ear. Some degree of sensorineural hearing loss (SNHL) may be present.

Treatment

- Medical treatment includes:
  - Complete bed rest with affected ear upwards
  - Labyrinthine sedatives such as stemetil, cinnarizine and betahistine.
- Surgical treatment:
  - Myringotomy if it follows ASOM
  - Cortical mastoidectomy operation if after ASOM
  - Modified radical mastoidectomy if cholesteatoma is present.

Diffuse Suppurative Labyrinthitis

Diffuse suppurative labyrinthitis is diffuse pyogenic infection of labyrinth, which leads to loss of vestibular and cochlear function.

Causes

- May be seen after serous labyrinthitis
- Infection through pathological or surgically created windows.
  Bacteriology:
  - B. hemolytic-streptococci
  - Pneumococci
  - *Haemophillus*
  - *Proteus*
  - *Pseudomonas*
  - Staphylococci.

Clinical features

Nausea, vomiting, severe vertigo and spontaneous nystagmus to the healthy side, SNHL, the patient lies curled up in bed on healthy side.

Headache, fever or pain does not occur from a labyrinth filled with pus because pus is scanty and its absorption in systemic circulation is not possible due to intact labyrinth capsule.

Treatment

- Medical treatment is same as for diffuse serous labyrinthitis recovery starts after 2 weeks and is complete within 4 to 6 weeks due to compensation of central mechanism.
- Surgical treatment is the same as for serous labyrinthitis. Drainage of labyrinth is required only if it is causing further complications such as meningitis or brain abscess.
  - Labyrinthectomy is rarely done when total loss of labyrinth function is present
  - Labyrinth (SCC) is drained by entering above the horizontal part of facial nerve and cochlea and saccule are drained by entering below the facial canal.

Apical Petrositis (Gradenigo's Syndrome)

This has been discussed in Chapter 5.

Facial Nerve Palsy

Facial nerve palsy may result from both acute SOM or chronic SOM.

i. In acute SOM, if bony canal wall of facial nerve is dehiscent and nerve lies under mucosa, inflammation may spread to epi- and perineurium causing facial nerve palsy.
ii. In chronic SOM, palsy occurs due to cholesteatoma or granulation tissue by causing destruction of bony wall and pressure on the nerve with inflammation leading to slowly progressive palsy.

Clinical Features

Features will be of acute or chronic SOM with facial nerve palsy such as inability to close the eye, inability to blow or wrinkle the face and forehead (**Figure 8.3**).

Treatment

i. In acute SOM cases good antibiotics and anti-inflammatory drugs. Patient may require myringotomy or cortical mastoidectomy operation.
ii. In chronic cases leading to VII nerve palsy exploration of mastoid for removal of cholesteatoma and decompression of nerve in the facial canal.
iii. Nerve grafting by greater auricular nerve may be required if part of nerve is missing. Recovery depends upon the extent of damage.

Osteomyelitis of Temporal Bone

Osteomyelitis is not very common complication and occurs when infection spreads to the marrow spaces of temporal bone.

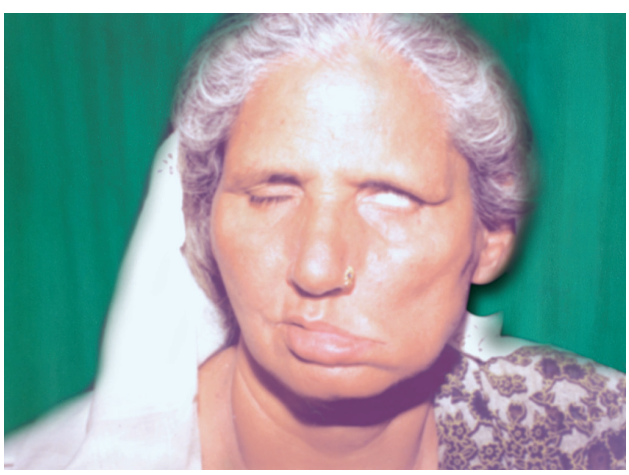


Figure 8.3 Facial nerve palsy due to CSOM in a 45-year-old lady

Septicemia or Pyemia

Septicemia may occur as a complication of acute or chronic SOM if treatment is not taken for a long time and the virulence of organism is high or patient has a poor resistance.

Otogenic Tetanus

Otogenic tetanus follows unhygienic cleaning of the ear or bathing in infected water and in cases where there has been no immunization. The treatment is same as for tetanus by injection of antitetanic serum and antibiotics besides general measures.

INTRACRANIAL COMPLICATIONS OF SOM

Extradural Abscess

- Collection of pus between bone and dura is called extradural abscess
- It is called epidural abscess if it lies medial to sigmoid sinus; but if it encloses the sinus, it is called perisinus abscess.

Pathology

- Infection reaches the area either by hyperemic decalcification in ASOM or by erosion of bone in cholesteatoma.
- Infection can also spread by venous thrombophlebitis
- Abscess may be found on the dura of middle or posterior cranial fossa or even in relation to venous sinuses
- The affected dura may be covered by granulations or appear discolored and unhealthy.

Clinical Features

- May be asymptomatic
- Persistent headache on the diseased side
- Pain in the ear
- Low-grade fever
- General malaise
- Pulsatile purulent discharge.

Diagnosis is made by contrast-enhanced CT scan.

Pott's puffy tumor is a sort of subperiosteal abscess commonly seen in frontal sinus disease.

Treatment

- Antibiotics
- Mastoid exploration and removal of tegmen to expose the dura till it is found healthy.

Complications

- Sinus thrombosis
- Meningitis
- Brain abscess.

Subdural Abscess

- Subdural abscess is collection of pus between dura and arachnoid mater. Infection spreads from ear by erosion of bone and dura or by thrombophlebitis.
- Pus spreads in subdural space causing pressure symptoms. It may get localized with time.

Clinical Features

- Meningeal irritation causing headache, fever 102°F, malaise, dizziness, neck rigidity and positive Kernig's sign
- Thrombophlebitis of cortical veins leading to nominal aphasia, hemiplegia, hemianopia, jacksonian fits
- Raised intracranial pressure causing papilledema, ptosis, dilated pupils, other cranial nerve palsies.

Diagnosis

It is made by clinical features and CT scan.

Treatment

- Antibiotics
- Neurosurgical by burr holes to drain the abscess
- Mastoidectomy to control ear disease.

Otogenic Meningitis

There is bacterial invasion of meninges and CSF in subarachnoid space.

It is considered most dreaded and fatal complication of SOM.

Mode of Infection

Infection may spread

- Through preformed pathways
- Venous thrombophlebitis
- Direct erosion of bone and dura by cholesteatoma
- It may result from ASOM in infants and from CSOM in adults.

Types

- Serous type (meningismus)
- Purulent type (leptomeningitis).

Clinical Features

- Raised temperature, nausea, vomiting, headache
- Photophobia, mental irritability, drowsiness
- Neck rigidity, cranial nerve palsies, hemiplegia
- Positive Kernig's sign, i.e. painful extension of leg on flexed thigh
- Positive Brudzinski's sign, i.e. flexion of neck causes flexion of hip and knee
- Papilledema
- Babinski' sign, i.e. extension of big toe on stimulation of lateral aspect of sole
- Tendon reflexes become sluggish.

Diagnosis

Lumbar puncture shows increased cell count of polymorphs, increased proteins and decreased chlorides and sugar.

Treatment

- Antibiotics such as penicillin/ampicillin, chlormyecetin or cephalosporin by intravenous route for 7 to 10 days
- Intrathecal medication is avoided as it causes fibrosis resulting in deafness and blindness
- ***Surgical treatment:*** Myringotomy or cortical mastoidectomy, RM/MRM (in presence of cholesteatoma) when general condition of the patient becomes stable.

Otogenic Brain Abscess

- Brain abscess follows acute SOM in children and chronic SOM in adults.
- Cerebral abscess is twice common than the cerebellar abscess.
- Almost 50 percent in adults and 25 percent brain abscesses in children are due to ear disease.
- Temporal lobe abscess is most commonly due to otogenic causes.

Routes of Infection

- Direct extension through tegmen
- Retrograde thrombophlebitis
- Cerebellar abscess occurs by extension through Trautmann's triangle. It may follow labyrinthitis. Sigmoid sinus thrombosis or extradural abscess.

Bacteriology

Staphylococci, Streptococci, *Proteus*, *E. coli*, *Pseudomonas* and anaerobes.

Pathology

Stage of invasion: There are a few symptoms such as fever, malaise, headache, and drowsiness.

Stage of loculation: No symptoms due to natural localization.
Stage of enlargement: As the abscess begins to enlarge, there occur symptoms of increased intracranial pressure and pressure of cerebrum and cerebellum.
Stage of termination: There occurs rupture of abscess into ventricle or sub-arachnoid space resulting in fatal meningitis.

Clinical Features

- Signs and symptoms of increased intracranial tension such as nausea, vomiting (projectile), headache, drowsiness, confusion and coma, papilledema (after 2 to 3 weeks of raised intracranial tension), slow pulse rate and subnormal temperature.
- Localized features of brain abscess:
  - *Temporal lobe abscess:* Nominal aphasia, homonymous hemianopia, contralateral motor paralysis, epileptic fits, hallucinations of taste and smell, pupillary changes and oculomotor palsy.
  - *Cerebellar abscess:* Headache, ipsilateral spontaneous nystagmus, ipsilateral ataxia to the side of lesion, past pointing and intentional tremors, dysdiadochokinesia (rapid pronation and supination of forearm shows slow and irregular movements on affected side).

Investigations

- X-ray skull to see midline shift and gas in abscess cavity
- CT scan to see site and size of abscess. **Ring sign**—A hypodense area surrounded by enhancing ring due to increased vascularity (**Figures 8.4 and 8.5**)
- X-ray both mastoids
- Lumbar puncture, which shows increased CSF pressure, proteins and cell count
- Carotid angiography is useful for temporal lobe abscess only
- Ventriculography
- Radioisotope study
- Electroencephalography (EEG) to see any midline shift.

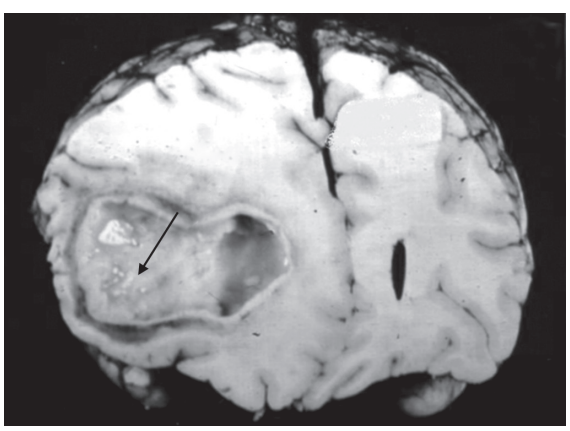


Figure 8.4 Brain abscess

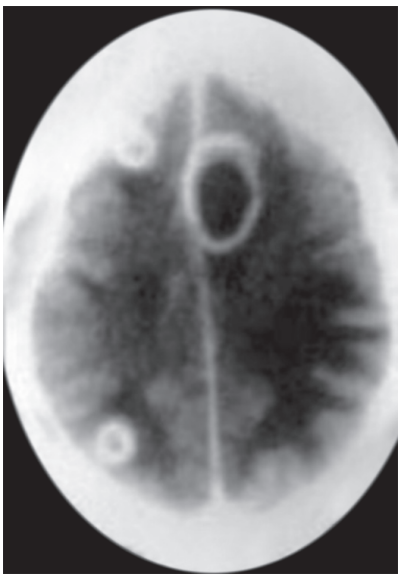


Figure 8.5 CT scan showing brain abscess

Treatment

- *Medical:* Antibiotics such as penicillin and gentamicin with metronidazole, dexamethasone 4 mg IV or 20 percent mannitol.
- *Neurosurgical:*
  - Aspiration of pus through a burr hole.
  - Excision of abscess, i.e. open incision and evacuation.
- Treatment of associated ear disease by radical or modified radical mastoidectomy.

Lateral or Sigmoid Sinus Thrombosis

- This complication was first described by Hooper in 1826
- It used to be a fatal complication in preantibiotic era.
- It is inflammation of the walls of sigmoid sinus with formation of thrombus.

Etiology

- Complication of acute coalescent mastoiditis or masked mastoiditis
- Chronic SOM with cholesteatoma.

Pathology

- Infection spreads to sigmoid sinus by thrombophlebitis leading to perisinus abscess
- Infection further spreads to inner wall of sigmoid sinus with deposition of fibrin, platelets and blood cells leading to the formation of thrombus and endophlebitis
- There occurs enlargement of thrombus occluding the lumen in which organisms invade causing abscess formation, releasing infected emboli and causing septicemia
- Thrombus spreads proximally to superior sagittal sinus or cavernous sinus and distally via mastoid emissary vein to jugular bulb and jugular vein.

Bacteriology

S. haemolyticus, Pneumococci, Staphylococci, *Pseudomonas*, *E. coli*.

Clinical Features

- Hectic fever with rigors, picket fence type of chart, i.e. fever rises and comes to normal. In between bouts of fever, the patient is normal and alert. It is due to release of toxins in the blood that there occurs sharp rise of temperature with rigors.
- Headache of mild to severe degrees.
- Progressive anemia with emaciation.
- Torticollis of neck.
- *Griesinger's sign:* Edema over the posterior aspect of mastoid due to thrombosis of mastoid emissary vein.
- Papilledema is seen when large right side sigmoid sinus is thrombosed or when clot extends to superior sagittal sinus. Fundus may show blurring of disk with hemorrhages and it may be normal if a collateral circulation is present.

- **Tobey-Ayer test (Queckenstedt's test)**
  - In this test, CSF pressure after lumbar puncture is recorded and internal jugular vein is pressed on one side
  - If there is thrombosis on that side, no change or increase in CSF pressure will be seen; but if no thrombosis, it will produce a rise in CSF pressure
  - False negative test occurs if there is a good collateral circulation and false positive occurs if one sinus is smaller (usually left).
- **Crow Beck test**
  - Pressure on jugular vein on one side produces engorgement of retinal veins. If there is a thrombosed sinus, no such change is seen.

Lemierre's Syndrome

- It is septic thrombophlebitis of internal jugular vein (IJV) secondary to acute oropharyngeal infection by Fusobacterium
- Tenderness along internal jugular vein when thrombus extends to jugular vein.

Investigations

- Blood culture shows bacteria
- CSF examination is normal, but the pressure is increased
- X-ray mastoid and delta sign on CT scan are very helpful.

Treatment

- IV antibiotics
- Mastoidectomy with sinus exploration and removal of thrombus
- Ligation of internal jugular vein if thrombus is extending to it
- Anticoagulants.

Complications or Sequelae

- Septicemia
- Pyemia
- Meningitis
- Subdural abscess
- Cerebellar abscess
- Thrombosis of jugular bulb and vein
- Cavernous sinus thrombosis
- Otitic hydrocephalus.

Otitic Hydrocephalus

Also called benign intracranial hypertension or Symond's syndrome. It is characterized by increased intracranial pressure with a normal CSF due to blockade of arachnoid villi and edema of brain. It may be seen in children and adolescents with acute or chronic middle ear diseases.

How it Occurs

Thrombus of lateral sinus extends to superior sagittal sinus thereby impeding function of arachnoid villi to absorb CSF resulting in increased intracranial tension.

Clinical Features

Symptoms
Nausea, vomiting and headache diplopia due to involvement of VI nerve blurring of vision due to papilledema and optic atrophy.

Signs
Papilledema nystagmus, lumbar puncture shows increased pressure of more than 300 mm of water but otherwise normal.

Treatment

- Pressure of CSF should be reduced to prevent optic atrophy and blindness by repeated lumbar puncture or ventricular puncture
- Shunt operation is done to drain CSF into a vein (e.g. ventriculoperitoneal shunt)
- Middle ear pathology should be tackled as required.

Key Points

1. **Complications occur** either due to direct spread, retrograde thrombophlebitis or preformed pathways.
2. Nystagmus is towards **affected ear** in localized labyrinthitis and towards the healthy ear in diffuse labyrinthitis.
3. **Kernig's sign, Brudzinski's sign** and Babinski's sign help in diagnosis of meningitis.
4. **Brain abscess** is the most common intracranial complication of suppurative otitis media.
5. Temporal lobe abscess is the most common brain abscess with features of nominal aphasia.
6. **Griesinger's sign, Tobey-Ayer test** (Queckenstedt's test) and crow beck test point towards the diagnosis of lateral sinus thrombosis.
7. **Delta sign seen** on CT scan in sigmoid sinus thrombophlebitis is an empty triangle at the level of sigmoid sinus consisting of clot surrounded by high intensity rim of contrast-enhanced dura.
8. A patient of **labyrinthitis** likes to lie on the normal side but prefers to see on the diseased side, because the patient has nystagmus towards the healthy side.
9. **Cranial nerves involved in CSOM** are:
   - II, III and IV-------- In cavernous sinus thrombosis
   - V nerve ---------- If petrous is involved
   - VI nerve ------- Dorello's canal involved
   - VII nerve -------- Erosion of mastoid bone
   - IX, X, XI, XII nerve----- Jugular fossa is involved in lateral sinus thrombosis.
10. **Intracranial complications of otitis media—remember mneumonic: ESMOL:** E: **E**xtradural abscess; S: **S**ubdural abscess; M: **M**eningitis; O: **O**togenic brain abscess; L: **L**ateral sinus thrombosis.
11. **Gradenigo's syndrome—remember mneumonic: EAR:** E: **E**ar discharge; A: **A**bducens nerve palsy; R: **R**etro-orbital pain.

Chapter 9 Nonsuppurative Otitis Media

What Students Must Know!

- **Serous Otitis Media**
  - Etiology
  - Clinical Features
  - Investigations
  - Treatment
- **Chronic Adhesive Otitis Media**
  - Causes
  - Treatment
- **Aero-otitis Media**
- **Tubercular Otitis media**

OTITIS MEDIA WITH EFFUSION

- Politzer described this condition in 1869
- Various names have been given to this disease such as silent otitis media, serous otitis media, secretory otitis media or otitis media with effusion (OME)
- The term glue ear has been used when there occurs a collection of thick mucus like a glue in the middle ear
- It is seen mostly between 2 and 7 years of age, in spring or winter months
- In this condition there is present a sterile effusion, which is usually thin but when it becomes thick and sticky it is called glue ear
- Incidence of this disease is 3 to 4 percent of ENT disease and about 10 percent in preschool and schoolgoing children.

Etiology

- Allergy of nose and upper respiratory tract.
- Recurrent viral infections.
- Barotrauma.
- Eustachian tube dysfunction due to adenoid hypertrophy, which acts by:
  - Mechanical blocking of the opening of eustachian tube such as adenoids hypertrophy
  - Obstruction of lymphatics draining the middle ear
  - Providing a focus of infection.
- Other causes such as chronic rhinosinusitis, chronic tonsillitis, tumors of nasopharynx, cleft palate, posterior nasal packing, postadenoidectomy trauma and hypothyroidism.
- Unresolved acute otitis media due to inadequate antibiotics in acute suppurative otitis media (ASOM).
- Immunological factors may also play a role in causation of glue ear.

Pathogenesis

- Inflammatory mediators like prostaglandins and leukotrienes have an important role in the etiopathogenesis of secretory otitis media
- Besides, due to eustachian tube obstruction, which if persists, a negative pressure develops in the tympanic cavity
- Normally pressure of oxygen in the tympanic cavity is higher than in the blood vessels therefore oxygen diffuses into blood vessels resulting in lowering of pressure in the cavity
- Once the negative pressure in the middle ear is established, there occurs swelling of the mucosal lining and exudate fluid starts collecting in it
- Nitrogen level in the middle ear is more than in blood vessels, which then diffuses into these vessels
- Because of the constant negative pressure in the tympanum, tympanic membrane retracts and collapses
- Besides, this infection causes hyperactivity of the mucous glands, thereby, increasing the effusion of exudate which does not pass out due to blocked eustachian tube.

Clinical Features

- Periodic deafness of conductive type of 40 to 50 dB loss throughout the speech frequencies and it improves on lying on abdomen or sitting forward

- Plugged up feeling in the ears
- Autophony and tinnitus
- Mild earache
- Delayed and defective speech
- It may be asymptomatic
- On examination, the external auditory canal shows excessive keratinization of debris possibly due to excessive hyperemia of tympanic membrane (TM) and deep meatus
- Tympanic membrane findings are as follows:
  - It is dull and opaque
  - Retracted and bulging at places
  - Changing fluid level and air bubbles are seen when TM is thin and transparent (**Figure 9.1**)
  - Middle ear structures can be seen through thin TM
  - Mobility is restricted.

Note: Remember in secretory otitis media there is no perforation in TM, which is a feature of chronic suppurative otitis media (CSOM).

Investigations

- Tuning fork tests confirm conductive hearing loss
- Pure tone average (PTA) shows 25 to 40 dB conductive loss and sometimes sensorineural hearing loss (SNHL) due to fluid pressing over round window
- Impedance audiometry shows a flat curve (B type) with reduced compliance and a shift to negative side
- X-ray mastoid shows clouding of air cells.

Treatment

Medical Management

- Decongestants, i.e. oral decongestants and nasal decongestants in the form of drops or sprays.
- Antiallergics play an important role, especially if the cause is allergy.
- Antibiotics are used to prevent secondary infection.
- Middle ear aeration is promoted by Valsalva, politzerization, catheterization and chewing gum exercises also help in opening the tube.

Surgical Management

- Myringotomy and aspiration of fluids (**Figures 9.2A to C**) if thick mucus is present. Aspiration and suction may be done by instilling normal saline or mucolytic agents like chymotrypsin or urea solution.
  It helps in the following:
  - Drainage of secretions
  - Ventilation of middle ear
  - Helps in reverting epithelium back to normal
  - It improves hearing.
- LASER assisted tympanostomy is a newer technique.

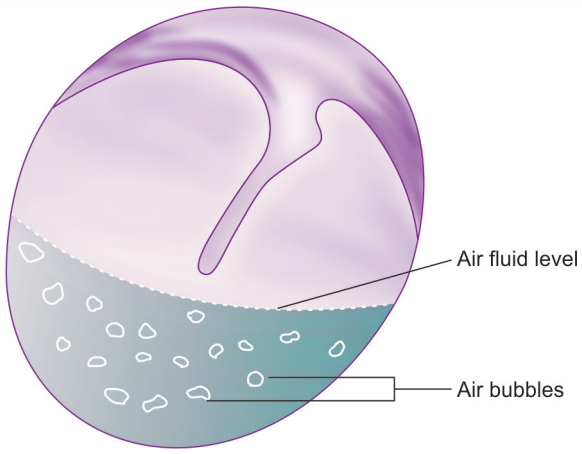


Figure 9.1 Secretory otitis media with air fluid level and air bubbles

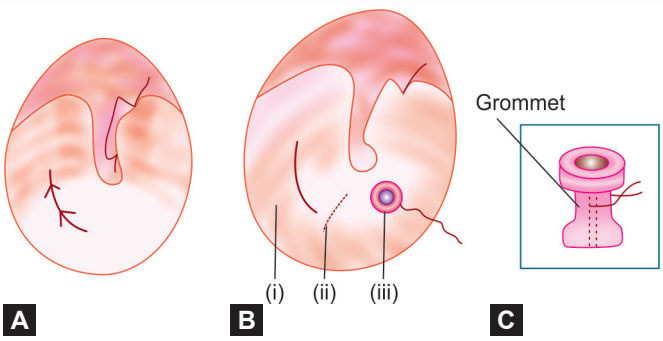
- *Grommet insertion:* Grommet is inserted in the antero-inferior quadrant of tympanic membrane (**Figure 9.3**). Shea or Shepard grommet is used and it helps in providing continuous aeration of middle ear and is left in place for a few weeks to months.
- Tympanotomy or cortical mastoidectomy has a very limited role.
- Surgical treatment of the causative factors, e.g. adenoidectomy, tonsillectomy or antral wash, etc.

Otitis Media with Effusion in Children: Causes

- Nasopharyngeal obstruction, e.g. large adenoids or tumor mass resulting in eustachian tube dysfunction
- Acute otitis media, untreated or inadequately treated, middle-ear effusion may occur
- Allergic rhinitis, will predispose to middle-ear effusions
- Parental smoking has been shown to predispose to OME in children
- Otitis media with effusion is more common in winter months
- Otitic barotrauma—most commonly caused by descent in an aircraft, especially if the subject has a cold
- Idiopathic—no cause is apparent
- Myringotomy and aspiration of fluids, adenoidectomy helpful.

Complications or Sequelae of Glue Ear

- Adhesive otitis media
- Cholesteatoma due to retraction pockets
- Atrophy of TM
- Atelectasis of drum
- Ossicular necrosis
- Tympanosclerosis
- Cholesterol granuloma due to stasis of secretions
- Retraction pockets formation.



Figures 9.2A to C Different views of myringotomy incision. (A) Incision in ASOM; (B) (i) Curvilinear incision, (ii) Radial incision in secretory otitis media, (iii) Radial incision with grommet in place; (C) Magnified view of a grommet

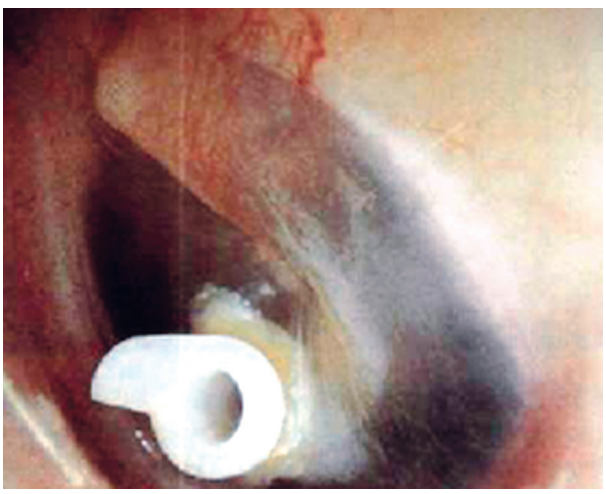


Figure 9.3 Grommet insertion

To summarize glue ear

- A child presenting with bilateral hearing loss with frequent colds
- No history of ear discharge from both ears
- Hearing loss is purely conductive and coincides with incidence of seasonal upper respiratory tract infections.
- TM examination shows a dull looking retracted or bulging tympanic membrane or even with fluid level but no perforation
- Pure tone audiometery confirms moderate degree of fluctuating conductive hearing loss
- Impedance audiometry shows a flat B type of curve
- Management is conservative. Treatment of underlying cause like adenoidectomy or treatment of allergy and myringotomy with grommet insertion.

CHRONIC ADHESIVE OTITIS MEDIA

- Also called fibrotic otitis media and is a condition in which adhesions have developed as a result of previous inflammation
- For this condition to develop, it is necessary that a fibrinous exudate must form and stay in the middle ear for a sufficient long time
- ***Atelectatic ear:*** It is a dry ear with complete collapse of thin TM towards middle ear with loss of middle ear space usually seen in advanced adhesive otitis media of grade IV type.

Grades of atelectasis

Grade I	Pars tensa is retracted medially but is not touching the incudostapedial joint.
Grade II	Pars tensa retracted and is overlying the incudo-stapedial joint.
Grade III	Pars tensa lies over the promontory without adhering to it.
Grade IV	Pars tensa adheres to the promontory.
Grade V	Pars tensa perforates and squamous epithelium drapes the promontory.

Causes

The process is bilateral and develops from secretory type or follows inadequately treated suppurative otitis media.

Clinical Features

Symptoms

- Deafness of conductive type
- Long history of discharge from ear or allergy/sinusitis.

Signs

- Tympanic membrane is thin and atrophic and may show middle ear structures
- Mobility of TM is markedly restricted because of numerous adhesions between TM and promontory or ossicles
- Calcified patches may be seen on TM.

Treatment

- If adequate hearing is present, no treatment.
- If hearing loss is of moderate degree, hearing aid is the best treatment.
- Results of fenestration are poor and may result in Tullio, phenomenon, i.e. in the presence of mobile stapes, making an additional window in horizontal semicircular canal (HSCC) may give rise to vertigo in the presence of loud sounds.

- ***Exploratory tympanotomy:*** It is done to find out the exact nature of adhesions but should be avoided if TM is thin and malleus and incus are fixed.
- Silastic sheet may be inserted to prevent reformation of adhesions.
- Use of polyethylene tubes to ventilate the middle ear through anterosuperior quadrant may help in early cases.

AERO-OTITIS MEDIA

Otitic Barotrauma

Otitic barotrauma occurs due the dysfunction of eustachian tube resulting in inability to maintain the middle ear pressure. Usual cause is when one is traveling in an aeroplane while rapid descent is taking place or when one is doing under water diving or during compression in pressure chambers.

How it Occurs

When there occurs a difference of 90 mm Hg between the middle ear and outside, eustachian tube gets locked and sudden negative pressure in the middle ear leads to retraction of TM; hyperemia and engorgement of blood vessels and transudation. Rupture of labyrinth if takes place may lead to vertigo and SNHL.

Clinical Features

Severe earache, deafness, tinnitus, vertigo, TM is retracted, congested or there may be effusion in middle ear and conductive type of hearing loss.

Treatment

Middle ear ventilation should be restored by decongestants, catheterization or even myringotomy.

Precautions should be taken by avoiding traveling during upper respiratory catarrh (URC), avoiding sleep during descent, Valsalva should be done and chewing gum exercises. Use of vasoconstrictor and decongestants should be done.

TUBERCULOUS OTITIS MEDIA

Tuberculous otitis media is usually seen secondary to pulmonary tuberculosis when the tubercle bacilli find their way through eustachian tube and rarely it may be blood borne. In this condition, small multiple tubercles may be seen in the middle ear, which may show caseation.

Multiple perforations of the TM, which may join to form a big perforation is the characteristic of tuberculous otitis media (**Figure 9.4**).

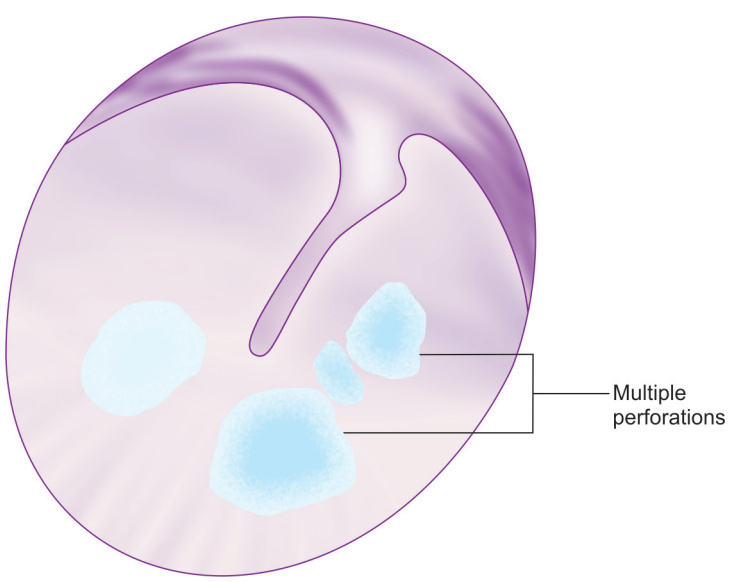


Figure 9.4 Tuberculous otitis media showing multiple perforations

Painless yellow granulation tissue not responding to usual treatment and biopsy or microscopical demonstration of acid-fast bacillus (AFB) confirms the diagnosis.

Treatment of primary lesion with antitubercular therapy (ATT), i.e. rifampicin, streptomycin/isoniazid and para-aminosalicylate (PAS).

SYPHILITIC OTITIS MEDIA

Syphilitic otitis media is seen secondary to syphilis of nose and nasopharynx when the *Treponema* find their way through eustachain tube into middle ear. There is a lot of necrosis and osteitis of the bone causing foul smelling discharge and perforation.

Diagnosis

It is confirmed by *Treponema pallidum* immobilization (TPI) or demonstration of antibodies by absorbent technique or venersal disease research laboratory test (VDRL)/ Wassermann's reaction.

Treatment

Large doses of penicillin are very effective.

Key Points

1. **Silent otitis** media or otitis media with effusion (OME) shows fluid level and air bubbles with no perforation in TM with B type (flat) curve on impedance audiometry.
2. **In chronic adhesive otitis media,** adhesions form between drum and middle ear, while in atelectatic ear there is complete collapse of thin drum on the promontory.
3. **Best treatment** of adhesive otitis media is hearing aid.
4. **Fluctuating deafness** of conductive nature is seen in secretory otitis media, while fluctuating SNHL is a feature of Ménière's disease, perilymph fistula and malingerers.
5. **Pot belly tympanic membrane** is a feature of secretory otitis media.
6. **In Tullio's phenomenon,** vertigo in the presence of loud sounds is due to making of additional window in HSCC along with a mobile stapes.
7. For **barotrauma** to occur, there should be a difference of 90 mm Hg between the middle ear and outside, which causes locking of opening of eustachian tube.
8. **Barotrauma cannot occur in those patients who have perforation in the tympanic membrane.**
9. **Multiple perforations** seen in tubercular otitis media are due to multiple tubercles with painless yellow granulations in the middle ear, which show caseation.
10. **Multiple perforations** may be seen in tuberculous otitis media, fungal infection, trauma due to foreign body or iatrogenic.

Chapter 10 Otospongiosis

What Students Must Know!

- **Otosclerosis**
  - Introduction
  - Types
  - Etiology
  - Clinical Features
- **Treatment**
  - Medical and Surgical
  - Differential Diagnosis

INTRODUCTION

- **Otospongiosis** also called otosclerosis is a primary localized disease of the otic capsule
- In which the normal lamellar bone is replaced by spongy bone leading to its fixation at the oval window thus causing conductive hearing loss
- Otic capsule has three layers:
  - Endosteal layer, which lines the bony labyrinth
  - Enchondral layer, which develops from cartilage and ossifies into bone, it is here that some islands of cartilage are left unossified and develop into otosclerosis
  - Third layer periosteal layer covers the bony labyrinth.
- Adam Politzer (1894) introduced the term otosclerosis while Siebenmann (1912) used the term otospongiosis
- Otosclerotic focus most commonly involves the stapes region
- It may be bilateral in 70 to 85 percent cases and the focus may be symmetrical on both sides
- Antonio Valsalva (1741-42), an Italian anatomist, described this condition
- Bezold (1885) described **Bezold's triad** in which Rinne's is negative, elevation of lower tone limit and prolonged bone conduction (BC) with normal tympanic membrane.

OTOSPONGIOSIS

Incidence

- Incidence of clinical otospongiosis is between 0.5 to 2 percent of the population
- It is seen more in white races (8-10%) than blacks (1%)
- It is low in Chinese and Japanese
- Female to male ratio is 2:1
- Age is usually between 20 and 30 years and is rarely seen before 10 and after 45 years.

Types

Clinical Otosclerosis

- It may be
  - Stapedial otosclerosis
  - Cochlear otosclerosis
- In this type, the symptoms of hearing impairment are present

Purely cochlear otosclerosis is strongly indicated, if:

- Schwartze's sign is positive
- A strong family history
- Progressively increasing sensorineural hearing loss (SNHL) at young age
- Computed tomography (CT) showing demineralized otic capsule.

Histological Otosclerosis

Histological otosclerosis is seen in about 9 to 12 percent cases where there are no clinical features, but histologically the focus is present.

Malignant Otosclerosis

Malignant otosclerosis is a severe type of cochlear otosclerosis. It starts early in life and progresses rapidly.

Etiology

1. *Idiopathic:* Remnants of embryonic cartilage resting in the otic capsule may be the etiological factor.
2. *Hereditary:* Almost 50 percent patients give family history (**Autosomal dominant transmission**).
3. *Hormonal:* Symptoms increase during pregnancy and menopause.
4. Autoimmune disease.
5. Van der Hoeve syndrome, which is otospongiosis associated with osteogenesis imperfecta and blue sclera.
6. Racial, seen more in white races.
7. Sex and age, more in females between 20 and 30 years.
8. Viral etiology has been suggested by immunohistochemical studies

Anatomically, otic capsule is a box, which encloses the inner ear.

- Fourteen ossification centers appear on the otic capsule between 16 and 21st week of intrauterine life
- Fissula antefenestram and fissula post-fenestram and otic duct are the appendages of otic capsule
- Cartilaginous remnants persist throughout life at stapes foot plate, rim of oval window and at fissulas as above which may get activated to form new spongy bone due to nonspecific factors.
- Expansion of focus may be due to hydrolytic enzymes produced by osteoclasts and histiocytes.

Distribution of Otosclerotic Foci

- Fissula ante-fenestram (2-3 mm area in front of oval window)—80 to 90 percent of ears have this type of focus
- Outer attachment of round window in 30 to 50 percent of ears
- Footplate of stapes
- Anterior border of internal acoustic meatus
- Cochlear capsule
- Walls of semicircular canals.

Blue mantles are typical of inactive otosclerotic focus near the semicircular canals. In stapedial otosclerosis, the lesion starts at the site of predilection, which may be at

- Fissula ante-fenestram (anterior focus),
- Fissula post-fenestram (posterior focus),
- Circumferential (at the margin of stapes footplate),
- Biscuit focus (focus in the footplate, but free annular ligament) or
- Obliterative focus (complete footplate is involved) (**Figure 10.1**).

In cochlear otosclerosis (14%), round window and other areas of the capsule are involved. In this, the SNHL is due to liberation of toxic material into inner ear.

Pathology

Grossly

The lesion appears as chalky white, pale or yellow focus. It is red if the lesion is active.

Microscopically

In the immature focus, there are present vascular spaces, osteoclasts, osteoblasts and fibrous tissue and immature focus stains blue on hematoxylin and eosin staining (blue mantles).

Mature focus is less vascular with a lot of fibrous tissue and a few osteoblasts. It stains red on H and E stain due to presence of cementum substance.

Clinical Features

A young female presenting with bilateral conductive hearing loss (CHL) with intact drum should be investigated for otospongiosis.

- Conductive type of hearing loss of 50 to 60 dB level. It is usually bilateral, progressive with insidious onset
- Sensory neural hearing loss occurs in cochlear otosclerosis when round window gets involved due to otosclerotic focus or due to cytokines released by focus
- Paracusis Willisii is a phenomenon in which the patient hears better in noisy surroundings than quiet places because the person will speak in a higher pitch by raising his voice
- Tinnitus is present in 70 percent cases and is seen more in active focus and cochlear otosclerosis
- Vertigo is not seen
- Patient's speech is well modulated, soft and monotonous and speech discrimination is normal
- Patient usually perceives her own voice as quite loud and so speaks in a soft voice, but when SNHL overlay occurs this phenomenon is abolished and patient starts speaking loudly.

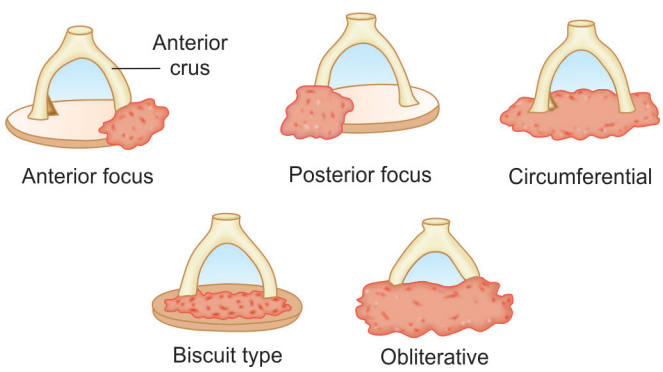


Figure 10.1 Different sites of stapedial otosclerotic foci

How to suspect SNHL in otospongiosis

- Strong family history of otospongiosis.
- Positive Schwartze's sign
- Flat or cookie-bite curve in audiogram
- Progressive pure cochlear loss
- Unilateral CHL consistent with OS and bilateral, symmetric SNHL
- Stapedial reflex demonstrating the biphasic effect
- Demineralization of the cochlea on CT

Signs

- Tympanic membrane is normal and mobile
- Schwartze's sign +ve (10% cases) means reddish hue due to an active focus covered by vascular mucous membrane of otospongiosis on the promontory. It is also known as Flamingo pink appearance of tympanic membrane
- Tuning fork tests show CHL
- Gelle test is positive and pure tone audiometry (PTA) shows normal BC and sometimes Carhart notch
- Carhart notch is bone dip at 2,000 Hz and it may be due to **Inertia of ossicles** or changes in stiffness, mass and friction of transformer mechanism by the focus (**Figure 10.2**), which may be because of Carhart effect which means over closure of AC-BC gap at 2 kHz postoperatively
- SDS score good in pure conductive hearing loss cases
- Impedance audiometry shows **as type of curve**, which indicates reduced compliance, normal middle ear pressure
- Absent stapedial reflex
- Reduced caloric response in 40 percent
- CT scan thin sections of labyrinth show areas of reduced bone density.

Differential Diagnosis

- Serous otitis media
- Adhesive otitis media
- Tympanosclerosis
- Fixation of malleus
- Congenital stapes fixation
- Ossicular chain disruption.

van der Hoeve's syndrome

Features

- Osteogenesis imperfecta
- Stapes fixation
- Blue sclera

Treatment

Medical Treatment

It is not of much use in the treatment of otosclerosis, but if the disease is active sodium fluoride may be used.

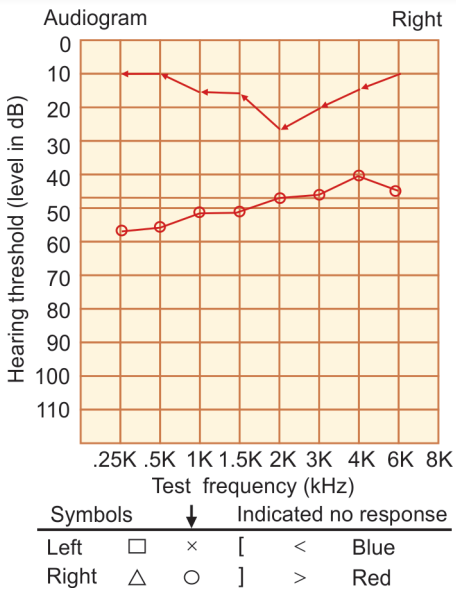


Figure 10.2 Audiometric graph showing Carhart notch (dip at 2 kHz in bone conduction)

a. Sodium fluoride in the doses of 50 to 75 mg/day is given for 2 to 3 months to 2 years. It helps to hasten the maturity of active focus by promoting recalcification and arrest further progression of cochlear otosclerosis.
b. Calcium and vitamin D are widely accepted but are not approved by Food and Drug Administration (FDA).
c. Bisphosponates inhibits osteoclastic activity.
d. Cytokine antagonists inhibit bone resorption.

Indications for sodium fluoride therapy

- Sensorineural hearing loss
- Vestibular symptoms
- Patients with positive Schwartze's sign.

Dangers of fluoride therapy are:

- Fracture long bones and spine due to fluorosis.
- So X-ray spine and long bone to see the thickening of trabeculae be done as a routine. Blood fluoride levels should be monitored.

Care in giving sodium flouride should be observed, especially in cases of:

- Chronic nephritis
- Allergy to medications
- Asthmatics
- Arthritic symptoms
- Patients with gastric symptoms.

Genetic Counseling

Patients should be advised to avoid marriages in families with history of otosclerosis.

Surgical Treatment

Although surgery is the best method of treatment if successful, but there is a very heavy price to pay in the event of failure.

Indications

- Conductive hearing loss with air bone gap of more than 20 dB
- Patient having negative Rinne with 1,024 Hz are excellent candidates
- Speech discrimination 70 percent or better
- Stable middle and inner ear
- Patient unable to use a hearing aid.

Contraindications

- Only hearing ear
- Perforated tympanic membrane
- Active middle ear disease
- Age less than 18 years
- Scuba diver occupation
- Rapidly spreading otosclerosis with positive Schwartze's sign
- During pregnancy.

To summarize

- Otosclerosis is a primary disease of the otic capsule
- Usual onset in second and third decades
- Two-thirds give a family history
- Two-thirds are female
- The gene is not sex-linked
- Deafness may be unilateral or bilateral
- Causes progressive CHL/SNHL
- Paracusis Willissii is often present
- Tinnitus is often present
- The physical appearance of the tympanic membrane (TM) is typically normal
- The audiogram remains the key to diagnose
- Audiometry shows conductive type with Carhart's notch
- Tuning fork tests show conductive deafness
- Cochlear impairment may be present
- The disease is present histologically in 8 to 10 percent of the Caucasian population
- Disease begins by bone resorption around vascular channels and later matures as dense, sclerotic bone
- Sodium fluoride given only when the disease is active
- Stapedectomy mainstay of treatment and is an alternative of hearing aid.

Various surgical procedures

Stapedectomy

- Shea (1958) was the pioneer of stapedectomy operation (**Figure 10.3**)
- In this operation, stapes head and crurae are removed and a prosthesis, teflon piston, 4.0 to 4.5 mm long is inserted between long process of incus and foot plate of stapes (**Figures 10.4 and 10.5**)
- Hole is made in posterior part of footplate because postoperative vertigo is less and better gain of higher frequencies
- Improvement in hearing occurs in 90 percent cases
- In 2 percent cases SNHL may result and dead ear may occur in 0.5 percent
- In case of loose prosthesis in stapedectomy hearing improves on Valsalva and hearing deteriorates after swallowing
- The patient's only hearing ear is a contraindication for stapedectomy because of the risk of SNHL (1:100).
- Stapedotomy—procedure resembles stapedectomy but differs in the sense that foot plate is not removed rather a hole is drilled in it by an electric drill, LASER (Argon or [KTP]) or hand held perforator for the prosthesis
- Reverse stapedotomy means insertion of prosthesis before removing superstructure of stapes (Fisch).

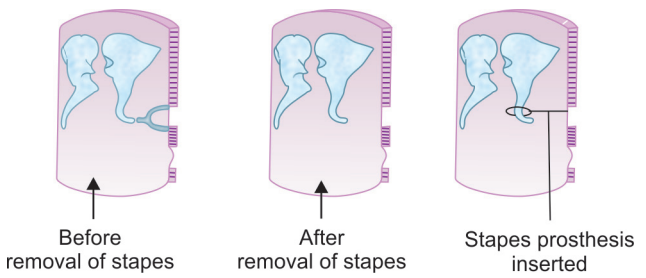


Figure 10.3 Various steps of stapedectomy operation

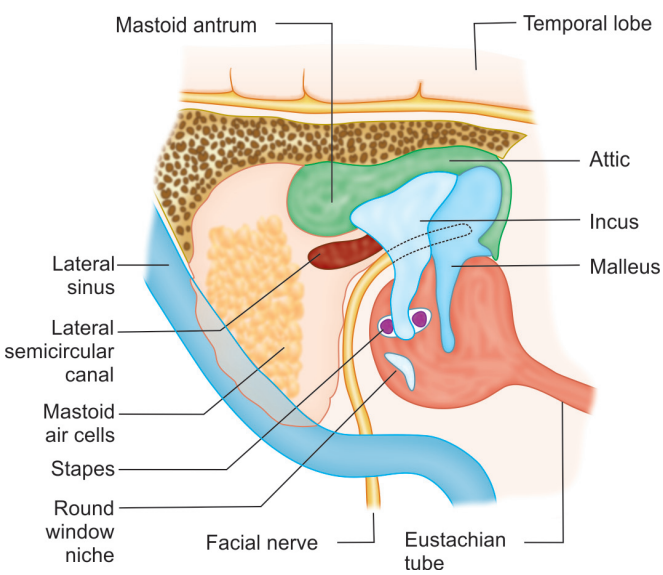


Figure 10.4 Various landmarks of middle ear and mastoid

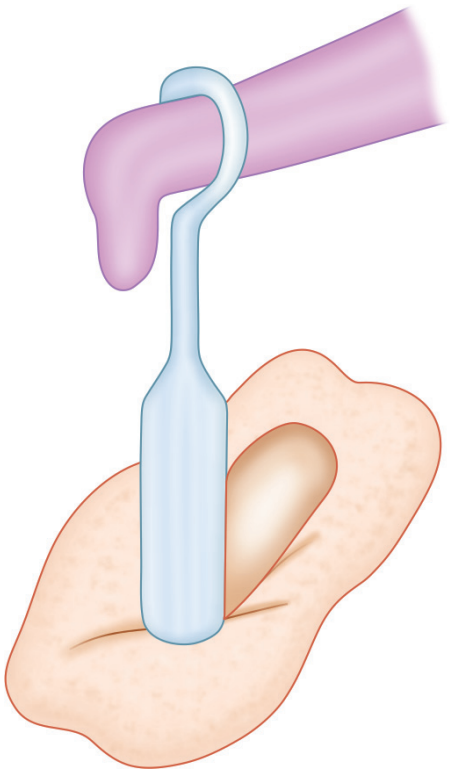


Figure 10.5 Insertion of prosthesis

Complications of stapedectomy:

Intraoperative:
- Bleeding
- Facial nerve injury
- Perilymph gusher.
- Fracture/dislocation of incus
- Floating footplate (Iatrogenic).

Postoperative:
- Acute otitis media
- TM perforation
- CHL
- SNHL and vertigo, tinnitus
- Facial nerve palsy
- Chorda tympani nerve injury (dysgeusia).

Instruction to patient after stapedectomy:
- Patient should avoid nose blowing, sneezing and coughing
- Flying should be avoided for 10 days or so
- Diving and swimming should be avoided
- Heavy weight not to be lifted
- Any hearing loss, vertigo or infection to be reported to the surgeon.

Stapes mobilization
Operation was discovered before stapedectomy, but remained in existence for a short duration. Results are not good in this as refixation may occur.

Fenestration operation
Fenestration operation is not done these days because of creation of mastoid cavity and complications such as facial palsy, labyrinthitis, endolymphatic hydrops, gradual SNHL and closure of fenestration. Hearing after the operation improves slowly in 3 months time.

Sonoinversion
When sound transmission is routed through round window instead of oval window by putting a prosthesis between incus and round window.

Hearing aids
- Hearing aid is the best for those patients who do not want surgery or are unfit for surgery
- It is said that those patients of otospongiosis who are ideal for surgery, are ideal for hearing aids also.

Key Points

1. **Fissula ante-fenestram**—an area 2 to 3 sq mm in front of oval window is the commonest site for otospongiosis (80-90%).
2. **SNHL is seen in cochlear otosclerosis** when focus involves the round window due to absorption of toxic material into inner ear.
3. **Paracusis Willisii** is a phenomenon typical of otosclerosis in which the patient hears better in noisy surroundings due to raising of voice by a person in noisy areas.
4. **Schwartze's sign** is a red hue on promontory seen behind the intact tympanic membrane due to active vascular focus.
5. **Sodium fluoride therapy** has a role in helping maturity of active focus to arrest cochlear loss.
6. Stapedectomy is the surgical treatment of choice. If not willing or unfit for surgery, **hearing aid is the best**.
7. **Neo stapedectomy** procedure; stapedial tendon and incudostapedial joint is preserved.
8. **Cookie bite audiogram** is seen in cochlear otosclerosis.
9. Definite diagnosis of otospongiosis can be made by **exploratory tympanotomy** and not by CT or impedance audiometry.
10. Important **complications of stapedectomy** are injury to facial nerve, chorda tympani and tympanic membrane perforation, SNHL perilymph fistula floating foot plate, displaced prosthesis, dead ear.
11. **A's type of curve** is seen in otospongiosis; congenital fixation; fixed Malleus/incus syndrome and congenital cholesteatoma (A's $\rightarrow$ s stands for stiffness).
12. **Posterior crus** of stapes is long thick and curved in comparison to anterior.
13. **Bezold's triad** is seen in otosclerosis and consists of:
    - Negative Rinne
    - Prolonged bone conduction and
    - Raised lower tone limit.

Chapter 11 Facial Nerve Disorders

What Students Must Know!

- **Surgical Anatomy of Facial Nerve**
  - Important Facts About Facial Nerve
  - Course of Facial Nerve
  - Important Relations of Facial Nerve
- **Types of Nerve Lesions**
  - Sunderland's Classification
- **Assessment of Facial Nerve Palsy**
  - Electrodiagnostic Tests
  - Anatomical Diagnosis
- **Facial Nerve Palsy**
  - Etiology
  - Management of Facial Nerve Palsy
- **Bell's Palsy**
  - Ramsay Hunt Syndrome
  - Postoperative Facial Nerve Palsy

SURGICAL ANATOMY

- Facial nerve is a mixed nerve of second branchial arch and develops during 3rd week from fascio acoustic primordium, which gives rise to VII and VIII cranial nerves
- At full term, the anatomy of facial nerve approximates that of adult
- It has motor fibers for the muscles of face, buccinator, stapedius, posterior belly of digastric and stylohyoid muscle
- It is secretomotor to submandibular, sublingual salivary and lacrimal glands
- Lastly carries the taste fibers from palate and anterior two-thirds of tongue.

Nuclei of Facial Nerve

- Four nuclei of facial nerve are situated in **lower part of pons**
- These four nuclei are motor nucleus, superior salivary nucleus, lacrimatory nucleus and nucleus of tractus solitarius (gustatory nucleus)
- Motor nucleus receives fibers from pyramidal tracts of both sides, which constitute the supranuclear pathway of facial nerve
- Motor root of the facial nerve winds around the abducens nucleus from medial to lateral side and emerges at the cerebellopontine angle and at the base of brain
- Sensory root(also called nerve of Wrisberg) and motor root lie medial to VIIIth nerve to reach the internal acoustic meatus.

Course of Facial Nerve

Facial nerve has been divided into six segments.

1. **Intracranial segment**; extending from brainstem to porus of internal acoustic meatus (23-24 mm)–intratemporal course.
2. **Meatal segment** within internal auditory canal (IAC) passing above falciform crest at the fundus separated posteriorly from superior vestibular nerve by a vertical crest called Bill's bar (8-10 mm).
3. **Labyrinthine segment** (3–5 mm) from meatal foramen or fundus of internal acoustic meatus to distal part of geniculate ganglion and is 0.68 mm in diameter. It is close to basal turn of cochlea. Posterolateral to labyrinthine segment is ampulla of horizontal semicircular canal. Infact the nerve rests on the vestibule. Geniculate ganglion lies between cochlea and middle cranial fossa.

4. **Tympanic or horizontal segment** from geniculate ganglion to pyramidal eminence (8-10 mm).
5. **Mastoid or vertical segment** extends from pyramidal process to styloid foramen, anterior to digastric ridge (10-14 mm).
6. **Extratemporal segment** from stylomastoid foramen to muscles of innervation in the substance of parotid gland dividing at the posterior border of ramus of mandible. (15-20 mm).

Important facts about facial nerve

1. In the internal acoustic meatus, sensory root lies between motor root and 8th nerve with labyrinthine vessels.
2. At the bottom of internal acoustic meatus, the two roots fuse to form one trunk and part from the 8th nerve to enter the facial or fallopian canal (**Figure 11.1**).
3. Meatal segment varies between 8 and 10 mm only.
4. In the intratemporal course, the nerve runs in the bony facial canal and there are three parts of this course made by two bends.
5. The first part is labyrinthine segment from fundus of IA meatus to geniculate ganglion. It is 3 to 5 mm and is the shortest and thinnest (0.68 mm) segment. **Geniculate ganglion lies between cochlea and middle cranial fossa**.
6. The second part **or tympanic segment** or horizontal segment (**first genu)**, extends from below the geniculate ganglion to pyramidal eminence. It is about 8 to 10 mm and lies below horizontal semicircular canal (HSCC) and above the oval window. Dehiscences are more commonly seen in this segment.
7. The third segment **or vertical mastoid segment, (second genu),** is about 15 to 20 mm and it extends from pyramid to stylomastoid foramen.
8. Facial nerve leaves the skull through stylomastoid foramen along with stylomastoid branch of posterior auricular artery, crosses the styloid process laterally to enter the posteromedial surface of parotid gland,
9. It then crosses the retromandibular vein and external carotid artery and divides behind the neck of mandible into five terminal branches, forming the pes anserinus.
10. Narrowest part of facial canal is 4 mm above the stylomastoid foramen.

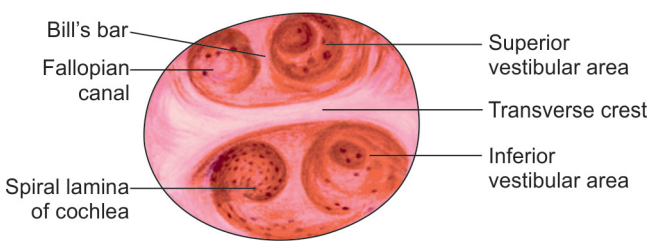


Figure 11.1 Fundus of internal acoustic meatus

BRANCHES OF FACIAL NERVE

1. In the fallopian canal it gives:
   - Greater superficial petrosal nerve, which joins deep petrosal nerve to form the vidian nerve (or nerve of pterygoid canal) to reach pterygopalatine ganglion for supplying the lacrimal gland and mucous glands of nose, palate and pharynx. Various segments and branches of facial nerve is given in **Figure 11.2**.
   - Nerve to stapedius.
   - **Chorda tympani:** The name has been given because of its close relationship with tympanum. It enters the middle ear through posterior wall and exits through anterior wall passing via the middle ear cavity through petrotympanic fissure to emerge in the infratemporal fossa to join the lingual nerve. It supplies the submandibular and sublingual glands and also carries taste sensations from anterior two-thirds of tongue.
2. At its exit from stylomastoid foramen, it gives:
   - Posterior auricular nerve supplies posterior auricular, occipitalis and intrinsic muscles on medial side of auricle.
   - Digastric branch supplies posterior belly of digastric.
   - Stylohyoid branch supplies stylohyoid muscle.
3. Terminal branches are temporal, zygomatic, buccal, mandibular and cervical—all these branches supply the muscles of face and neck.
4. **Communicating branches:** They communicate with nerves of 1st and 3rd branchial musculature.

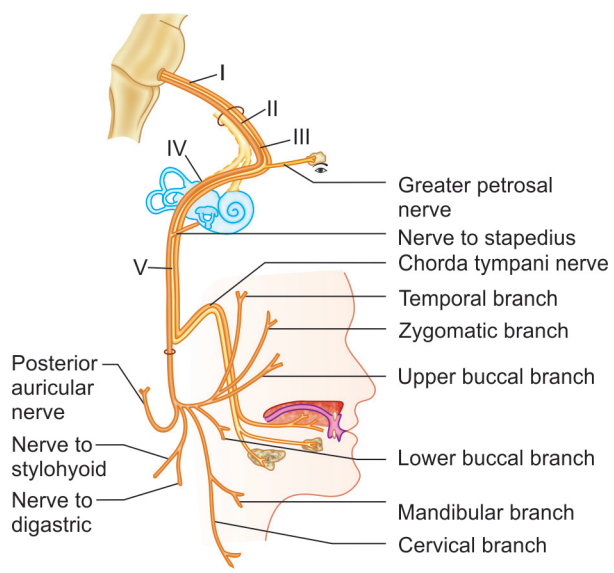


Figure 11.2 Various segments and branches of facial nerve

BLOOD SUPPLY OF FACIAL NERVE

Blood is supplied by branches of middle meningeal artery, stylomastoid artery (branch of posterior auricular), branch of internal auditory artery and anterior inferior cerebellar artery (AICA).

RADIOLOGICAL DEMONSTRATION OF FACIAL NERVE

- Stylomastoid foramen can be seen in submentovertical view of skull base, while IA meatus is shown well in Towne's and Stenver's view
- Fallopian canal will be shown in tomography and computerized tomography scan. Facial nerve sheath consists of outer tough periosteal layer, middle vascular plane and a firm inner fibrous layer.

Surgical Landmarks

Various surgical landmarks for the facial nerve are as follows:

Neck and Face

- Parotid segment is exposed by classical parotidectomy incision
- Dissection is done below the external auditory meatus between mastoid and parotid gland to define the trunk at a deep level.

Vertical Segment

Vertical segment is exposed through classical radical mastoidectomy from lateral semicircular canal (SCC) above to the digastric ridge below.

Tympanic Segment

Tympanic segment is approached through a narrow crevice which is bounded

- Above by fossa incudis;
- Lateral SCC above and medially
- Tympanic annulus below and laterally
- Nerve is exposed best, if the incus is sacrificed.

Petrous Segment

- Petrous segment is exposed by House's middle cranial fossa approach (1963).
- Translabyrinthine approach, if there is already total cochlear deafness.

Intracranial Portion

Approach is by posterior cranial fossa craniotomy. Cerebellum is elevated and cere bellopontine (CP) angle approached.

IMPORTANT RELATIONS OF FACIAL NERVE

- **Processus cochleariformis:** Geniculate ganglion lies anterior to this and tympanic segment of facial nerve starts here
- **Oval window and HSCC:** Facial nerve runs above the oval window and below the horizontal semicircular canal
- **Incus:** Facial nerve lies medial to short process of incus in fossa incudis
- **Pyramid:** Facial nerve lies and runs behind the pyramid
- **Tympanomastoid suture:** Nerve lies behind it
- **Digastric ridge:** Facial nerve exits at the anterior end of digastric ridge.

MUSCLES OF FACIAL EXPRESSION

- Muscle of happiness—zygomaticus major
- Muscle of anger—dilator naris and depressor septi nasi
- Muscle of sadness—levator labi superioris, zygomaticus minor and levator anguli oris
- Muscle of worry—orbicularis occuli
- Muscle of surprise—frontalis and procerus
- Muscle of displeasure—corrugator supercilli and levator labi superioris.

HOW TO PROCEED IN FACIAL NERVE PALSY (WORKOUT)?

History

Onset, duration, progress, alteration in taste sensation, vertigo, lacrimation, pain, history of diabetes, history of trauma.

Local Examination

Ear and mastoid bone, pharynx and nasopharynx, neck and parotid region, other cranial nerves and central nervous system (CNS).

Investigations

1. X-ray mastoid and CT scan to demonstrate IA meatus and CP angle.
2. Examination of auditory and vestibular system.
3. Blood examination including fasting blood sugar (FBS).
4. Electrodiagnostic tests.
5. Topognostic tests.

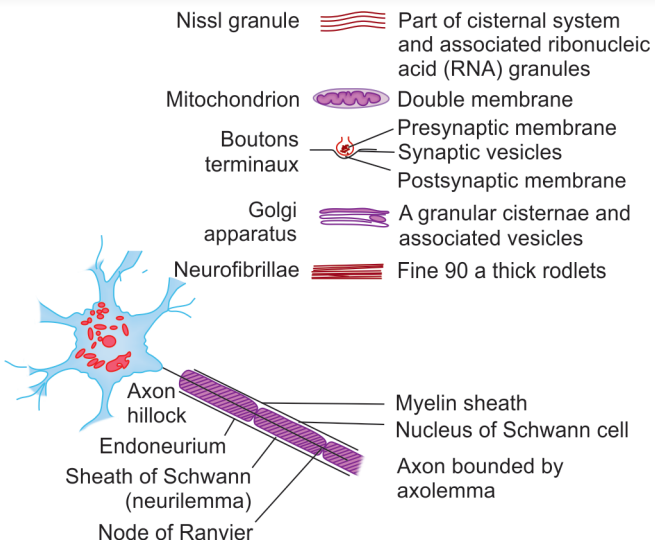


Figure 11.3 Structure of a neuron

TYPES OF NERVE LESIONS

The lesions may be due to compression, crushing, cutting, stretching, cold, heat, cautery or anesthesia (**Figure 11.3**).

Nature of Injury

Injury can be in terms of the following:

Neurapraxia

- Neurapraxia is a minor degree of injury
- Conductivity of nerve fibers is blocked at the site of lesion, but distal to the lesion normal nerve action potential is evoked
- Sunderland's classification type degree I.

Axonotmesis

The axon is severed leading to its death, but endoneural sheaths are preserved and complete recovery is possible.

Neurotmesis

- If nerve trunk is cut and dies, it is called neurotmesis.
- Axons are destroyed and includes Wallerian degeneration.
- Nerve stimulation after 48 to 72 hours is not effective. (Sunderland's classification type degree 5).

Wallerian Degeneration

The process of degeneration of an axon after injury is called wallerian degeneration.

Rate of regeneration of an axon is 1 mm/day provided the neurilemmal tube is intact and recovery takes place in about 10 to 14 weeks period.

Sunderland's classification

Sunderland's classification is most accepted classification at present.

- 1st degree—it is like neurapraxia and there is a partial block to flow of **axoplasm**
- 2nd degree—it is like axonotmesis and there is intact endoneural tube in which axons grow with good recovery
- 3rd degree(neurotmesis)—during recovery axons of one injured endoneurium tube can grow into another and synkinesis may result
- 4th degree—there is partial transaction of nerve and due to injury to perinurium, regeneration of nerve fibers is impaired
- 5th degree—there occurs injury to epineurium and complete transaction of nerve takes place. It is seen in accidental or surgical trauma.

ASSESSMENT OF FACIAL NERVE PALSY

History and Clinical Examination

- In upper motor neuron palsy, upper half of face is less involved or is spared and voluntary movements show greater impairment than emotional facial expressions
- Besides, other pyramidal tract signs may be present
- In peripheral palsy, disturbances of taste, hearing and lacrimation are helpful signs. Topognostic tests for facial nerve is given in **Figure 11.4**.

Radiological Assessment

- High resolution CT scan is the study of choice for assessment of fallopian canal
- Magnetic resonance imaging (MRI) is useful for evaluation of facial nerve at the level of CP angle.

Assessment of Motor Functions

Assessment is done by asking the patient to raise his/her eyebrows, close his eyes, wrinkle the nose, show the teeth and attempt to whistle. Both sides of the face are compared.

House-Brackmann Facial Nerve Grading System

- Grade I: Normal facial function
- Grade II: Mild dysfunction—slight weakness
- Grade III: Moderate dysfunction–obvious weakness, but no disfigurements
- Grade IV: Moderately severe dysfunction—obvious weakness and disfigurement
- Grade V: Severe dysfunction—barely perceptible motion
- Grade VI: Total dysfunction—no movement of facial muscles.

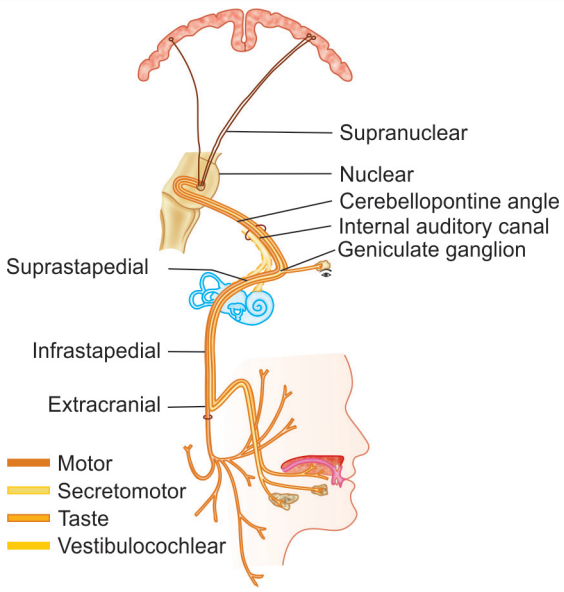


Figure 11.4 Topognostic tests for facial nerve

Electrodiagnostic Tests

Electrodiagnostic test helps to assess the functional condition of the nerve, especially in cases of complete facial paralysis.

Minimal Nerve Excitability Test

- Nerve excitability test (NET) described by Hilger in 1964, is a useful prognostic test
- 1 mA to 10 mA current is passed for 1 m sec to the skin over stylomastoid foramen
- The response is compared on both sides and the difference between the two sides is noted. Surgical decompression should be planned, if a difference of 3.5 to 4.0 m amplifier exists between the two sides.
- It compares the current threshold required to elicit minimal muscle contraction on the normal and paralysed side of face
- In neuropraxia no difference is seen.

Electromyography (EMG)

- In this, electrode is placed in the muscle
- On voluntary stimulation, muscle shows a diphasic wave called motor unit potential
- Fibrillation appears after 12 days of nerve section and motor unit potential reappears 3 months prior to faradic response and hence is useful in predicting recovery.

Maximal Stimulation Test (Strength Duration Measurement)

- Maximal stimulation test is a modified nerve excitability test in which intensity of maximum current required to evoke muscle contraction are plotted graphically
- This test gives an indication of proportion of neurapraxia to degenerated fibers if done 3 days after the onset of facial palsy
- Only problem with this test is difficult to quantitate and will have subjective variation.

Denervation Potential

- Also called fibrillation potential, it appears only if the motor nerve supply has degenerated and will appear only on or after 10 days of paralysis
- Absence of fibrillation is very informative and indicates negligible degeneration.

Polyphasic Motor Unit Potential

Seen on EMG. They are seen a week or two before clinical evidence of recovery after reinnervation of motor units.

Electroneuronography (ENoG)

- Provides quantitative analysis of extent of degeneration without depending on subjective variations
- It is the most accurate prognostic indicator of all electrodiagnostic tests between 4 and 21 days of facial palsy
- Surgical decompression needs to be done if 90 percent degeneration has occurred.

Anatomical Diagnosis

Level of lesion in facial nerve palsy can be seen by history of chronic suppurative otitis media (CSOM) (unsafe type) or by the other features such as of acoustic neuroma (**Figure 11.4**).

Schirmer's Test of Lacrimation

A strip of filter paper 2 to 3 cm by 5 mm is hooked over the lower eyelid on both sides and a marked difference in reduction of lacrimation on the paralysed side suggests the involvement of geniculate ganglion.

Stapedial Reflex

Stapedius muscle contracts, when contralateral ear is stimulated with loud sounds and this is mediated due to integrity of VIIth and VIIIth nerve.

Hyperacusis

Also known as phonophobia, occurs due to undue sensitivity to loud sounds. Loud sounds not eliciting any protective reflex indicates stapedius paralysis.

Electrogustometry

Salt, sugar or acid taste sensations are tested on both sides or even by quantitative electrogustometry which finds out the amount of direct current required to induce a metallic taste. Failure to perceive any taste on affected side indicates the involvement of chorda tympani nerve.

Salivary Flow Test

In this test, submandibular salivary flow is measured by cannulation of the duct on both affected and unaffected side and results are compared with each other.

Magnetic Evoked Neuromyography

Magnetic evoked neuromyography (MNOG) is a relatively new technique designed to stimulate facial nerve intracranially.

FACIAL NERVE PALSY

Etiology

Intracranial Lesions

Brainstem level

- Infections such as polio, diphtheria and polyneuritis
- Tumors
- Trauma as in head injury
- Vascular such as emboli, thrombus and hemorrhage.

Brainstem to IA meatus

- Meningitis
- Tumors like CP angle tumors, acoustic neuroma
- Trauma, i.e. accidental or surgical.

Intratemporal Causes

- Idiopathic (66% cases)
- Infections, i.e. atticoantral type of CSOM and Ramsay Hunt syndrome
- Tumors both benign and malignant
- Trauma such as fracture temporal bone, after mastoid operation or stapedectomy operation.

Extracranial Causes

- Trauma such as birth trauma, facial injuries or after parotidectomy
- Tumors of parotid gland.

Other Conditions

- Diabetes
- Syphilis, sarcoidosis and diphtheria
- Lead poisoning
- Congenital.

Important causes of facial nerve paralysis

Supranuclear and nuclear

- Cerebral vascular lesions
- Poliomyelitis
- Cerebral tumors.

Infranuclear

- Bell's palsy
- Trauma (birth injury, fractured temporal bone, surgical)
- Tumors (Acoustic neuroma, parotid and tumors of middle ear)
- Acute or chronic otitis media
- Ramsay Hunt syndrome
- Multiple sclerosis
- Guillain–Barré syndrome
- Sarcoidosis.

Management of Facial Nerve Palsy

- General management
- Specific management.

General Management

1. Reassurance to the patient by explaining the nature of disease and its prognosis.
2. Care of the paralysed muscles:
   a. Supporting of the paralysed muscles by hooks, which give additional disfigurement, hence not used. Use of plumping acrylic bar to the upper teeth or denture is good to improve the appearance of face.
   b. Massage of muscles is not very useful.
   c. Active exercise in front of a mirror helps the patient to learn to disguise his disability successfully.
   d. Care of eyes to protect cornea and conjunctiva by wearing dark glasses. Eye drops and tarsorrhaphy are also helpful.
3. Long-term sequelae after 12 to 18 months can be treated by:
   a. Face lift plastic surgery/operation.
   b. Insertion of facia lata slings.
   c. Facial hypoglossal nerve anastomosis.
   d. Associated movements due to cross reinnervation.
   e. Muscle contractures may occur.
   f. Facial tics and spasms—cause not known and no treatment.
   g. Crocodile tears, i.e. excessive lacrimation during meals is due to misdirection of parasympathetic secretory nerve impulses meant for salivary glands.

The symptom is treated by section of tympanic nerve, which is found on the promontory.

Complications of Facial Nerve Palsy

- Exposure keratitis
- Synkinesis which means mass movements, i.e. when he/she wants to close eyes, angle of mouth also shows movements
- Partial recovery
- Crocodile tears—there is lacrimation, while eating and is due to faulty regeneration of parasympathetic fibers which instead of supplying to salivary glands supply lacrimal gland and is treated by tympanic neurectomy
- Contractures of facial muscles may result due to fibrosis of atrophied muscles
- Frey's syndrome results due to injury to facial nerve after parotid surgery in which there is flushing of skin of face over parotid gland area, while eating.
- Psychological problems may result due to the effects of facial nerve palsy.

Specific Management

Specific management of facial nerve palsy depends upon the etiology of paralysis.

BELL'S PALSY

- Bell's palsy is the most common cause of facial nerve palsy
- Originally documented by Sir Charles Bell in 1921.
- It is also called idiopathic facial nerve palsy as the exact cause is not known
- However, herpes virus, autoimmune disorder (sarcoidosis), allergy, vasospasm of the blood vessels near stylomastoid foramen, or when exposed to chills or emotional upsets have been implicated in causing facial nerve palsy (**Figures 11.5A and B**).

Pathology

Ischemia due to vasospasm leading to edema of the connective tissue in the facial nerve canal compresses the nerve.

Theory of vasospasm also substantiates the palsy following exposure to cold.

Clinical Features

- Sudden paralysis associated with mild pain behind the ear in a few cases
- Infranuclear type of palsy is present
- Taste may be affected
- Hyperacusis or phonophobia may be present
- Salivation and lacrimation are reduced on the side of lesion
- Ear and other CNS functions are normal
- Eye symptoms—corneal dessication, diminished lacrimation, altered corneal reflex.

Differential Diagnosis

From supranuclear type of nerve palsy, trauma and other general causes, e.g. diabetes.

Investigations

- History and neurological examination
- Radiographs and CT scan

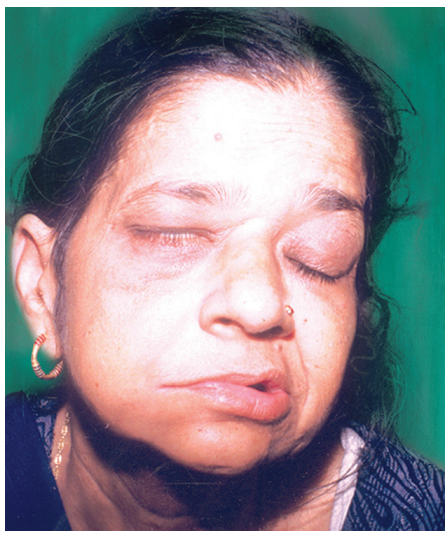


Figure 11.5A Facial nerve palsy right side (lower motor neuron type)

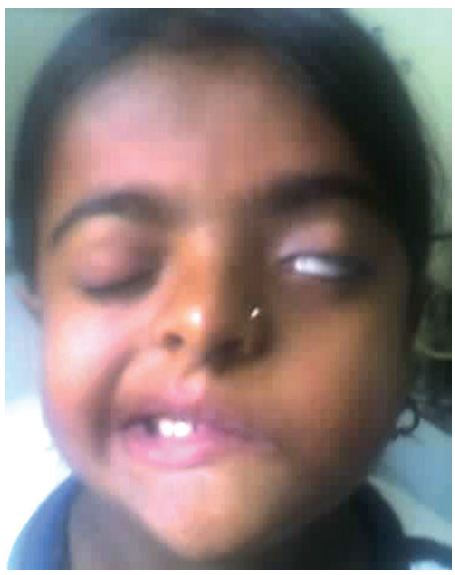


Figure 11.5B Facial nerve supply

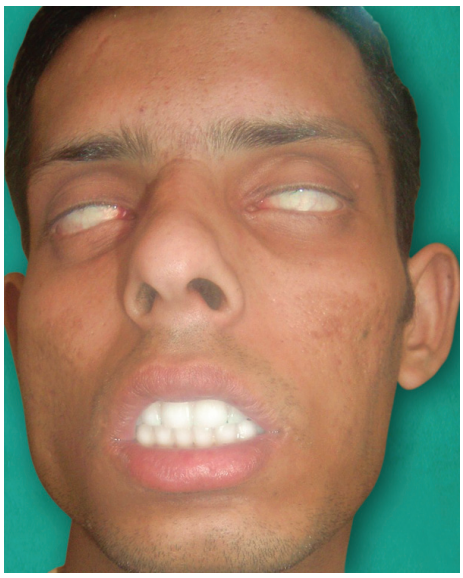


Figure 11.5C Case of bilateral facial palsy

- Fasting blood sugar (FBS)/ Veneral Disease Research Laboratory (VDRL)
- Electrodiagnostic tests
- Topographic tests—these help to locate the site of lesion.

Treatment

The main aim of treatment should be to prevent degeneration of fibers.

Reassurances
Explaining to the patient that it is not a serious problem gives him solace.

Role of Vasodilators

Vasodilators role is doubtful. These may help to relieve vasospasm. Nicotinic acid, intravenous (IV) histamine or procaine have been used.

Role of Steroids

Steroids help by anti-inflammatory action and reduce the edema, thus preventing degeneration of nerve. Early use of steroids is very helpful such as prednisolone 10 mg/kg body weight/day after breakfast. The doses are reduced in 7 to 10 days period. Alternatively, Stennert's protocol may be followed which involves parenteral high dose injections of methyl prednisolone tapered over 2 weeks along with a vasodilator such as pentoxifylline. Adrenocorticotropic hormone (ACTH) IV injection also helps similarly, but is contraindicated in pregnancy, diabetes, hypertension, pulmonary Koch's and peptic ulcer.

Role of Vitamins

Vitamins B_1, B_6 and B_{12} combinations are given as neurotonics.

Care of the Eye

Care of the eye should be done by using eye drops, dark glasses, eye pads or tarsorrhaphy to avoid exposure keratitis.

Physiotherapy

Bell's palsy patient if shows no improvement after 2 weeks, should be given physiotherapy and electrical stimulation such as active exercises in front of a mirror and short wave diathermy should be done. It gives lot of psychological support to the patient.

Decompression of Facial Nerve

- Decompression of facial nerve is done only if no recovery is seen in 8 to 12 weeks and it may be required in 1 to 2 percent cases only
- A simple mastoidectomy is performed under microscope
- Landmarks identified are HSCC, short process of incus, digastric ridge and tympanic annulus
- Facial nerve is exposed using a diamond burr over the fallopian canal
- Sheath may need to be incised in cases of Bell's palsy.
- Decompression, whether total or partial depends upon the outcome of topognostic tests.

Facial Reanimation

Best outcome is obtained with direct neural anastomosis or by using interpositional grafts, when tension free anastomosis is not possible, but facial musculature must be intact

- Nerve cross over anastomosis involves facial hypoglossal anastomosis
- Neuromuscular transfer and facial slings are used, if muscular atrophy has occurred
- Prognosis 85 to 90% patients recover fully whereas 10 to 15% recover partially
- Prognosis is good in incomplete facial nerve palsy.

BAD syndrome

- B is lack of Bell's phenomenon
- A is anesthesia of cornea
- D is dry eyes and this all is an indication for surgery in Bell's palsy.

Facial Palsy in Acute or CSOM

Facial pasy is seen more commonly, if there is dehiscence of the nerve in the bony canal. The palsy is gradual, usually partial and gross degeneration is not present.

It is usually because of complications of CSOM, which have already been discussed.

Postoperative Facial Nerve Palsy

- In stapedectomy, tympanic segment may be damaged, while removing the overhang of posterior canal wall or while removing the bridge in mastoidectomy, if there is dehiscence of nerve (**Figure 11.6**)
- Mastoid segment may be damaged while lowering the ridge
- Surgery of acoustic neuroma may also damage the nerve
- In infants, standard postaural incision may divide the nerve at its exit from stylomastoid foramen

Surgery for obliterative otosclerosis or congenital anomalies may be associated with facial nerve palsies.

To avoid injury:

- No curette should be used in front of the plane of HSCC
- Adequate cooling should be done, while using drill machine
- Slipping of burr points during surgery should be avoided.

Management of Traumatic Facial Palsy

1. If palsy has been immediate, nerve should be explored immediately from stylomastoid foramen to the site of injury and appropriate treatment, such as removal of a bony chip, suturing or nerve grafting, may be required along with splinting with a solution of human fibrinogen and human thrombin.
2. A few surgeons prefer to observe palsy for 2 to 3 weeks with the futile hope of spontaneous recovery. Therefore, in some cases no recovery is seen within 8 weeks, surgical exploration of the nerve is the procedure of choice.
3. If first observed beyond 8 weeks, then one can wait a few more weeks before attempting anything.
4. EMG gives a good indication of impending recovery in the 3rd or 4th month after the damage.

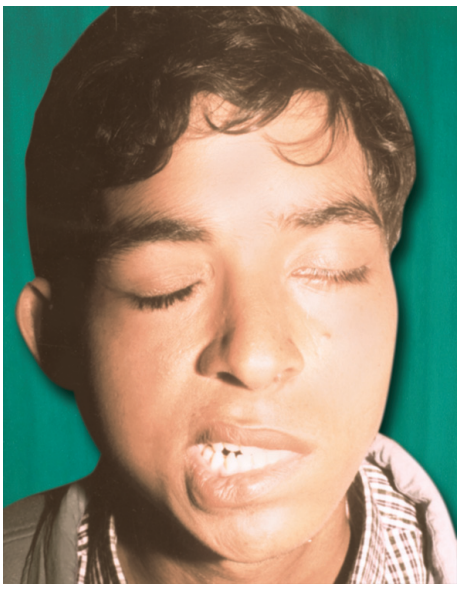


Figure 11.6 Postoperative facial nerve palsy left side

5. However, if no signs of recovery are seen by 16 weeks, exploration should be done and the defect repaired, under minimum possible tension.
6. If a significant gap is present, the nerve graft using greater auricular nerve, lateral cutaneous nerve of thigh or from sural nerve should be done.

Head Injury and Facial Nerve Palsy

- Temporal bone fracture is responsible for traumatic facial palsy
- Bleeding into the canal or bruising of nerve sheath results in palsy
- Fracture may be longitudinal (90%) or transverse (10%) in respect to the axis of petrous bone
- Facial nerve palsy is more often seen in transverse fracture of petrous bone
- As a rule, hearing is spared and facial nerve may be injured, but is never cut in longitudinal fracture
- While in transverse fracture, hearing is lost senosolineural hearing loss (SNHL) and facial nerve is severely damaged (30-50%)
- Longitudinal fractures are along the axis of petrous pyramid
- While transverse fractures are at right angle to petrous pyramid
- CT scan is helpful in finding out the extent of injury.

Management

Management is important to know, whether the paralysis was of immediate or delayed onset because delayed will recover with usual treatment and complete palsy of immediate onset requires exploration of nerve, decompression/reanastomosis or nerve graft, as soon as the general condition of the patient allows.

Ramsay Hunt Syndrome

Also called herpes zoster oticus, it has already been discussed.

Tumors of Temporal Bone with Facial Nerve Palsy

- Radical treatment of tumor always takes precedence over the preservation of function of facial nerve
- If total paralysis persists after cure of the carcinoma or glomus tumor, long graft can be given by Dott's operation
- Neurofibroma of nerve itself is treated by excision and greater auricular nerve graft
- Malignant diseases of the parotid are treated by wide excision along with the facial nerve and suitable grafting is done by greater auricular nerve and its branches.

Other Miscellaneous Conditions

Melkersson's Syndrome

Melkersson's syndrome is recurring facial nerve paralysis and swelling of lips and in some cases, there is congenital furrowing of tongue. Cause is not known and course of disease is like Bell's palsy and recovery takes place.

Heerfordt's Syndrome

Heerfordt's syndrome is bilateral parotid enlargement with uveitis and transient facial palsy due to sarcoidosis. Treatment is symptomatic.

Bilateral Facial Paralysis

Bilateral facial paralysis is seen in:

- Guillain-Barré syndrome (demyelinating polyneuropathy) (**Figures 11.5C and 11.7**). Usual presentation is 40 years female with cyanosis, bilateral facial nerve palsy, shallow respiration and motor weakness of extremities.
- Leukemia
- Bulbar palsy
- Skull fracture
- Sarcoidosis
- Moebius syndrome
- Bell's palsy.

Antoni's Palsy

Antoni's palsy is like Bell's palsy, there is a viral prodrome and features are facial weakness, pain, epiphora, loss of taste, hyperacusis and decreased lacrimation. Other cranial nerves Vth, IXth and IInd cervical and vagus nerve on same side may be involved.

Lyme Disease

Also called Bannwarth's syndrome. There is rash, fever, myalgias, arthralgia, pharyngitis and lymphadenopathy with facial nerve palsy (unilateral or bilateral).

It is due to spirochaetal infection transmitted by a tick in the United States of America (USA). Other symptoms may be meningitis, encephalitis and cardiac abnormalities.

Facial Hemispasm or Clonic Spasm

Facial hemispasm disease is characterized by violent contraction of facial muscles without any facial nerve palsy. Cause is not known and in worst cases, facial nerve may have to be cut to give relief of symptoms—sometimes hypoglossal-facial anastomosis is done.

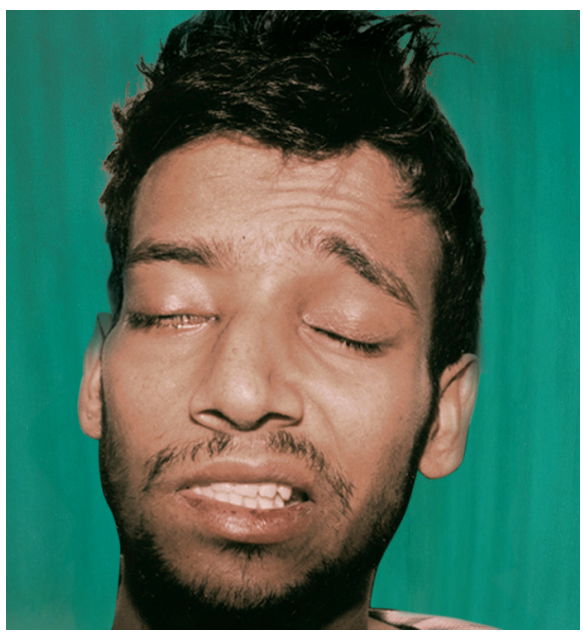


Figure 11.7 Facial nerve palsy with polyneuropathy involving V, IX and X nerve

Key Points

1. **Total length** of facial nerve is 60 to 70 mm.
   - Intracranial segment: 15 to 20 mm
   - Meatal segment: 8 to 10 mm
   - Labyrinthine segment: 3 to 5 mm
   - Tympanic segment: 8 to 10 mm
   - Mastoid segment: 15 to 20 mm
   - Extratemporal segment: 15 to 20 mm.
2. **Vidian nerve** is formed by greater superficial petrosal nerve joining deep petrosal nerve (sympathetic) for supplying the lacrimal glands, mucous glands of nose, palate and pharynx.
3. **Electrodiagnostic tests**, such as nerve excitability test, EMG or maximal stimulation tests, are useful in assessing the condition of nerve, hence its prognosis in recovery.
4. **Schirmer's test**, taste sensation or salivation test give information about the probable site of lesion in facial nerve injury.
5. **Crocodile tears,** while eating are due to misdirection of regenerating secretomotor impulses meant for salivary gland innervating lacrimal gland and are treated by tympanic neurectomy.
6. Melkersson's syndrome is characterized by recurrent facial nerve palsy, swelling of lips and furrowing of tongue
7. **BAD syndrome** includes absent Bell's phenomenon, anesthesia of cornea, dryness of eyes
8. **Bell's phenomenon**—globe turns up and out during an attempt to close the eyes.
9. **ENoG** is the best guideline for facial nerve decompression.
10. In whistling and blowing **buccinator muscle** is tested and eye closure tests the orbicularis oculi.
11. **Most common site of injury** to facial nerve in mastoid surgery is second genu.
12. Facial palsy is seen more (50%) in **transverse fractures** of temporal bone.
13. **Stapedial paralysis leads to hyperacusis**.
14. **Rate of generation** of facial nerve is 3 mm per day.
15. **Processus cochleariformis** serves as a landmark for posterior aspect of geniculate ganglion.
16. **Anterior end of digastric ridge** points to the lateral and inferior aspect of vertical course of facial nerve.
17. **Tragal pointer** is anteromedial edge of tragal cartilage and nerve is usually located 1 cm deep and inferior to tragal pointer.
18. **All muscles of facial expression and buccinator** are supplied by facial nerve except levator palpebrae superioris, which is supplied by occulomotor nerve.

Chapter 12 Tumors of Ear

What Students Must Know!

- ❖ **Classification of Tumors of Ear**
- ❖ **Tumors of External Ear**
  - Tumors of External Auditory Meatus
- ❖ **Tumors of Middle Ear**
  - Glomus Tumors
  - Clinical Features
  - Management
- ❖ **Malignancies of Middle Ear and Mastoid**
- ❖ **Tumor of Internal Ear**
  - Acoustic Neuroma

INTRODUCTION

Tumors of ear are not commonly encountered in the ear, nose and throat (ENT) practice.

However, the commonly seen tumors are:

- Carcinoma of the pinna
- Carcinoma involving external auditory meatus and the middle ear
- Glomus tumor of the middle ear
- Acoustic neuroma.

Since temporal bone contains all types of human tissue, therefore every type of tumor can arise within the temporal bone.

CLASSIFICATION OF TUMORS OF EAR

Tumors of External Ear

Pinna

1. *Congenital tumors*
   - Hemangioma
   - Lymphangioma
   - Dermoid cyst.
2. *Others may be*
   - Benign such as papilloma, fibroma and chondroma.
   - Malignant tumors such as squamous cell carcinoma, basal cell carcinoma, malignant melanoma.

Tumors of External Auditory Meatus

1. *Benign* may be histiocytosis X; papilloma; fibroma; exostosis; osteoma; chondroma; angioma; paraganglioma and adenoma (may be sebaceous adenoma or ceruminoma).
2. *Malignant tumors* are squamous cell carcinoma, basal cell carcinoma and adenocarcinoma.

Tumors of Middle Ear and Mastoid

1. Benign are glomus jugulare tumors, adenoma, chordoma, schwannoma, paraganglioma, hemangiopericytoma.
2. Malignant tumors may be squamous cell carcinoma, adenocarcinoma, cylindroma, sarcoma (rhabdomyosarcoma, spindle cell sarcoma, giant cell sarcoma, neurofibrosarcoma, Ewing's tumors, osteosarcoma), malignant melanoma and multiple myeloma.
3. Secondary deposits from breast, prostate, kidney and bronchus.
4. Conditions looking like tumors such as:
   - Malignant granuloma
   - Lipoid dystrophies
   - Epidermoses
   - Fibrous dysplasia.

Tumors of Internal Ear

The VIII nerve tumors, i.e. acoustic neuroma or schwannoma or neurilemmoma.

TUMORS OF EXTERNAL EAR

Pinna

Squamous Cell Carcinoma of the Pinna

Squamous cell carcinoma of the pinna is not commonly seen, but the patient presents with a nonhealing ulcer with everted margins and induration (**Figure 12.1**). Histopathology confirms the diagnosis.

Treatment
It is wedge resection of the tumor with a clear, healthy margin if the lesion is limited; but in case of extensive lesion, auriculectomy has to be done.

Basal Cell Carcinoma (Rodent Ulcer)

Basal cell carcinoma is a locally destructive lesion presenting as an ulcer with rolled over edges and central crusting. Lymph nodes are usually not involved. Biopsy confirms the diagnosis.

Treatment is wide surgical excision and if extensive, postoperative radiotherapy.

Malignant Melanoma

Patient presents with a brownish black nodular lesion on pinna, which grows rapidly and may ulcerate (**Figure 12.2**). Lymph nodes are usually involved and distant metastasis may take place.

Treatment
Radical excision with block dissection of lymph nodes. Prognosis is not good.

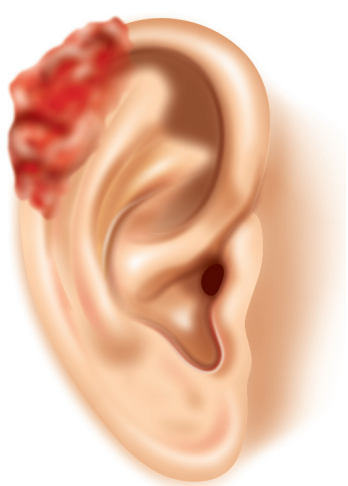


Figure 12.1 Squamous cell carcinoma of the pinna

TUMORS OF EXTERNAL AUDITORY MEATUS

Benign

Exostosis and osteoma have already been described.

Adenomas

Sebaceous adenoma arises from sebaceous glands of cartilaginous meatus and is treated by excision. Ceruminomas are not seen commonly and arise from ceruminous glands of cartilaginous meatus and these resemble sweat gland tumors of the skin.

These are premalignant and hence should be treated by wide excision and the patient should be kept under observation.

Malignant

Squamous Cell Carcinoma of the Meatus

Epitheliomas are rare in meatus. The patient may present with a nonhealing ulcer or a friable mass in meatus with history of blood-stained discharge (**Figures 12.3 to 12.5**). Facial nerve may be involved along with local lymph nodes of upper deep cervical group. Histopathology proves the diagnosis.

Treatment
It is wide excision of the mass by extended radical mastoidectomy followed by radiotherapy.

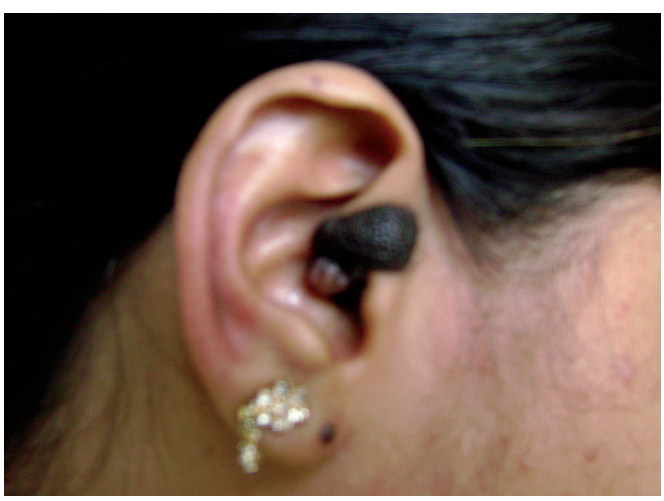


Figure 12.2 Malignant melanoma of pinna and meatus

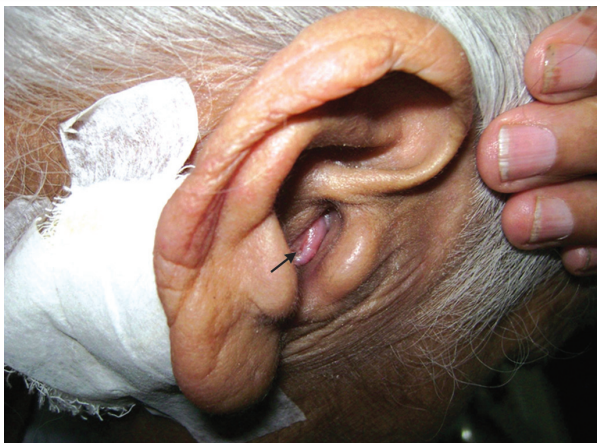


Figure 12.3 Malignant mass in the ear canal

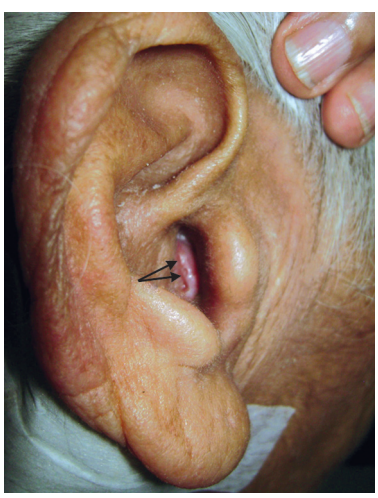


Figure 12.4 Growth external auditory meatus

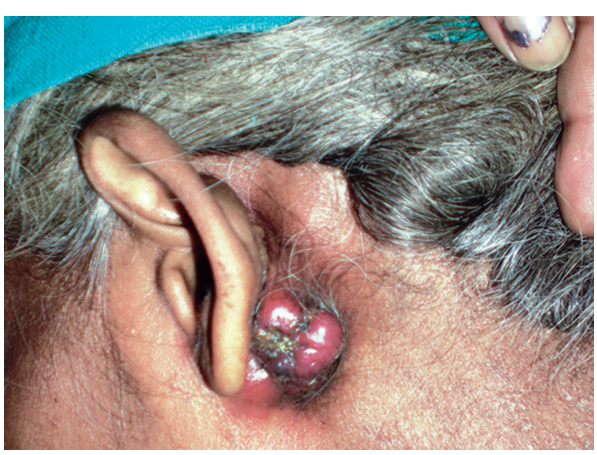


Figure 12.5 Carcinoma. External auditory meatus eroding mastoid cortex

Basal Cell Carcinoma and Adenocarcinoma

Basal cell carcinoma and adenocarcinoma are not commonly seen tumors in the external auditory meatus. Once proved by biopsy, they should be treated by wide excision and postoperative radiotherapy.

TUMORS OF MIDDLE EAR

Glomus Tumors

- Glomus tumors are the most commonly seen benign tumors of middle ear
- Although glomus is a misnomer, but it was named so because of its origin from the glomus complex
- It is also called chemodectoma, because it resembles carotid bodies
- The tumor arises from paraganglionic cells of the neuroectoderm, which are found in abundance on the jugular bulb, along the aorta and its main branches or on the promontory arising from tympanic branch of glossopharyngeal nerve (Jacobson's nerve)
- These cells produce catecholamines and neuropeptides serving as neurotransmitters.

Etiopathogenesis

- Commonly seen between 40 and 50 years of age
- The male:female ratio is 1:5
- It is slow growing, benign, noncapsulated, locally invasive and extremely vascular tumor.

Histopathology

Histopathology shows thin-walled vascular sinusoids with no contractile muscular coat and plenty of epitheloid cells with large oval nuclei and granular cytoplasm.

Types (Oldring and Fisch classification)

Glomus tympanicum
Glomus tympanicum arises from paraganglion cells along the tympanic branch of glossopharyngeal nerve (Jacobson's nerve) on the promontory and is confined to the middle ear (Fisch Type I).

Glomus jugulare
Glomus jugulare originates from dome of jugular bulb and is limited to the middle ear and bulb of jugular vein (Type II).

Glomus jugular tumors

Glomus jugular tumors destroys the bone and may invade mastoid and petrous apex (Type III). Further intracranial extension may occur to the base of skull, middle and posterior cranial fossa. Jugular foramen with IXth to XIIth cranial nerves may be involved (Type IV).

Clinical Features

Otological symptoms

- Earache, diminished, progressive conductive hearing loss.
- Pulsatile tinnitus, which stops on pressing the carotid artery, imbalance and blood-stained discharge.

> Otoscopy shows **Rising sun** sign behind the bluish tympanic membrane. 'Brown's sign' is seen when pressure is applied with Siegle's speculum, tumor pulsates and even blanches on increasing the pressure.

Neurological symptoms

- Facial nerve palsy
- IXth to XIIth cranial nerve palsies occur late; may be after many years in about 35 percent cases causing dysphagia, hoarseness of voice; paralysis of soft palate, trapezius and sternomastoid.

Other symptoms

- Headache, sweating, hypertension, anxiety and palpitation (due to release of catecholamines)
- A systolic bruit may be heard over the mastoid area with a stethoscope
- Remember Rule of 10 meaning 10 percent may be familial, 10 percent secrete catecholamines and 10 percent are familial.

Investigations

1. Blood for catecholamine level.
2. Urine exam for elevated levels of vanillylmandelic acid (VMA) or metanephrine levels.
3. Radiological:
   - X-ray mastoid; base of skull.
     - Computed tomography (CT) scan with fine cuts. It helps to visualize the site and extent of tumor, any bony erosion or dehiscence of bone
     - It shows Phelps sign, which is erosion of bone between internal carotid artery and internal jugular (IJ) vein.
   - *Magnetic resonance imaging* (MRI): It defines the soft tissue extent of tumor.
     - MRI, four-vessel angiography and venography to see the invasion of jugular bulb and IJ vein
     - Brain perfusion study is helpful, when planning surgery to assess opposite internal carotid vessel and circle of Willis.
   - Biopsy in suspected glomus tumor is never done as the tumor is highly vascular.

Management

The treatment depends on diagnostic evaluation along with age, type of tumor and general physical health.

Palliative treatment

Palliative treatment is given to elderly patients of 65 to 70 years, medically infirm or those patients having multicentric lesions.

Radiation therapy

Radiation therapy is given because of low morbidity, low cost and conservative therapy or to patients with unresectable tumors or to control the vascularity of tumors.

Side effects, such as hearing loss, osteoradionecrosis, central nervous system (CNS) damage and radiation-induced malignancy, must be kept in mind.

Surgical treatment

- The approach may be transmeatal tympanotomy (for Type I)
- Transmastoid with extended facial recess approach (for Type II-IV) or
- Skull base approach for advanced lesions. Infratemporal fossa approach of Fisch is good for large tumors.

In skull base approaches, identification and monitoring of facial nerve and internal carotid artery is vital. Intracranial extensions may have to be managed with the assistance of a neurosurgeon.

To summarize

- A female of 40-50 years presenting with unilateral progressive conductive hearing loss.
- Pulsatile tinnitus, imbalance with facial and other nerve palsies.
- Blood stained discharge.
- Otoscopy shows rising sun sign and Brown's sign on siegalization.
- Urine examination for VMA.
- CT/MRI confirm, Phlep's sign positive.
- Biopsy not indicated.
- Treatment by radiotherapy and surgical methods.

OTHER BENIGN TUMORS

Benign tumors are not very commonly seen. Some of the tumors seen are adenoma, hemangioma, osteoma, neurinoma of facial nerve, acoustic nerve or IXth and Xth nerve.

These are very slow growing tumors causing blockade, deafness and nerve palsies. Diagnosis is confirmed by tympanotomy and histopathology with wide excision of the mass.

Conditions Simulating Benign Tumors

Lipoid Dystrophies

1. ***Letterer-Siwe disease:*** It occurs under 2 years of age and is a fatal disease.
2. ***Hand-Schüller-Christian disease:*** It occurs in 10 to 20 years of age group and the patient presents with diabetes insipidus; exophthalmos and defect in skull bones. X-ray shows erosion of bone. Histology shows lipid-filled histiocytes.
   Treatment is radiotherapy.
3. ***Eosinophilic granuloma:*** This condition is seen in children, the frontal bone is commonly involved and the symptoms resemble to acute osteomyelitis. Histology shows mononuclear histiocytes with mitotic figures.
   Treatment is excision followed by radiotherapy.

Wegener's Granuloma

Wegener's granuloma is a systemic disease involving mainly the nose, nasopharynx, lungs and kidney, the etiology of which is not known. It is very rarely seen in ear, but when present, patient presents with blood-stained ear discharge, granulations, lot of destruction of external auditory canal and the middle ear structure.

Biopsy from the tissue shows epithelioid granuloma and necrotizing vasculitis.

Treatment is by systemic steroids and cytotoxic drugs.

Fibrous Dysplasia

Fibrous dysplasia is a benign tumor like lesion of bone, rarely affecting the external auditory canal wall and middle ear. It may be of monostotic or polyostotic type. Once the diagnosis is confirmed by biopsy, the treatment is by wide incision.

MALIGNANCIES OF MIDDLE EAR AND MASTOID

- Malignancies of middle ear and mastoid are very rare conditions
- Incidence may be 0.006 per thousand cases seen in ear, nose and throat (ENT) outdoor and the usual age group is 40 to 60 years
- Females are affected more commonly and there is a history of long-standing ear discharge of 20 years duration causing constant irritation
- Persons working in radium dial painting in watch companies, may be more prone to carcinoma of the middle ear
- Histologically, squamous cell carcinoma is the most common type of carcinoma followed by adenocarcinoma and sarcoma (rhabdomyosarcoma)
- Carcinoma of the middle ear may spread through natural cavities to the facial canal; internal ear; deep bony meatus, petrous apex; mastoid or rarely to dura, which is quite resistant.

Symptoms and Signs

- Long-standing cases with blood-stained and offensive discharge
- Deep-seated pain of moderate to severe degree of throbbing nature
- Facial nerve paralysis
- Examination shows granulations or friable mass in the meatus and middle ear
- Progressively increasing deafness
- Vertigo is a late feature.
- Metastases may occur to cervical lymph nodes later.

Investigations

- X-ray middle ear and mastoids
  - CT scan
  - Biopsy of the tissue.
- Carotid or jugular vein angiography
- Air encephalography.

Treatment

- Depending on the extent of tumor, radical or extended radical mastoidectomy with block dissection of neck nodes followed by radiotherapy administered expertly.
- Total petrosectomy is done in cases in which petrous apex is also involved.
- If there is intracranial spread and various cranial nerves are involved, radiotherapy alone in doses of 5,000 to 7,000 rads may be given as a palliative treatment.
- In case of rhabdomyosarcomas seen in children, the diagnosis is confirmed by biopsy and treatment is surgery, if the lesion is limited. But if the disease is extensive, a combination of radiotherapy and chemotherapy will be effective for hopeless and advanced cases.

Multiple Myeloma

Multiple myeloma is a rare tumor of the bone marrow. Skull bone is affected and X-ray shows multiple, small, translucent punched out areas in bones. The patient may have spontaneous fractures. Biochemistry shows raised globulin and Bence Jones proteins in the urine. Bone marrow biopsy shows mitotic figures of myelocytes and erythroblasts.

Treatment is chemotherapy (melphalan being the drug of choice) or radiotherapy.

TUMOR OF INTERNAL EAR

Acoustic Neuroma

Synonyms: Neurinoma, neurilemmoma, schwannoma; neurofibroma or VIII nerve tumor.

It is a tumor which

- Originates from **Schwann cells of the vestibular nerve**
- Seen between 40 and 60 years of age
- Equally in both males and females
- Extremely slow growing tumor
- Benign, fleshy, encapsulated
- Usually firm, single, arising from Schwann or neurilemmal cells of the vestibular division of VIII nerve inside the internal acoustic meatus
- Incidence accounts in 80 percent of all cerebellopontine (CP) angle tumors and 8 to 10 percent of all head and neck tumors
- Size may vary from a few mm being confined inside the internal auditory meatus of 5 to 6 cm, when it will present itself at CP angle displacing the V to IX cranial nerves, brainstem and sometimes even the cerebellum
- It is not associated with type I neurofibromatosis.

Macroscopically: It is firm, nodular, benign and non-invasive, yellow tumor and it may be:

- Antoni Type A (*fasciculated)*
- Antoni Type B (*reticular*).
  - *In Antoni Type A*: Fusiform cells with oval nuclei in an orderly arrangement.
  - *In Antoni Type B*: There is loose meshwork of cells in a disorderly manner with intercellular vacuoles.

Symptoms and Signs

Auditory Symptoms

Symptoms and signs are due to strategic position of tumor in internal acoustic meatus, which gives rise to audiovestibular and serious intracranial symptom.

- Progressive unilateral sensorineural hearing loss, which may be of sudden onset (10%)
- Unilateral tinnitus (earliest symptom)
- Difficulty in understanding speech [poor speech discrimination score (SDS)]
- Recruitment is not present
- Short increment sensitivity index (SISI)—low score
- Tone decay of more than 30 dB is present.

Vestibular Symptoms

- Classical vertigo is not present. Vague imbalance may be a feature (although it arises from vestibular nerve, but because of slow growth and central adaptation, true vertigo does not occur)
- Canal paresis present (response to both hot and cold absent)
- Nystagmus of first degree
- Past pointing and positive Romberg's test indicate involvement of cerebellum
- Ataxia occurs, if tumor is very large.

Cranial Nerve Lesions

- Trigeminal is the earliest cranial nerve involved. Absent or reduced corneal reflex indicates a large tumor going into CP angle involving V nerve (**earliest sign**)
- Sensory disturbances of face
- Facial tic may be present before actual facial nerve palsy
- Hypoesthesia of posterior canal wall (Hitselberger's sign)
- Reduced taste threshold
- Reduced lacrimation
- IX and X nerve involvement is indicated by dysphagia and hoarseness of voice due to paralysis of palate, pharynx and laryngeal musculature
- Other nerves, such as III, IV and VI; or XI and XII, are involved if the tumor attains a large size
- Raised intracranial tension is a late feature indicated by papilledema, headache and vomiting
- Cerebellar symptoms are indicated by ataxia, nystagmus, incoordination
- Weakness, numbness of arms and legs and increased tendon reflexes indicate brainstem involvement
- Ultimately, stupor, respiratory failure and coma are the terminal events.

How to make diagnosis of acoustic neuroma?

Any young adult presenting with unilateral sensorineural hearing loss (SNHL) and or tinnitus must be investigated with MRI/CT to rule out acoustic neuroma.

Clinical Features

Such as unilateral high frequency SNHL with tinnitus and Hitselberger's sign positive.

Audiovestibular Tests

- Recruitment test positive gives 9 to 1 against acoustic neuroma
- SDS is poor
- SISI low score (0–20% score)
- Tone decay positive
- Absent caloric response
- Brainstem evoked response audiometry (BERA) test, a delay of more than 0.2 msec in wave V between the two sides is important.

Neurological Tests

- Reduced corneal reflex
- Facial weakness
- Cerebellar signs
- Cerebrospinal fluid (CSF) shows increased proteins
- Fundus examination shows papilledema.

Radiological Tests

- Plain X-ray of internal acoustic meatus not very useful. (Towne; Stenvers view)
- CT scan is very useful even for small to moderate size tumors (**Figure 12.6**)
- MRI with gadolinium contrast is thought to be the **best and gold standard** (**Figure 12.7**) for the diagnosis of tumors of very small size, which may be intracanalicular type
- *Vertebral angiography*: It helps to make differential diagnosis from other cerebellopontine (CP) angle tumors such as meningioma, arachnoid cyst, aneurysm or metastasis

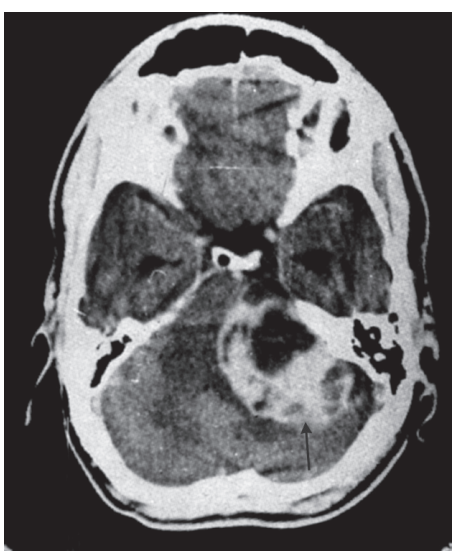


Figure 12.6 CT scan of acoustic neuroma

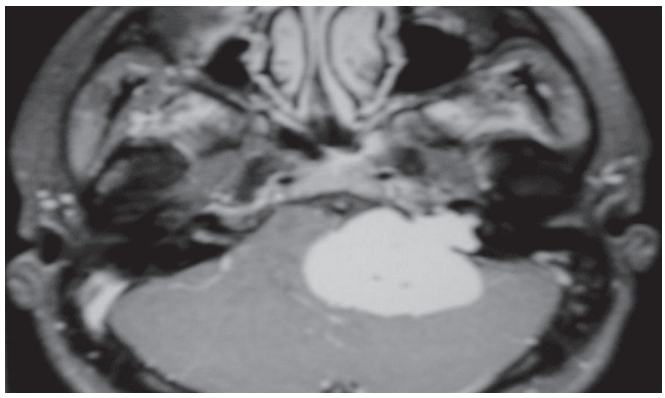


Figure 12.7 MRI cerebellopontine angle showing acoustic neuroma

- Pneumoencephalography and contrast cisternography are quite useful, when done along with lumbar puncture.

Differential Diagnosis of Acoustic Neuroma

Ménière's disease

- Severe vertigo
- Recruitment positive
- SDS is poor
- Tone decay is not a feature
- Loudness discomfort level is not raised
- Abnormal caloric response.

Meningioma

- Cranial nerves, other than VIII nerve are involved first
- Caloric response is normal
- CT scan shows no erosion of internal auditory (IA) canal.

Arachnoid Cyst

- May follow otitic meningitis (history is suggestive)
- It may be congenital
- May be present along with acoustic neuroma.

Others May Be

- Congenital cholesteatoma
- Pontine glioma
- Multiple sclerosis.

Treatment of Acoustic Neuroma

Surgical Removal of Tumor

By far, the best treatment is surgical removal of tumor.

Approach depends upon the size of tumor.

1. Intracanalicular tumor up to 8 mm size with reasonable

hearing. Approach should be middle cranial fossa approach.
2. Intracanalicular tumor with no hearing translabyrinthine approach.
3. Medium size tumor up to 2.5 to 3.5 cm with or without 5th nerve involvement. Approach should be translabyrinthine.
4. Large tumors of more than 2.5 cm with raised intracranial tension. Approach will be suboccipital decompression combined with translabyrinthine approach.
5. Bilateral medium to large tumor with good hearing. Treatment would be retrolabyrinthine with preservation of labyrinth.
6. Small, medium or large tumor in high risk cases. Approach should be quick and fast translabyrinthine approach.
   - Mortality rate is nearly 10 to 15 percent and death is due to infarction of brainstem due to vascular injury, when the tumor is being excised
   - An effort is always made to preserve the function of facial nerve and possibly of VIII nerve.

Gamma Knife Surgery

Gamma knife surgery is not an actual surgical treatment and is done through linear accelerator or by cobalt-60 source. It is a type of stereotactic radiotherapy, which is used in those patients who are not fit for surgery or who refuse surgery or where there has been residual tumor after conventional surgery. Head is fitted on a frame and high dose rhabdoid tumor (RT) focused onto tumor.

Cyberknife is another modification over Gamma knife and is a more accurate procedure and works through computer controlled robotics.

Conventional Radiotherapy

- Conventional radiotherapy has no role in the treatment of acoustic neuroma.
- Ultrasonic dissection; is another form of treatment modality.

To summarize

- A female or male of 40-50 years presenting with unilateral progressive sensory neural hearing loss.
- Non-pulsatile tinnitus, no imbalance with 5th and other nerves palsies.
- Poor discrimination score, absent recruitment, SISI low score and tone decay of more than 30 dB.
- Corneal reflex absent.
- Otoscopy shows normal TM.
- MRI gold standard in diagnosis.
- Treatment by surgical methods.

1. **Squamous cell carcinoma ulcer** has everted margins, while **basal cell carcinoma ulcer** has rolled over margins.
2. **Glomus tumor** arises from paraganglionic cells of the neuroectoderm.
3. **Rising sun sign and Brown's sign** are seen in glomus tumor, while **Schwartze's sign** is typical of active otosclerosis.
4. **Acoustic neuroma** usually arises from superior vestibular division of VIII nerve, but true vertigo is not present due to central adaptation.
5. **Hitselberger's sign** is characterized by hypoesthesia of posterior canal wall and is a sign of involvement of facial nerve in acoustic neuroma.
6. **MRI** is considered as the gold standard for diagnosis of acoustic neuroma.
7. **Ménière's disease in contrast to acoustic neuroma** has vertigo; positive recruitment; poor SDS and abnormal caloric response.
8. **Teal's sign** is present in acoustic neuroma involving facial nerve.
9. **Phlep's sign** is pathognomic of glomus jugulare.
10. In advanced acoustic neuroma, **V nerve involvement is the earliest sign** (loss of corneal reflex).
11. **Meckel's cave (trigeminal cave),** which houses trigeminal ganglion is formed by evagination of internal layer of dura matter of posterior cranial fossa.

Chapter 13 Vertigo and Ménière's Disease

What Students Must Know!

- **Vertigo**
  - Definition
- **Causes of Vertigo**
  - Classification
  - Treatment
  - Labyrinthine Exercises
- **Ménière's Disease (or Endolymphatic Hydrops)**
  - Pathophysiology
  - Investigations and Diagnosis
  - Treatment of Ménière's Disease
- **Benign Paroxysmal Positional Vertigo**
  - Clinical Features
  - Treatment

INTRODUCTION

The balance and the posture of human body is maintained by a complex, highly sophisticated system consisting of the:

- Vestibular apparatus in the inner ear which is inter-connected with the visual apparatus
- Proprioceptive system from neck and limbs.

Impulses thus integrated are controlled by vestibular nuclei, cerebellum, extrapyramidal system and cerebral cortex.

VERTIGO

Vertigo is generally considered a difficult problem to manage by the otologist as a vast variety of causes may be involved in causing imbalance such as:

- Cardiovascular system (CVS)
- Central nervous system (CNS)
- Visual problems
- Otological problems
- Locomotive system disturbances.

Definition

Vertigo should be distinguished from dizziness, which is a vague layman's term to describe general imbalance, light headedness, swimming sensation, floating sensation, etc. whereas the term vertigo can be defined as

- 'Hallucination of movement', where one feels as if a person is moving as compared to his surroundings or that his surroundings appear to be moving in relation to the subject
- It varies from a sense of mild imbalance to severe vertigo accompanied by nausea, vomiting, perspiration and diarrhea due to vagal stimulation.

Physiology

- Equilibrium is maintained primarily by the vestibular part of labyrinth
- It is aided by visual proprioceptive senses distributed all over the body
- Final control of equilibrium is done by the cerebellum and cerebrum
- Thus, vertigo can occur from disorders of any of the three systems, vestibular, visual or somatosensory
- Normally, the impulses reaching the brain from the three systems are equal and opposite
- If any component on one side is inhibited or stimulated, the information reaching the higher center is mismatched leading to vertigo.

Causes of Vertigo

Classification

There can be different methods for classifying vertigo.

According to one classification, it can be divided into aural and extra aural:

Aural Causes

External ear

a. Wax
b. Furuncle.

Middle ear

a. Eustachian tube catarrh
b. Otitis media (usually unsafe).

Inner ear

1. *Trauma:*
   a. Head injury leading to fracture of temporal bone.
   b. Latrogenic trauma while performing mastoid surgery or stapedectomy, vestibule may be damaged.
   c. Acoustic trauma, especially in congenital syphilis.
2. *Infections:*
   a. Viral labyrinthitis due to measles, mumps.
   b. Bacterial labyrinthitis due to unsafe otitis media.
   c. Syphilitic labyrinthitis.
3. *Vascular causes:* Thromboembolism of the vessels supplying labyrinth.
4. *Tumors:* Acoustic neuroma.
5. *Motion* sickness.
6. Ototoxic drugs like streptomycin.
7. *Others:*
   a. *Ménière's disease:* Benign paroxysmal positional vertigo (BPPV).
   b. *Vestibular neuritis:* Lermoyez syndrome.

Extra Aural

Cardiovascular causes: Hypertension with atherosclerotic changes in the blood vessels supplying the labyrinth.

Central nervous disorders

1. Disseminated sclerosis.
2. Tumors or abscess of cerebellum.
3. Increased intracranial tension.
4. Head injury.

Metabolic disorders

1. Diabetes mellitus causing neuronitis of the VIII nerve.
2. Hypoglycemia.

Ophthalmic causes

1. High refractive error.
2. Diplopia.

Other

Cervical spondylosis
Anemia.

Another Classification

Vertigo can also be classified into pathological, non pathological and functional.

Pathological Vertigo

Inflammatory

- Furuncle of the external auditory canal
- Otitis media (especially of unsafe type)
- Labyrinthitis (bacterial or viral)
- Syphilitic labyrinthitis.

Traumatic

- Head injury
- Latrogenic (during mastoid exploration)
- Acoustic trauma.

Neoplastic

- Acoustic neuroma.

Others

- Thromboembolic phenomenon
- Ototoxic drugs
- Ménière's disease
- Vestibular neuronitis
- BPPV
- Lermoyez syndrome.

Nonpathological Vertigo

1. *Heights:* Middle ear pressure changes.
2. Fun games on giant rotating wheels due to vestibular fluid disturbance.
3. Sudden change in floor texture—visual stimuli.

Functional

It is quite common, especially in females and emotionally weak personalities.

Classification: Alphabet

Yet another classification of vertigo can be done by the alphabet making up the word vertigo.

Vascular—V

- Thromboembolic phenomenon
- Vertebrobasilar insufficiency
- Anemia
- Hyper-or hypotension.

Epilepsy—E

Endocrinal disorders like diabetes, hypothyroidism.

Remedial Drugs—R

- Antibiotics—streptomycin
- Sedatives
- Antihypertensives.

Trauma—T

- Head injury
- Iatrogenic.
- *Tumor:* Acoustic neuroma.

Infections—I
Viral/bacterial/syphilitic labyrinthitis.

Glial Diseases—G
Disseminated sclerosis.

Ocular Diseases—O
High refractive error or diplopia.

Others
- Ménière's disease
- Vestibular neuronitis
- BPPV
- Lermoyez syndrome.

How to Find the Cause of Vertigo? Diagnosis of Vertigo

1. Episodic with aural symptoms
   - Ménière's disease
   - Migraine.
2. Episodic without aural symptoms
   - BPPV
   - Cervical spondylosis
   - Epilepsy
   - Migraine
   - Cardiac arrhythmia
   - Postural hypotension.
3. Persistant with aural symptoms
   - Chronic suppurative otitis media (CSOM) with erosion of labyrinth
   - Acoustic neuroma
   - Ototoxicity.
4. Persistant without aural symptoms
   - Alcoholism
   - Multiple sclerosis
   - Degenerative disorder of the vestibular labyrinth
   - Posterior fossa tumor.
5. Single acute attack with aural symptoms
   - Head injury
   - Labyrinthine fistula
   - Viral infection, e.g. mumps, herpes zoster
   - Vascular occlusion
   - Round-window membrane rupture.
6. Single acute attack without aural symptoms
   - Vestibular neuronitis
   - Trauma
   - Vasovagal faint.

Investigations

1. *Detailed history*: It is a very important tool to reach a precise diagnosis. One should ask regarding the duration, intensity, diurnal variations, positional variation, its association with deafness, tinnitus, etc. Previous history of surgery and metabolic disorders should be obtained.
2. *Ear, nose and throat (ENT) examination* with special emphasis on tympanic membrane (TM) findings in relation to unsafe pathology.
3. *General systemic examination* with special emphasis on CVS and CNS including Romberg's test, posturography, gait and past pointing.
4. *Hearing tests* like tuning fork tests and audiometry.
5. *Labyrinthine tests* like caloric test, and electronystagmography, posturography, Dix-Hallpike maneuver.
6. *Radiological investigations* like X-ray mastoids, X-ray transorbital view for the comparison of internal auditory meatus and X-ray cervical spine.
7. *Pathological investigations* like:
   - Complete hemogram
   - Urine examination
   - Blood sugar tests
   - Serum cholesterol
   - Veneral disease research laboratory (VDRL)
8. Electrocardiogram (ECG)
9. Neurological investigations like:
   - CSF examination
   - Electroencephalography
   - Ventriculography.
10. Computed tomography (CT) scan.

Treatment

Reassurance

It is the most important part of the treatment. The patient should be consistently reassured regarding the benign nature of disease and the possibility of its reappearance after some interval.

General Treatment

Complete omission of smoking, alcohol and other intoxicants.

Medical Treatment

1. *Labyrinthine sedatives*
   a. Prochlorperazine (Stemetil).
   b. Promethazine (Phenergan).
   c. Dimenhydrinate (Dramamine).
   d. Chlorpromazine (Largactil).
2. *Vasodilators*
   a. Nicotinic acid.
   b. Cinnarizine (25 mg tds).
   c. Betahistine (16 mg tds).
3. *Histamine drip:* Intravenous drip containing 1 mL of histamine in 500 mL of 5 percent glucose.
4. *Vitamins* like B_1, B_6, B_{12} in conditions like vestibular neuronitis.
5. *Diuretics and low-salt diet* may help in reducing the tension of endolymph.
6. Tranquilizers and antidepressants to allay anxiety.

Surgical

1. Decompression or shunt operation of the endolymphatic sac.
2. Partial destruction of the vestibule by ultrasonic waves.
3. Vestibular nerve section.
4. Labyrinthectomy for very severe cases.

Labyrinthine Exercises

These are helpful in regaining the self-confidence of the patient.

Standing exercises

1. Rotating the eyeballs from left to right and vice versa for 10 times.
2. Approximating the chin to the shoulders one by one, 10 times.
3. Shrugging both the shoulders for 10 times.
4. With both the hands on occiput forcing the head to bend and making the neck muscles stiff for counter-pressure.

Sitting exercises

1. Repeating the above exercises in sitting position.
2. Throwing an object on floor and picking with eyes open and eyes closed.

Epley's Maneuver

- Epley's maneuver is very effective for BPPV in which there is disorder of posterior semicircular canal (SCC), where otoconial debris released from maculae of utricle settle in cupula of posterior SCC causing vertigo.
- By this maneuver, debris are repositioned back to the utricle by moving the head to 45° first followed by rotating the whole body and head away from the affected ear.
- Then the patient sits with head still turned to the unaffected side by 45° and finally the head is turned forward and chin is brought down by 20°.

MÉNIÈRE'S DISEASE

- Ménière's disease is known after the name of a French physician **Dr Prosper Ménière** who described it in 1861.
- It has also been called 'endolymphatic hydrops' because of hydropic distension of the endolymphatic system.

The disease is characterized by:

- Recurring attacks of episodic vertigo
- Fluctuating low-tone sensorinural hearing loss (SNHL)
- Tinnitus
- Seen over the age of 30 years
- Affects both sexes equally
- Unilateral in 50 percent cases and later may become bilateral (3–8%)
- Incidence varies in different regions but in our country it is less than 0.1 percent.

Ménière's Syndrome

In this group of symptoms have diverse etiologies and the term has been abandoned in favor of Ménière's disease.

Causes

1. Idiopathic.
2. Ischemia and vasospasm causing decreased blood supply of labyrinth.
3. Emotional factors contribute to the development of the disease by causing sympathetic system over-activity.
4. Hydrops of endolymph, due to reduced absorption of endolymph, tension increases in labyrinth leading to distension of sac.
5. Hormonal disturbances by causing water and electrolyte disturbances in endolymph, hypothyroidism (3% cases).
6. Allergy and infection may also be responsible.
7. Autoimmune disorders.
8. Viral infection.
9. Metabolic disorders of carbohydrate metabolism.
10. Syphilis and cochlear otosclerosis.
11. Anatomical causes such as small vestibular aqueduct.
12. Trauma, which may be physical or acoustic.

Pathophysiology

- Normally, endolymph moves from cochlea, (where it is produced,) to endolymphatic sac, where it is absorbed.
- Any disturbance in production or absorption results in accumulation of endolymph in cochlea and membranous labyrinth causing distention or hydrops leading to distension and rupture of Reissner's membrane.
- Distortion of cochlear duct produces hearing loss while due to pressure changes, the labyrinth causes vertigo (**Figures 13.1 to 13.3**).

Clinical Features

1. Episodic rotatory vertigo with sudden onset and may be mild to severe occurring at variable intervals. Attack comes in clusters with periods of spontaneous remission lasting for weeks months and years.
   - *Tullio's phenomenon:* It means feeling of vertigo on exposure to loud sounds.
     It may be seen in:
     – Ménière's disease
     – Perilymph fistula

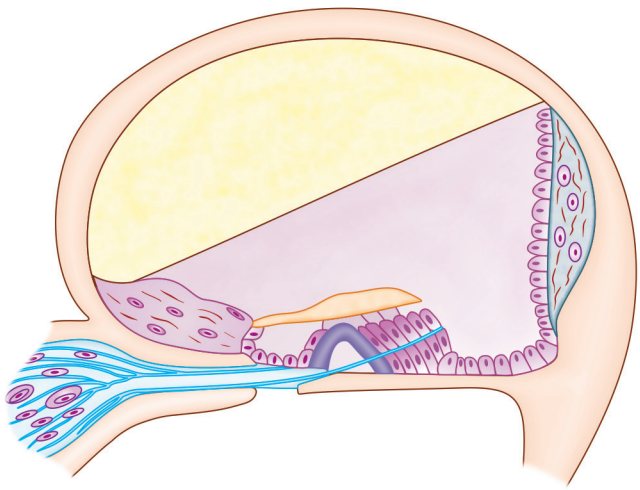
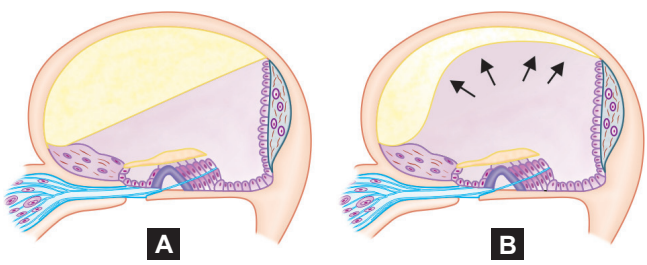


Figure 13.1 Scala media (Cochlear duct)



Figures 13.2A and B Pathology in Ménière's disease: (A) Normal cochlear duct; (B) Distended cochlear duct in Ménière's disease

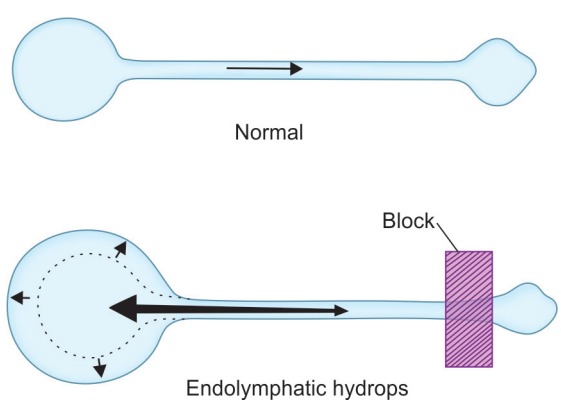


Figure 13.3 Pathophysiology of Ménière's disease

- Fenestration
- Vestibulofibrosis
- People wearing hearing aids
- Fluctuating low tone sensorineural hearing loss, the patient may have diplacusis and intolerance to loud sounds because of recruitment phenomenon.

Fluctuating hearing loss is a feature of

- Ménière's disease
- Lermoyez syndrome
- Labyrinthine fistula
- Metabolic diseases like diabetes, hypothyroidism hyperlipidemia
- Glomus jugulare
- Glue ear
- Eustachian tube dysfunction

2. Tinnitus (low pitched) may be continuous or occurring during attacks only.
3. Nausea, vomiting, perspiration, gastric upset and diarrhea due to vagal stimulation.
4. Aural fullness on the affected side.
5. Headache and anxiety may also be present.
6. Intolerance to carbohydrates may be seen.
7. **Remember, duration of attack varies from a few hours to a few days and in between the attack, the patient is normal.**

Investigations and Diagnosis

Following are the investigation and diagnosis of Ménière's disease (**Table 13.1**).

- History and examination of ear.
- Tuning fork tests show fluctuating SNHL.
- Pure tone audiometry shows low-tone SNHL.
- Impaired speech discrimination during the attack.
- Caloric test shows canal paresis.
- Recruitment test positve.
- Short increment sensitivity index (SISI) test score is better than 70 percent in most of the cases.
- Tone decay of less than 20 percent.
- Glycerol test 1 to 2 mL/kg in lemon water is given and improvement in hearing confirms the disease by acting as a dehydrating agent.

- Bekesy audiometry shows type II tracings.
- Electrocochleography is helpful. Summating potential more than 40 percent of action potential and ratio of summating potential/action potential (SP/AP) is more than 30 percent (normal is 20%).

Table 13.1: Differential diagnosis of Ménière's disease

Symptom	*Ménière's disease*	*Acoustic neuroma*	*Benign paroxysmal positional vertigo (BPPV)*	*Vestibular neuronitis*
Vertigo	Acute/brief severe attack	Mild chronic vertigo	Short lasting and is paroxysmal	Acute for a few days to weeks
Duration	Hour	–	Few second	Day to week
Nausea and vomiting	+	–	–	+
Sensori neural hearing loss (SNHL)	Fluctuating	Progressive	Absent	Absent
Tinnitus	+	–	–	–
Fullness of ear	+	±	–	–
Recruitment	+	–	–	–
Cranial nerve palsies	–	+	±	–
Confirmation	Electrocochleography 8th nerve action potential	Cerebrospinal fluid (CSF) study	Positional test +ve	Normal pure tone audiometry (PTA) Positional test –ve

Staging of Ménière's Disease

It is based on pure tone average in dB in previous 6 months.

- Stage I—less than 25 dB
- Stage II—26–40 dB
- Stage III—41–70 dB
- Stage IV—more than 70 dB.

Variants of Ménière's Disease

1. *Lermoyez syndrome (1919):* First symptom is sudden progressive SNHL, tinnitus, followed by attack of vertigo when hearing may recover (reverse of Ménière's triad).
2. *Cochlear hydrops*: Primary symptoms are that of cochlea only.
3. *Vestibular hydrops:* Cochlear symptoms are absent. Only vertigo is present.
4. *Secondary Ménière's disease:* Seen in
   - Association with syphilis (congenital or acquired)
   - Otosclerosis
   - Paget's disease
   - After stapes operation (**Table 13.2**).
5. Atypical Ménière's disease patients who complain of some of but not all the typical symptoms of Ménière's disease.
6. Tumarkins Crisis or drop attacks in which sudden falling attacks of short duration occurs.

Treatment of Ménière's Disease

Treatment of Ménière's disease (see **Table 13.2**).

General Measures

- Reassurance
- No smoking/alcohol
- Low salt and water diet
- Avoid over indulgence in coffee and tea
- Avoid stress by yoga and other activities.

Conservative Treatment in Acute Attack

- Complete bed rest
- Reassurance
- Labyrinthine sedatives like dramamine, Promethazine or prochlorperazine (stemetil). Diazepam 10 mg I/V may be given in acute cases
- Diuretics like furosemide 40 mg as required with potassium
- Vasodilators like carbogen and histamine drip 2.75 mg in 500 mL of glucose given slowly.

Treatment of Chronic Case

- Vestibular sedatives
- Vasodilators
- Diuretics
- Probanthine 15 mg thrice a day is effective
- Hormones after finding out any endocrinal disorder such as thyroid profile
- Chemical labyrinthectomy with injection Gentamicin, which is vestibulotoxic and is given in middle ear daily or weekly. Gentamycin profusion of round window may give 80 to 90 percent control. In bilateral disease injection streptomycin intramuscular is given.

Table 13.2: Treatment of Ménière's disease

Conservative		Surgical
Medical treatment	***General treatment***	*Conservative operation*
During attack	• Avoid smoking	• Stellate ganglion block
— Reassurance as to the complete bedrest	• No alcohol	• Cervical sympathectomy
— Labyrinthine sedatives such as cinnarizine 25 mg, betahistine 16 mg, prochlorperazine	• Treat infection	• Intratympanic gentamicin therapy
— Vasodilators, e.g. Carbogen inhalational nicotinic acid	• Labyrinthine exercises	• Endolymph sac decompression
— Histamine drip 1 mL in 500 mL	— Cooksey-Cawthorne exercises for adaptation of labyrinth	• Shunt operation, i.e. endolymphatic mastoid shunt, endolymphatic subarachnoid shunt
— Diuretics		*Destructive operations*
— Tranquilizers		• Labyrinthectomy (hearing loss is permanent)
In between attacks		• Vestibular nerve section
— Salt and fat-restricted diet		• LASER/ultrasonography cause partial destruction of labyrinth without hearing loss
— Reassurances		
— Betahistine, cinnarizine help in improving microcirculation of inner ear		
— Elimination of allergen		
— Diuretics: Frusemide		
— Avoid carbohydrate-rich diet		

Surgical Treatment

Conservative surgery

1. *Endolymphatic sac decompression*
   - By this operation pressure in the sac is relieved and patient becomes free of symptoms.
   - Briefly the procedure is done under local or general anesthesia.
   - A simple mastoidectomy is done and three SCC are delineated.
   - Endolymphatic sac lies close to posterior SCC keeping in mind the Donaldson's line.
   - Bone in this area is drilled with a diamond burr to expose the sac, which gets decompressed thus relieving the symptoms without affecting the hearing.
2. *Endolymphatic shunt operation:* A tube is put between subarachnoid space and endolymphatic sac for drainage of excessive fluid.
3. *Sacculotomy (Fick procedure):* Saccule is punctured with a needle through stapes footplate. Cody's tack procedure, places a stainless steel tack to periodically decompress the sac.
4. Vestibular nerve section.
5. Ultrasonic destruction of vestibular labyrinth.

Destructive surgery

- Like labyrinthectomy by opening through oval window or horizontal semicircular canal (HSCC)
- Vestibular nerve section
- Intermittent low pressure pulse therapy by using a Meniett device helps to decrease the symptoms of vertigo.

Adaptation Exercises

Cooksey-Cawthorne exercises for adaptation of labyrinth.

To summarize

- A 30 years Patient presenting with:
  - Recurring attacks of episodic vertigo,
  - Unilateral fluctuating low tone SNHL, Tinnitis
  - with Multifactorial causes.
- Caloric test shows Canal paresis SISI better than 70%
- Tone decay less than 20dB Glycerol Test positive.
- Treatment with Labyrinthine sedatives and surgical operations like endolymphatic sac decompression
- Shunt operation or vestibular nerve Section

Vestibular Neuronitis

Vestibular neuronitis is believed to be a viral infection of vestibular nerve causing giddiness, nausea and vomiting. It is seen between 30 and 50 years in both sexes and exact etiology is not known although viral etiology may be the cause.

Clinical Features

Vestibular neuronitis are like Ménière's disease, but there is absence of cochlear symptoms. Severe giddiness is present

lasting for a few days and these attacks of vertigo weaken over a period of time.

Management

- Complete rest and assurance to the patient
- Labyrinthine sedatives such as cinnarizine and prochlorperazine help
- Vitamins B_1, B_6 and B_{12} are also given.

Benign Paroxysmal Positional Vertigo

Benign paroxysmal positional vertigo is characterized by:

- Sudden vertigo, which occurs only in certain positions of the head while changing the position or getting from the bed
- It is seen between 30 and 50 years of age
- In both sexes equally
- May follow head injury
- Labyrinthitis
- No apparent cause may be found.

Pathology

The lesion is in the maculae of utricle or saccule on one side. Otolithic membrane may be damaged.

Clinical Features

Similar to Ménière's disease but deafness and tinnitus are absent and giddiness occurs suddenly on getting up and lasts for a few seconds only. Neurological features are not present.

Diagnosis

Diagnosis is made by

- Typical history
- Dix-Hallpike maneuver
- Positional tests of vertigo
- Nystagmus is directed to the undermost ear; has a latent period and is fatigable, unlike the central type of nystagmus, which has no latent period, is nonfatigable and directed to the uppermost ear.

Treatment

- Antivertiginous drugs such as cinnarizine 25 mg tab
- Epley maneuver is being used to displace the otoliths by placing the head and in turn SCC in different positions for immediate relief.

Key Points

1. **Vertigo** occurs due to disorders of either vestibular, visual or somatosensory system when there is mismatching of information reaching higher centers.
2. In **Ménière's disease** there is hydropic distension of endolymphatic system and duration of attack varies from a few hours to a few days.
3. **Glycerol test** 1 to 2 mL/kg in lemon water given, if causes improvement in hearing confirms the diagnosis of Ménière's disease.
4. **Lermoyez syndrome** has SNHL first followed by attacks of vertigo.
5. **Epley's maneuver** is very beneficial in the management of BPPV.
6. Ménière's disease is autosomal dominant and is more seen in females.
7. Low frequency sounds are affected most commonly in Ménière's disease.
8. **Electrocochleography** (ECoG) is the gold standard for diagnosis of Ménière's disease.
9. Fick and CodyTack procedure is a type of sacculotomy performed in Ménière's disease.
10. **Cochlear hydrops** is seen in all cases of Ménière's disease.
11. In positional vertigo posterior SCC is involved.
12. Vestibular neuronitis is not accompanied by deafness but has severe vertigo of sudden onset.
13. **Ménière's disease** is idiopathic, while in Meniere's syndrome cause is known.
14. **Causes of vertigo—remember mneumonic; AEIOU TIPS:** A: **A**lcohol; E: **E**pilepsy; I: **I**nsulin (diabetic emergency): O: **O**verdose/oxygen deficiency; U: **U**remia; T: **T**rauma; I: **I**nfection; P: **P**sychosis or poisoning; S: **S**troke
15. **Fluctuating hearing loss—remember mneumonic: SPAM: S**yphilitic labyrinthitis; **P**erilymph fistula; **A**utoimmune disorder of inner ear; **M**énière's disease.

Chapter 14 Deafness and Various Rehabilitative Measures

What Students Must Know!

- **Work Out of a Case of Deafness**
- **Hearing Tests for Children**
- **Comparison Between Conductive and SNHL**
  - Management of Conductive Deafness
  - Sensorineural Hearing Loss
  - Comparison between Cochlear and Retrocochlear SNHL
- **Sudden Deafness**
  - Etiology
  - Treatment
- **Malingering (Simulated Deafness)**
- **Deafness in Children**
- **Rehabilitative Measures**
  - Hearing Aids
  - Cochlear Implants

IMPAIRMENT OF HEARING

- Impairment of hearing leads to a great social and educational handicap as man is a gregarious animal who lives by communication with the world around him
- Loss of hearing is the most psychological trauma of the sensory losses and this is exactly how the deaf drowns in a sea of silence
- We are living in an age where new hearts and genes are being given, but the totally deaf are denied the hope, and may be because the deaf rank too low in the order of medical and financial priorities
- A deaf person is the one who has a severe hearing loss and is not benefitted by any hearing aid.

Classification

- Hearing loss may be of conductive type, sensorineural type or mixed type
- It can also be classified into congenital or acquired (**Tables 14.1 and 14.2**)
- It is estimated that about 50 percent of sensorineural hearing loss (SNHL) is caused by genetic factors, 20 to 25 percent are attributed to identifiable causes and 20 to 30 percent cases are of uncertain aetiology
- In 1980, the WHO recommended degree of hearing loss as:
  - No loss (0-25 dB)
  - Mild (26-40 dB)
  - Moderate (41-55 dB)
  - Moderately severe (56-70 dB)
  - Severe (71-90 dB)
  - Profound (more than 90 dB)
  - Total loss
- Hearing loss causes an impairment, which leads to disability and handicap
- The simplest way to find out a handicap in a person is to do pure tone audiometry (PTA) test of both ears and calculate the average of 3 speech frequencies, i.e. 500, 1000 and 2000 Hz.

  Let us presume it comes to be as under:

  Right ear 55 dB
  Left ear 35 dB

  As per the World Health Organization (WHO) classification, there is no disability up to 25 dB so it will be:

  Right ear = 55 – 25 = 30 dB
  Left ear = 35 – 25 = 10 dB

  Multiply it by 1.5, i.e.

  Right ear = 30 × 1.5 = 45 percent
  Left ear = 10 × 1.5 = 15 percent

  Percentage of handicap of the person will be:

  Better hearing ear x 5 + percent of bad ear divided by 6

  In above case, it will be 15 x 5 + 45 divided by 6 = 20 percent

  So total disability or handicap will be 20 percent.

Comparison Between Conductive and Sensorineural Hearing Loss

Refer **Figure 14.1** and **Table 14.3**.

Table 14.1: Classification of congenital deafness

Prenatal	Perinatal	Nongenetic	Postnatal
Genetic • Waardenburg's syndrome • Pendred syndrome • Usher's syndrome • Bing Siebenmann • Mondini-Alexander • Scheibe	• Difficult labor • Prematurity • Kernicterus	• German measles • Diabetes • Syphilis • Toxemia – Quinine – Aminoglycosides – Thalidomide	• Alport's syndrome • Measles • Meningitis • Head injury

Table 14.2: Classification of acquired deafness

Conductive type	**SN type*	*Mixed*	*Sudden*
• External ear Wax/otomycosis/foreign bodies/otitis externa atresia/tumors • Middle ear – Congenital defects – Traumatic – Otitis media (OM) – Nonsuppurative OM – Tuberculosis/syphilis – Otosclerosis – Tumors – Eustachian tube (E tube) – E tube catarrh – Barotrauma	• Head injuries • Viral infections • Mumps, measles, • Herpes • Noise trauma • Tumors – Acoustic neuroma • Ménière disease • Ototoxicity • Presbycusis • Hypertension • Cerebrovascular accident (CVA) • Diabetes • Hypothyroidism • Smoking and alcoholism • Psychogenic deafness	• Blast injury • Chronic suppurative otitis media (CSOM), senile • Otosclerosis	• Vascular • Trauma • Viral infection • Ménière disease • Ototoxicity • Meningitis • CVA • Functional

* *SN = Sensorineural*

WORK OUT OF A CASE OF DEAFNESS

1. Tests of hearing and equilibrium
2. Venereal disease research laboratory (VDRL) test
3. X-ray and computed tomography (CT) scan
4. Cardiovascular system (CVS) examination
5. Central nervous system (CNS) examination

HEARING TESTS FOR CHILDREN

Preschool Children

Simple Tests

Screening procedures

- Auropalpebral reflex (APR) tested with loud sound close to ear and looking at closure of eyes
- Auditory response cradle (ARC) in which a baby is placed in a cradle and his body response in relation to sounds stimuli is monitored by transducers
- *Distraction test*: By 7 months, a child responds towards the source of sound
- Moro's reflex is sudden movements of limbs and extension of head in response to sounds of 80 to 90 dB
- Cooperation tests up to 2 years of age by giving simple commands such as where is your ball and show me your doll
- Play audiometery and speech audiometery
- *Performance tests (2–5 years):* The child performs to a given command
- Otoacoustic emissions, which are absent in a baby with hearing loss of more than 30 dB.

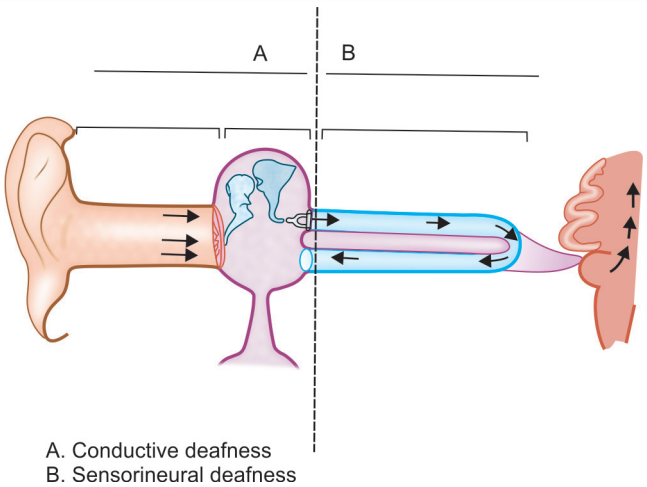


Figure 14.1 Sites and causes of conductive and sensorineural deafness

Diagnostic Tests

- Free field audiometry in which recorded test material is played through loudspeakers in a room where the child is sitting (**Figure 14.2**)
- *Sweep frequency testing*: Various frequencies are given through an audiometer and the response is noted
- Pure tone, impedance and speech audiometry for school-aged children
- BERA is another useful objective test.

Differential Diagnosis

- Cerebral palsy
- Mental retardation
- Delayed speech
- Central aphasia
- Secretory otitis media.

MANAGEMENT OF DEAFNESS

Before deciding the line of treatment, it is important to find out

- Type of deafness, i.e. conductive or sensorineural (SN) type
- Severity of deafness, i.e. mild, moderate or severe
- Type of audiogram whether high-frequency or low-frequency hearing loss
- Site of lesion, i.e. cochlear, retrocochlear or central type of hearing loss.

Deafness implies subjective perception of the disability, while in hearing loss the patient may not be aware of it.

Management of Conductive Deafness

It depends upon the cause of hearing loss such as:

- Removal of any cause in the external auditory meatus which may be wax, mass or stenosis
- If there is perforation, treatment will be myringo or ossiculoplasty, tympanoplasty
- In case of otospongiosis, stapedectomy is done
- Lastly, hearing aids will be useful in those cases where surgery is not possible.

Table 14.3: Conductive versus sensorineural hearing loss

Conductive	*Sensorineural*
• Disease process is limited to external ear and middle ear, including footplate of stapes	• Disease process is beyond the oval window in the inner ear
• Rinne –ve	• Rinne +ve
• Weber lateralized to worse ear	• Weber lateralized to better ear
• Absolute bone organization (ABC) is equal	• ABC shortened
• Pure tone audiometry (PTA) shows bone air gap	• PTA shows no bone air gap
• Low frequencies involved	• High frequency hearing loss
• Hearing loss up to 50–60 dB	• Hearing loss more than 60 dB
• Speech discrimination score (SDS) is good (95–100%)	• Poor SDS in cochlear (low score) and retrocochlear (very low score)
• Test for recruitment is –ve	• Recruitment test +ve in cochlear lesion
• Short increment sensitivity index (SISI) of 15%	• SISI above 60% in cochlear lesion
• No tone decay	• A tone decay of 30 dB seen in retrocochlear lesions
• Impedance audiometry is a useful parameter	• Impedence audiometry is not of much use
• Brainstem evoked response audiometer (BERA) not of much use	• BERA is a very useful diagnostic tool

Figure 14.2 Play audiometry

Management of Sensorineural Deafness

Children Born Deaf

- Parents must be educated to help a deaf child to develop language and communication skill
- Nature and extent of the problem and its future impact must be explained to the parents
- Remember, the development of receptive language precedes the development of expressive language in a child
- Hearing aid must be given as early as possible to develop receptive language, it may have to be supplemented by lip reading as well
- Responsibility rests with the parents for training of the child in natural environment such as home
- In patients who are not benefitted by hearing aid, cochlear implants may be recommended only if eighth nerve and its central connections are normal
- Education treatment of deaf-mute child should be planned in either:
  - Special schools for deaf-mutes
  - Special classes attached to normal schools
  - Normal schools with supplementary help such as hearing aid
- Hearing aid may be given to a deaf child as early as 12 months and use of residual hearing even in a profoundly deaf child should be made
- Effective range of hearing aids can be increased by installing an inductance loop system in the home.

SENSORINEURAL HEARING LOSS (ADULTS)

Comparison between Cochlear and Retrocochlear SNHL

Cochlear versus retrocochlear deafness is described in **Table 14.4**.

Special forms of SNHL

Presbycusis

- Presbycusis is progressive loss of hearing of SN type, which occurs with advancing age
- Usually, the age is above 65 years
- There are many factors, such as hereditary, atherosclerosis, dietary (high fats), noise trauma, diabetes, smoking and hypertension, which may hasten the process of hearing loss
- Usually, it is a high-frequency loss, which is bilateral and symmetrical
- Pathologically, there occurs sensory degeneration of hair cells, atrophy of stria vascularis with loss of neurons, which may be because of formation of bony cuffs around the end arteries causing ischemia.

Clinical features

Besides deafness, tinnitus, vertigo and distortion of sounds may occur. The PTA shows high frequency loss above 1000 Hz (descending type of PTA) (**Figure 14.3**).

Management

- Avoid consumption of tobacco, smoking, high-fat diet, stress, excess of alcohol
- Avoid excessive noise exposure
- Hearing aids are very helpful
- Drugs such as use of vasodilators, vitamins, antioxidants
- Good protein diet with mild-to-moderate walking exercise are always helpful.

Toxic Deafness

Toxic causes may be—exogenous, such as drugs and chemicals and endogenous due to metabolic or nutritional disorders.

- Drugs such as ototoxic antibiotics, for example, streptomycin, dihydrostreptomycin (cochleotoxic), neomycin, kanamycin, gentamicin, vancomycin and viomycin
- Tobacco and alcohol
- Quinine, salicylates and ethacrynic acid (diuretic)
- Aniline dyes, caffeine, CO, camphor, chloroform, iodine, lead, mercury and morphine.

Prevention

It is always better than cure. Be careful, while using these drugs and closely monitor the early symptoms.

Use of vitamins and vasodilators in early cases of recent onset may be helpful.

Endogenous cause

Such as hypothyroidism, avitaminosis, systemic disorders such as diabetes, leukemia, nephritis, sarcoidosis, and Paget's disease. Lermoyez syndrome (in which there is deafness and tinnitus before vertigo and is due to spasm of internal auditory vessels).

Table 14.4: Cochlear versus retrocochlear deafness

*Cochlear SNHL**	*Retrocochlear SNHL*
• Hair cells are damaged mainly • Recruitment is present • No significant tone decay • SISI† is positive • Bekesy shows no gap between I and C tracings (Type II) • Speech discrimination not highly impaired (SDS‡ is low) and roll over phenomenon not present • Subjective feeling of diplacusis, hyperacusis or fullness in the ear	• Lesion is of VIIIth nerve or its central connections • Recruitment absent • Tone decay is significant • SISI is negative • Bekesy shows wide gap between I and C tracings (Type III) • Speech discrimination highly impaired (SDS very poor) and roll over phenomenon is present • No such sensation or feeling

*SNHL = Sensorineural hearing loss; †SISI = Short increment sensitivity index; ‡SDS = Speech discrimination score.

Noise Trauma

- Noise is an unpleasant, unwanted and undesirable sound
- It may be continuous, intermittent or explosive
- Pink noise differs from white noise because in pink noise the sound is of very high intensity although frequency characters are similar
- One man's noise may be another man's music
- There occurs trauma to organ of Corti with destruction of hair cells mostly in the lower basal coil resulting in degeneration of spiral ganglion and atrophy of auditory nerve.

Effects of Noise

- When a person is exposed to temporary noise, it causes elevation of threshold of hearing causing acoustic dip in PTA at 4 kHz and it recovers in 48 hours if the person is taken away from the noise.
- If the person is exposed to permanent noise-induced hearing loss, i.e. occupational hearing hazards, it results in permanent pathological changes in cochlea and irreversible threshold shift in hearing acuity producing a dip at 4 kHz.
- It may be due to more firmly fixed basilar membrane at the basal turn of cochlea subjected to noise torsion and more liable to degenerative changes or may be it is due to hypofunction of middle ear musculature.
- It may also be due to hydrodynamic causes or because of less efficient blood supply of this part of basilar membrane.
- U-shaped or basin-shaped audiogram at 500 to 4 kHz is typical of acoustic accident during brief sudden exposure to noise (**Figure 14.4**).
- High-frequency sounds are in general found to be more damaging than low frequency
- Loud sounds more harmful than quite ones.
- Almost 120 dB is considered threshold of discomfort, tickle 130 dB and pain 140 dB.

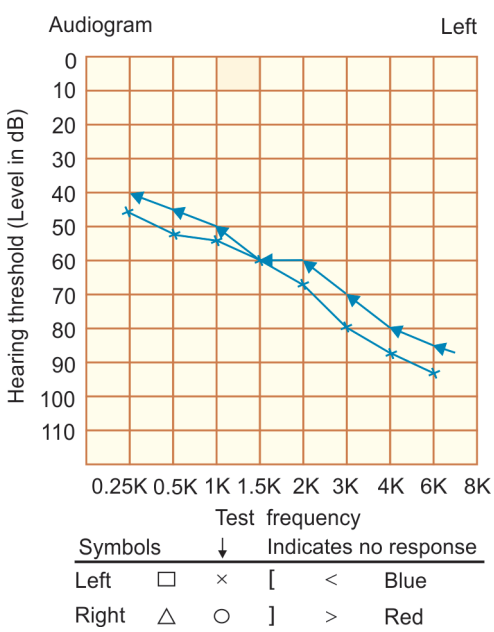


Figure 14.3 Audiogram in presbycusis

- Otitic blast injuries occur due to sudden explosive forces generated by bursting of shells or mine fields, bombs by primary and secondary waves.
- A noise of 90 dB, 8 hours a day for 5 days a week is the maximum permissible limit; but for 110 dB, only half an hour is permissible.
- Acoustic trauma is irreversible and occurs after a brief exposure to loud sound, such as gunfire, major explosions producing more than 160 dB level (impulse noise).
- Acoustic reflex does not provide any help in impulse noise because of long contraction time of the muscles of middle ear.

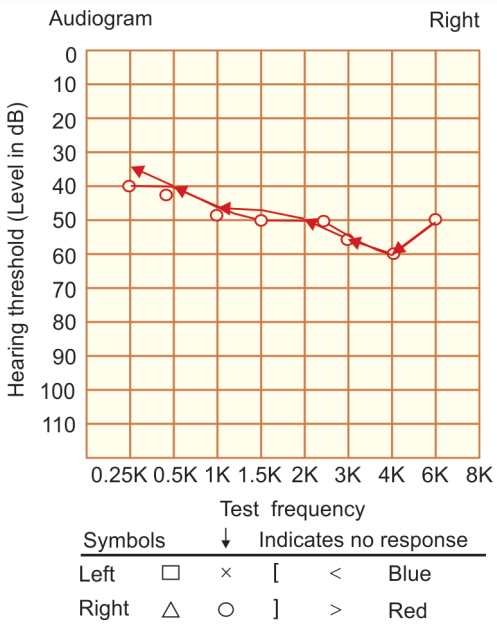


Figure 14.4 Audiogram in noise induced hearing loss (dip at 4 kHz)

Management

- Early detection of hearing loss is very important; therefore, regular audiogram of such patients is very necessary.
- Ear plugs or muffs should be used where noise level is more than 85 dB.
- Under Indian Factories Act, 1948, noise-induced hearing loss is a notifiable and compensable disease. Under this act, hearing protection is recommended to all workers who are consistently exposed to noise level of more than 85 dB at a frequency of more than 150 Hz.
- If hearing loss has already started, it would be necessary to move the person away from the noise,
- Use of vitamin E, nicotinamide, IV procaine or stellate ganglion block
- Hearing conservation programs such as reduction of noise at source and education and protection of employees.

SUDDEN DEAFNESS

A hearing loss of 30 dB occurring over a period of 3 days in 3 frequencies is called sudden deafness.

Etiology

- External and middle ear conditions (conductive hearing loss)—wax, foreign bodies, secretory otitis media and barotrauma.
- Sudden SNHL
  - Vascular causes such as hemorrhage, thrombosis or embolism of labyrinthine vessels. Vasospasm of the vessel may also cause it.
  - Traumatic such as acoustic trauma, head injury or spontaneous rupture of membrane in the endolymphatic system.
  - *Infective causes:* Viral infections such as encephalitis, mumps, herpes, meningitis, and viral labyrinthitis.
  - Toxic causes, e.g. various ototoxic drugs.
  - Otologic including Ménière's disease.
  - *Neoplastic:* CP angle tumors both primary and secondary.
  - Other causes may be idiopathic or Cogan's syndrome, multiple sclerosis, hypothyroidism, sarcoidosis or psychogenic.

Treatment

- Treat the cause if found on detailed history, laboratory investigations and examination.
- Large doses of adrenocorticotropic hormone (ACTH) or corticoids produce good response.
- Role of vasodilators such as betahistine 8 to 16 mg 3 to 4 times a day.
- Vitamin C—1000 mg twice daily has also been found to be helpful.
- Carbogen therapy consisting of 5 percent carbon dioxide and 95 percent oxygen helps by improving oxygenation of cochlea.
- Low molecular weight dextran helps by decreasing blood viscosity.
- Other drugs such as tranquilizers—sedatives: Use of hyoscine 0.3 mg or atropine 75 mg IM or IV in 250 ml of 5 percent glucose, if patients is seen in 1 to 3 days and use of nylidrin HCl 6 mg 4 times a day.
- Intratympanic Injection of steroids has also been tried.

Prognosis

Young patients with moderate loss, if reporting early have been seen to recover better than otherwise old patients.

PSYCHOGENIC DEAFNESS

In this form, the patient complains of deafness despite any organic lesion. It may be functional (hysterical) or stimulated, i.e. malingering.

Functional Deafness

In this, the deafness is beyond the control of patient's consciousness. The patient ceases to listen and fails to respond. There is increased resistance in the auditory path-

ways and seat of lesion is in the cerebral cortex. It is seen in emotionally labile personality, especially in women.

Diagnosis

It is made by other evidences of hysteria. Cochleopupillary and cochleopalpebral reflexes are absent and deafness persists during sleep. Voice is unaltered and vestibular responses are normal. Results of hearing tests are divergent varying from day to day. Sudden improvement with a psychiatric treatment confirms the diagnosis.

Special Diagnostic Tests

- They are as follows:
  - Repeated audiometry gives variable results.
  - Bekesy audiometry: Type V graph.
  - Impedance audiometry: If stapedial reflex is present, hearing must be present.
  - ERA because it is an objective test.
  - Difference limen test is increased only in functional deafness while it is decreased in organic deafness. This test is not done commonly.
  - *Stenger test:* Done with either PTA or speech audiometer or tuning forks and is useful in unilateral functional deafness.
- Two tuning forks of 512 Hz are struck, standing behind the blind folded patient and are held at 10" from the both ears and patients is asked if he hears it, a malingerer will deny hearing at all or at least on the so-called deaf ear. Now the tuning fork on feigned side is brought closer to the ear. The patient will deny hearing the fork and this mistake will establish the diagnosis. A patient with true deafness should continue to hear on the normal side.
  - *Doerfler-Stewart test:* A person with normal hearing raises his voice in the presence of background noise. The patient reads a passage from a book, noise is given to the deaf ear, if the deafness is real masking will have no effect; but if it is functional, voice will be raised.
  - Psychogalvanic skin resistance tests (PGSR) are of value as these are objective tests.
  - Hypnosis or pentothal abreaction also helps to reveal functional deafness.

Treatment

Early diagnosis and early suggestion therapy with rational explanation, narcotherapy, psychotherapy and hypnosis are the methods used for treatment of functional type of hearing loss.

MALINGERING (SIMULATED DEAFNESS)

The patient is able to hear yet pretends deafness perhaps due to maladjustment, medicolegal compensation or social circumstances.

In such cases, general behavior of patients must be kept under observation and the various tests are:

- *Stenger's test.*
- *Weber's test (Chamini-Moos test)*: Strike 512 Hz tuning fork, it is kept on vertex and the patient states that he hears the fork on good side indicating SNHL. Meatus of good ear is occluded; if truly deaf, the patient will say he hears the fork in occluded good ear or he may be uncertain; but if he is malingerer, he will say that he does not hear the fork at all.
- *Lombard's test*: A noise box is applied to the sound ear and the patient is asked to read from a book in his natural voice. With true deafness, the voice is markedly raised, while the malingerer continuous reading in the same tone or raises his voice slightly.
- *Erhard's test*: Good ear is occluded by a finger, a malingerer will deny hearing any loud sound.
- *Gault test*: Good ear is tightly occluded and a loud sound is given to deaf ear and blinking of eye is noticed indicating that sound is heard.
- *Stethoscope test*: One earpiece of stethoscope is occluded and the patient wears it and chest piece is replaced with a funnel into which words are spoken. The patient is confused whether sound is being conducted to both ears or to one or other ear.
- Repeated audiometry will give variable results.
- Bekesy audiometry gives type V graph.
- *Tests during sleep:* A loud noise wakens a malingerer.
- *Trick remarks and action:* Some commands are given to the patient and malingerer may be caught off the guard by responding to it.
- *Delayed feedback:* The malingerer is asked to read loudly from a book. His voice is recorded with 2 leads one of which records 0.1 to 1 sec after the other. This later sound is sent back to malingerer's bad ear, other is masked. If hearing is present, the patient will be unable to continue reading aloud or his voice and rate of speech will be altered.

Treatment

It is on similar lines as for functional deafness.

TRAUMATIC DEAFNESS

Head Injury and Deafness

Effect may be on the middle ear or inner ear causing mixed type or pure SNHL.

Petrous bone's weakest part is squamous-temporal suture line and longitudinal fracture is four times commoner than transverse fracture.

Longitudinal Fracture

Cases present with bleeding from the meatus with a conductive hearing loss.

Transverse Fracture

- May be internal in which fracture line traverses the internal acoustic meatus and shatters the anterior part of cochlea.
- It may be external when fracture line passes through the entire inner ear affecting cochlea, vestibule and fallopian canal.
- Hearing loss may also occur due to injury to retrocochlear pathways such as inferior colliculus, lateral leminiscus and superior olivary nucleus
- If SNHL lasts for more than 6 months after trauma, pathological process is of contusion perhaps with fracture and is likely to be permanent hearing loss.

Deafness due to Atmospheric Pressure Changes

1. Caisson's disease, which follows too rapid decompression after work in a compressed air chamber and may be seen in divers or in submarine operations. There may be disruption of organ of Corti causing sudden SNHL.
2. *Barotraumatic* injuries may cause vascular accidents caused by spasm.

Treatment

Prophylaxis is the best. Use of corticosteroids and antispasmodics have been tried along with stellate ganglion block.

INFECTIONS AND SNHL

- Viral conditions such as mumps, influenza, herpes, enterovirus and typhus. Deafness may be unilateral or bilateral and appears between 4th and 14th day.
- Bacterial infections such as meningococcal meningitis, typhoid fever, tuberculous meningitis and septic meningitis.
- Vogt-Koyanagi syndrome has the features of SNHL along with neuritis, alopecia, vitiligo and whitening of eyelashes.
- *Syphilitic deafness*: Its main features are as follows:
  - Congenital or acquired types of neurosyphilis.
  - Fairly sudden onset of bilateral fluctuating SNHL.
  - Tinnitus and vertigo disappear once the deafness is established.
  - Hennebert's sign present in late congenital syphilis (50%) along with Hutchinson's teeth and interstitial keratitis.
  - Child may be deafmute.
  - PTA shows high frequency SNHL with abnormal caloric response.
  - Confirmation is by Wassermann's reaction and TPI test.
  - Treatment with penicillin will help in recovery of early cases of deafness of acquired type, while little hope is present for late and congenital type.

DEAFNESS IN CHILDREN

- Child born deaf or who acquires hearing loss before language development is at a great disadvantage because there will be failure of communication, which is essential for social life, mental growth and future development.
- Parents suspect their child of being hearing impaired when there is failure to respond to sound, a lack of facial expression, failure to talk or there is defective speech.
- It is very important to diagnose the hearing defect before 2 years of age for learning language and development of speech. A detailed history of the mother during pregnancy, labor or after delivery and infection of the child should be taken and at risk factors should be recognized.
- Various causes leading to SN deafness have already been tabulated.

Syndromic Form of Deafness

- Scheibe type (sacculocochlear maldevelopment)
- Mondini-Alexander type with flat cochlea and underdeveloped vestibule
- Bing Siebenmann type—membranous labyrinth is malformed
- Michel type—inner ear not developed.

Waardenburg's Syndrome

- Malformation of inner angles of eyelid
- Congenital perceptive hearing loss
- Heterochromia iridum
- White forelock.

Pendred Syndrome

- Goiter
- SNHL.

Usher's syndrome

- SNHL
- Retinitis pigmentosa
- Night blindness.

Alport's syndrome

- Hereditary nephropathy
- SNHL
- Anterior lenticonus.

Other causes such as endemic cretinism, German measles, diabetes, nephritis, drugs, prematurity, hemolytic anemia, jaundice, anoxia, measles, mumps, and meningitis also affect the hearing due to degenerative changes and destructive effect on cochlea and saccule.

REHABILITATIVE MEASURES

Hearing Aids

Hearing aid is a device used to amplify the sounds for pronounced irreversible hearing loss and helps in clarity of hearing. All hearing aids have three parts.

a. *Microphone* collects the sound and transforms acoustic signals into electrical signals into electrical energy. It has a diaphragm with an electromagnet behind it.
b. *Amplifier* magnifies electrical signals/impulses by use of transistors and the usual range of amplification of hearing aids is 250 to 400 Hz.
c. *Receiver* transforms this electrical energy back into sound waves, which have much greater amplitude than the one received at microphone.

Acoustic gain of a hearing aid is the amount of amplification, which it gives. Output of the aid is sum of input and the gain.

Tone control and output limitation for clipping of loud sounds for better tolerance are incorporated in the hearing aid. Automatic volume control (AVC) in hearing aid is designed to overcome recruitment.

Types of Hearing Aids

Depending upon placement of hearing aid

Wearable hearing aids

- Body worn aids
- Post aural aids/Behind the ear (BTE)
- Spectacle aids
- In the ear (ITE) aids
- Canal type aids (In the canal[ITC]), completely in canal [CTC]
- Contralateral routing of signals (CROS) hearing aid for severe unilateral SNHL
- Programmable digital hearing aids are recent additions and these can be programmed according to the audiogram pattern of the patient and these provide very clear sounds to the patient due to digital technology and computerization of electronic circuits (**Figures 14.5A to D**).

Nonwearable aids

- Portable aids
- Group hearing aids
- Inductance loop systems
- Radio transmission aids.

Implantable hearing aids such as BAHA, otic capsule stimulator.

Bone anchored hearing aid

- In bone anchored hearing aid (BAHA), this vibratory energy is applied to skull bone
- Conventional bone conduction oscillator that is used has percutaneous attachment to the titanium screw, which is embedded in skull to achieve osseo integration
- These are particularly useful:
  - In congenital or acquired external auditory canal (EAC) atresia
  - Chroic otorrhea in CSOM, chronic mastoiditis
  - Chronic otitis externa
  - Congenital or acquired surgical defects of pinna where conventional hearing aid canot be used.

Situation where Aids are Required

- A patient who has hearing problem and which is not treatable by medical or surgical means is an ideal candidate for hearing aid. Hence, it is useful hearing device for deaf mutes along with speech and auditory training.
- In SNHL, however, all patients may not be benefitted with this aid because of distortion of sounds.
- Hearing aids give best results in conductive deafness patients who do not want surgery or are unfit for surgery.

Main factor influencing candidacy is neuron plasticity, which means ability of CNS to adapt to learn a new task, which is around 5 years.

Situation where Aids are not Indicated

- Hearing loss for pure tones does not exceed 30 to 35 dB.
- In monaural deafness.
- In patient where hearing for tones of low frequency is normal, while loss for high frequency sounds is great.
- Air conduction hearing aids are not given in discharging ears or congenital malformations. Here, bone conduction type hearing aids having a bone vibrator should be used.

Remember, it is important that the user first should learn to use the aid in good acoustic condition before progressing to less favorable ones. Practice is required to learn to

discriminate various sounds along with making use of lip reading as well.

Cochlear Implants

- It is an electronic device, detects mechanical sound energy and converts it to electrical signals, stimulates the cochlear nerve directly and therefore replaces the function of cochlea
- It differs from hearing aid, which amplifies the sound only and stimulates the cochlear hair cells, while cochlear implant by passes the cochlea
- It was in 1950s that work on cochlear implant started (Andre Djurno and Charles Eyries, 1957, France.)

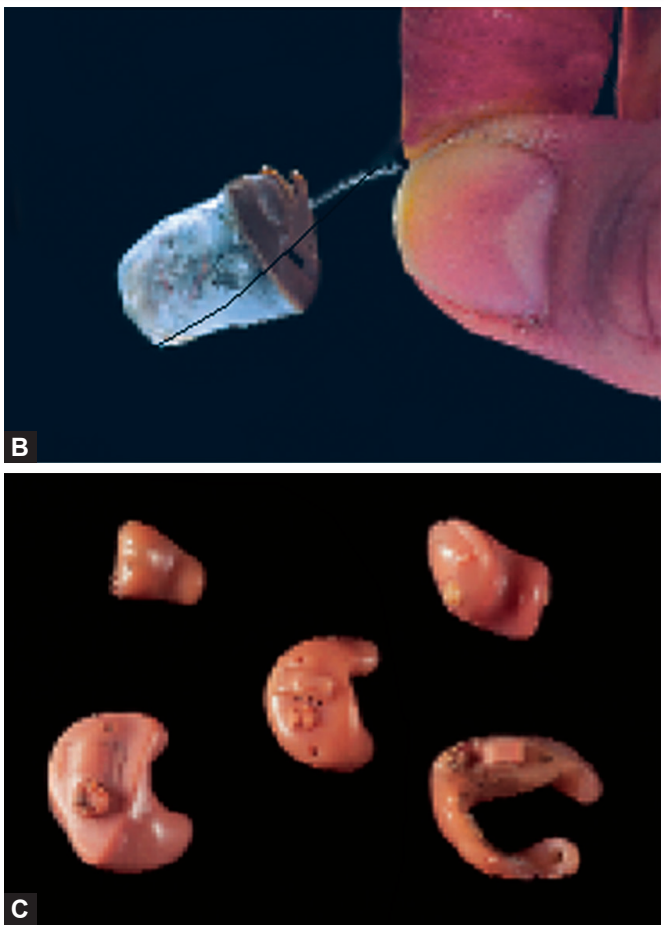
Bilateral deafness with inability to benefit from conventional hearing aid is an indication for cochlear implant.

Benefits of Cochlear Implants

- Implant will not produce normal hearing, but enables the person to hear environmental sounds and speech at comfortable loudness level
- It enhances lip reading and helps speech production in prelinguals
- It helps in building self-confidence of patient and is more helpful in patients who could hear earlier and than lost their hearing.

Parts of Cochlear Implant

Cochlear implant is divided into external and internal parts (**Figures 14.6 and 14.7**)



Figures 14.5B and C Various types of intracanalicular digital hearing aids

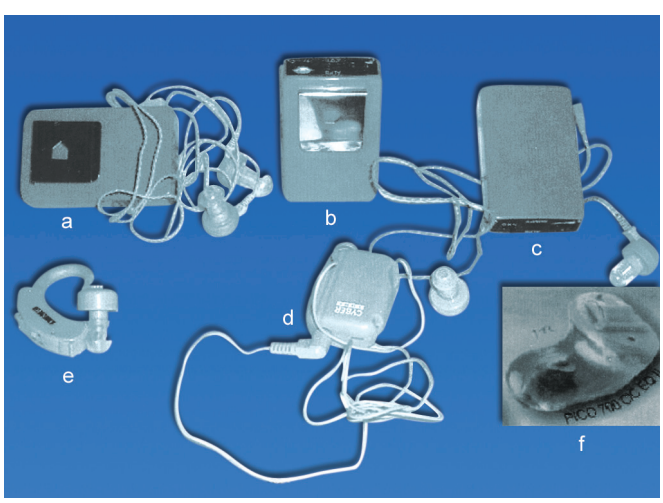


Figure 14.5A Various types of hearing aids. a, b, c, d—Pocket model type; e–Postaural type; f–In the canal type of the hearing aid

Figure 14.5D A child wearing binaural body worn type of hearing aid

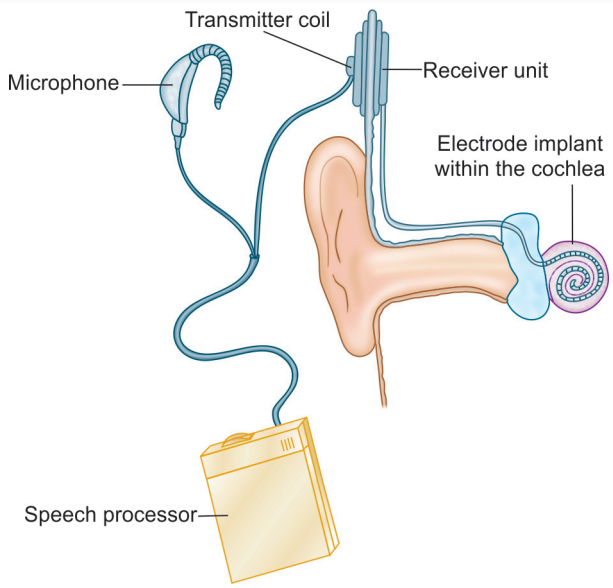


Figure 14.6 Parts of cochlear implant

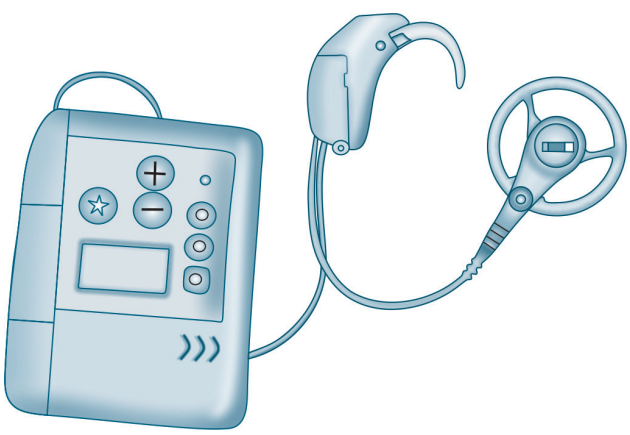


Figure 14.7A Parts of brainstem auditory response audiometry

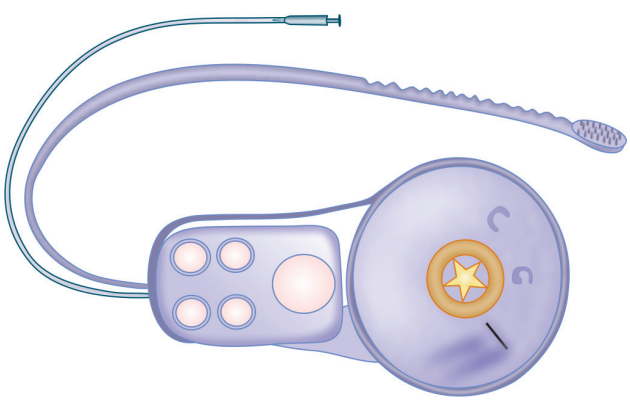


Figure 14.7B Multichannel electrode

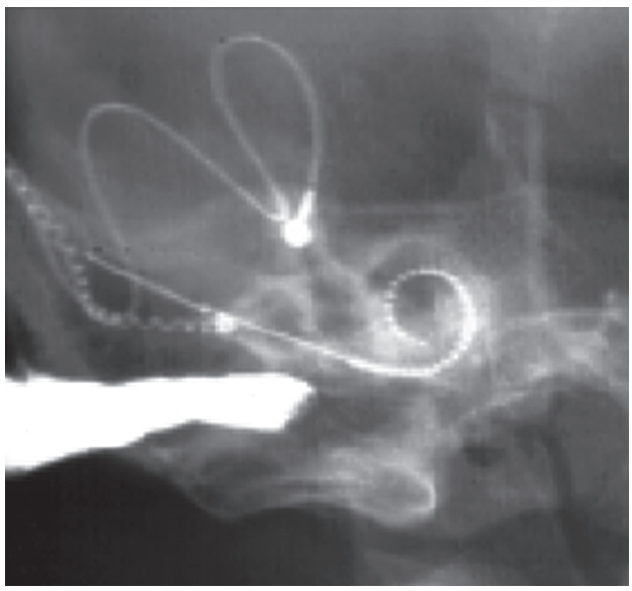


Figure 14.7C A view of implant *in situ*

External parts

- *Microphone* receives acoustic signals from the surrounding and looks like behind the ear hearing aid.
- *Speech processor* receives and processes the acoustic signals from the microphone into electrical signals and weighs about 100 g.

Internal parts

- *Induction coil* in the mastoid cavity sends electrical signals from speech processor to the electrode.
- *Electrode* stimulates the cochlear nerve may be extracochlear (electrode comes in contact with promontory), intracochlear (inside the scale tympani) or intraneural (in the cochlear nerve). Further, electrodes may be single or multichannel.

Indication for Cochlear Implants

- Bilateral profound SNHL above 90 dB where hearing aid is not helpful, especially in prelinguals and IQ of the patient is well within normal limits (**Figure 14.8A**).
- It may also be useful in those patient having damage to cochlea with intact VIIIth nerve such as traumatic, congenital, labyrinthitis, presbyacusis, Ménière disease, and drug toxicity.

Investigations

It includes the following:

- Medical and surgical fitness
- Psychological evaluation
- Laboratory investigations

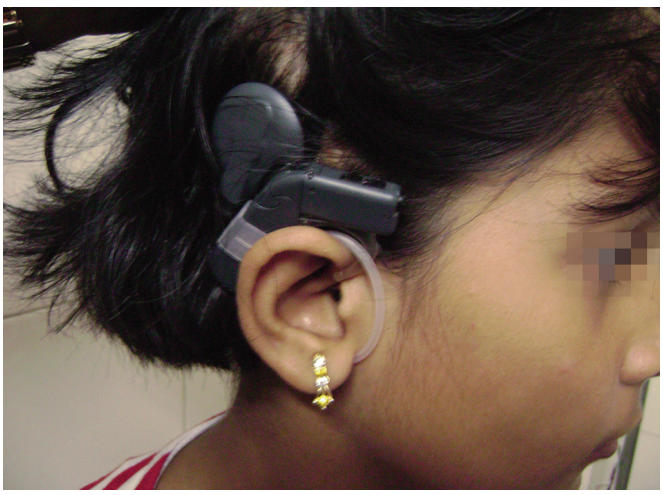


Figure 14.8A Cochlear implant in a patient

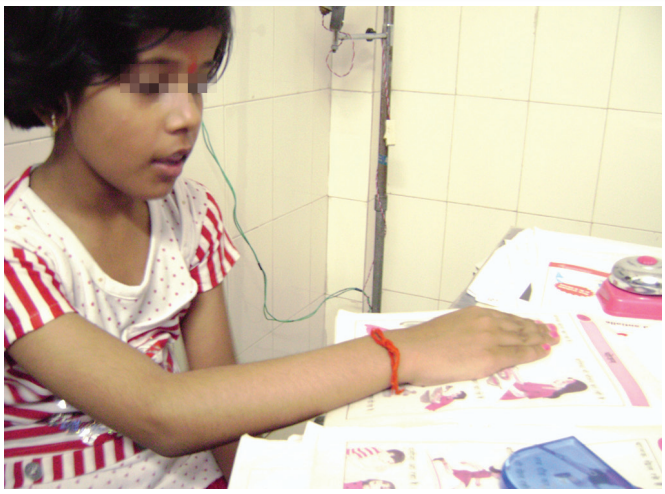


Figure 14.8B Same patient undergoing rehabilitation

- Radiological investigations, such as X-ray mastoid, chest X-ray, CT magnetic resonance imaging (MRI).
- Audiometry, i.e. impedance, speech. BERA, electrocorticogram (ECoG), and Vestibular function test
- Electrocardiogram (ECG).

Procedure

Simple mastoidectomy is done and through facial recess approach, round window and promontory is visualized and electrodes are implanted in the round window niche or cochlea after it is exposed.

- It is not costeffective at present. The present cost varies between rupees 4.5 and 8 lac and it is beyond the reach of most of the poor patients.
- It is not of any use in retrocochlear type of SNHL.

The patient after the cochlear implant needs intensive speech and auditory training (**Figure 14.8B**) for better discrimination of speech.

Key Points

1. **Deafness** means subjective perception of the disability, while hearing loss, the patient may not be aware of it.
2. The WHO (1980) classification of hearing loss:
   - ***No loss*** (up to 25 dB)
   - ***Moderately severe*** (56-70 dB)
   - ***Mild loss*** (26-40 dB)
   - ***Severe*** (71-90 dB)
   - ***Moderate*** (41-55 dB)
   - ***Profound*** (more than 90 dB)
3. **Ototoxic drugs** include dihydrostreptomycin, gentamicin, neomycin, kanamycin, vancomycin, quinine, salicylate, ethacrynic acid, lead, mercury, caffeine, chloroform, iodine, and aniline dyes.
4. Ototoxicity of streptomycin can be reduced by giving **ozothime** (an oxidative product of turpentine oil).
5. **Noise trauma** causes acoustic dip at 4 kHz and also U-shaped or basin-shaped audiogram.
6. **Sudden deafness** is unlikely to recover spontaneously after 3 weeks.
7. **Stenger's test and Chamini-Moos test, Lombard, Gault test** help to find functional deafness.
8. **Longitudinal fracture** of temporal bone causes conductive hearing loss, while **transverse fractures** cause SNHL.
9. **Hennebert's sign and Hutchinson's teeth** affecting incisors are features of congenital syphilis.
10. **Cochlear implants** are best indicated in postlingual, postpubertal patients with hearing threshold of less than 100 dB and speech discrimination less than 10 percent.
11. Unilateral hearing loss is commonly due to **mumps**.
12. Surgically treated patient of **bilateral vestibular schwannoma,** brainstem auditory implants placed close to cochlear nucleus may have auditory perception
13. **Dip at 4 kHz in acoustic trauma** is due to resonantor function of EAC and not due to cochlea.

Chapter 15 Tinnitus

What Students Must Know!

- **Tinnitus**
  - Types
  - Causes
  - Causes of Subjective Tinnitus
  - Causes of Objective Tinnitus
  - Measurement of Tinnitus
  - Investigations
  - Treatment

DEFINITION

1. Tinnitus is a sound sensation perceived by the patients or it may be described to indicate a subjective symptom of noises in the head or ear.
2. The word tinnitus is derived from a Latin word 'tinnire,' which means a jingle.
3. It may be felt like ringing, buzzing, clicking or escaping of steam from a pressure cooker.

TYPES

Types of tinnitus are give below:
Type I: Subjective tinnitus
Type II: Objective tinnitus.

Subjective tinnitus is the one, which is heard by the patient himself while objective tinnitus may be heard by examiner if amplified sufficiently.

CAUSES

The causes of subjective tinnitus and objective tinnitus (**Figure 15.1**) are given below:

Causes of Subjective Tinnitus

1. Due to changes in the cochlear hair cells of the basal turn, which may be like escaping of steam or like ringing of bells. They may be caused by:
   - Noise trauma
   - Presbycusis

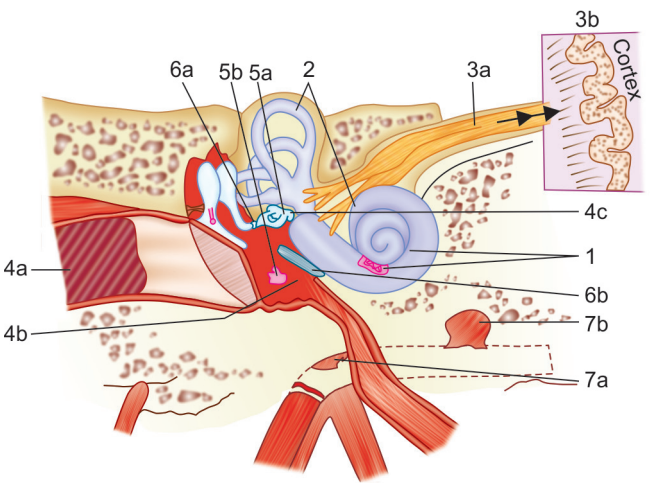


Figure 15.1 Different causes of tinnitus

1. Ménière's disease; 2. Acoustic trauma;
3a. Acoustic neuroma; 3b. Central causes;
4a. Impacted wax; 4b. Serous otitis media;
4c. Stapedial otosclerosis; 5a. Cochlear otosclerosis;
5b. Glomus jugulare; 6a. Muscular contraction of stapedius;
6b. Glomus tympanicum; 7a. Atherosclerosis;
7b. Arteriovenous malformation (AVM)

   - *Toxic causes*: Because of drugs such as salicylates, quinine, streptomycin, neomycin, ibuprofen, imipramine and heavy metals
   - Head injury causing labyrinthine concussion

- Ischemia caused by hypertension or atherosclerosis or vasomotor.

2. Physical distortion of cochlea, which may occur due to Ménière disease, endocrine disturbances such as hypothyroidism, diabetes and premenstrual tension. It gives rise to roaring, humming and bells like low-pitched tinnitus.
3. *Disorders of central nervous system (CNS):* In this type, other effects of CNS diseases are also present. There is high-pitched tinnitus.
   Causes may be:
   - Cerebellopontine (CP) angle lesions such as tumors or inflammation
   - Cerebral atherosclerosis as in old age (presbyscusis).
4. Due to changes in sound conduction
   - Impacted cerumen, foreign body, atresia
   - Secretory otitis media
   - Otosclerotic focus.
5. Vascular causes produce pulsatile tinnitus.
   - Carotid body tumors (glomus tumor)
   - Active otospongiosis
   - Severe anemia
   - Hypotension.
6. Muscular contraction of tensor tympani stapedius.
7. Psychogenic causes (**Figure 15.2**)
   - Depression
   - Anxiety
     - Middle ear tinnitus is low pitched, while cochlear tinnitus is high pitched
     - Pulsatile tinnitus is seen in acute suppurative otitis media (ASOM), barotrauma and glomus tumor
     - Tinnitus synchronus with respiration is seen in patulous eustachian tube.

Causes of Objective Tinnitus

1. Patulous eustachian tube, which may follow rapid weight loss or section of V nerve and excessive scarring of palate
2. Stenosis or aneurysm of carotid artery or its branches can cause tinnitus synchronous with pulse
3. Palatal myoclonus
4. Glomus jugulare tumor
5. Venous hum
6. Arteriovenous malformations (AVM).

Important Causes of Tinnitus

Local Causes

- Presbycusis
- Ménière disease
- Noise-induced deafness
- Otosclerosis
- Glomus jugulare tumor—tinnitus is pulsating
- Aneurysm, vascular malformation and some vascular intracranial tumors.

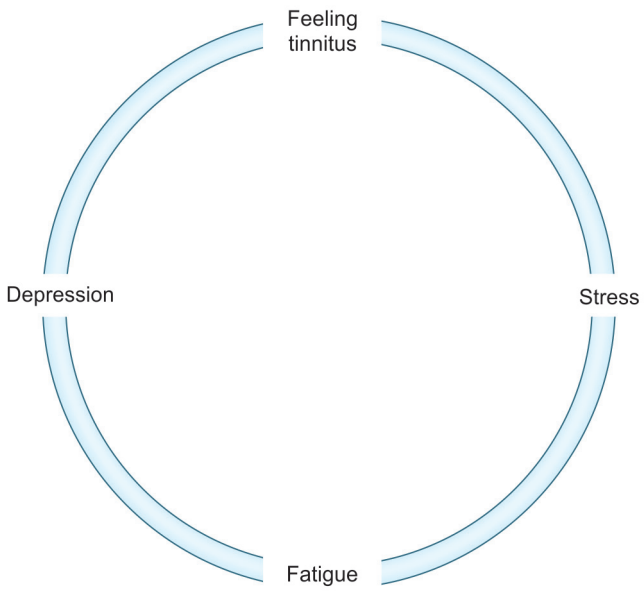


Figure 15.2 Vicious cycle of symptoms of tinnitus

General causes

- Endocrine disorders—hypothyroidism, diabetes
- Fever of any cause
- Cardiovascular disease—hypertension, atheroma,cardiac failure
- Blood disease—anemia, raised viscosity
- Neurological disease—multiple sclerosis, neuropathy
- Drug treatment—ibuprofen,aspirin, quinine, ototoxic drugs
- Alcohol abuse.

Measurement of Tinnitus

1. Masking by pure tones.
2. Measurement by loudness balance.
3. Free field matching.
4. Narrow band masking of clinical audiometer.

INVESTIGATIONS

1. Detailed history along with general and ear, nose and throat (ENT) examination is very important
2. Complete hemogram/fasting blood sugar (FBS)/lipid profile/serological tests of syphilis (STS)
3. Pure tone audiometry/impedance audiometry/vestibular examination.
4. Speech discrimination score (SDS) and speech reception threshold (SRT).
5. Tinnitus matching electronystagmography (ENG).
6. Computed tomography (CT) scan of CP angle.

TREATMENT

1. **Treatment of the cause** is most important and depends upon whether tinnitus is troublesome or non-troublesome.
2. Reassurance to the patient and **counseling**.
3. **Conservative treatment** such as vasodilators, sedatives, vitamins and tranquilizers.

   Tocainide is the latest drug used for treatment. Zinc therapy, carbamazepine, clonazepam and *Ginkgo biloba* have also been used.
4. **Surgical treatment** depending upon the cause:
   - Endolymphatic sac decompression
   - Intratympanic injection of alcohol or steroid
   - Cryotherapy for cochlear destruction
   - Cochlear nerve section if no hearing.
5. **Use of tinnitus maskers**
   Such as continuous (complete/partial), inhibitory or desensitizing type.

   If no cause is found, these are quite helpful such as putting a ticking alarm clock close to head or a very light soothing sound or music of radio through a headphone just to mask the noise, which may be disturbing the sleep.
6. **Hearing aid** improvization gives psychological effect as patient believes tinnitus to be a cause of hearing loss.
7. **Psychological treatment** of tinnitus includes the following:
   - Cognitive therapy
   - Relaxation training therapy
   - Biofeedback and hypnotherapy.

Key Points

1. Some commonly seen **causes of tinnitus** are hypertension, psychogenic, CSOM, Ménière's disease, otosclerosis, ototoxic drugs and presbycusis.
2. In about more than 85 percent patients, **tinnitus can be masked** with a sound of 6 dB or less.
3. **Reflex pathway of tinnitus is from:** End organs → auditory nerve → cochlear neurons → brainstem → cerebral cortex and back through olivocochlear bundle.
4. Some of the **nonsurgical measures for control of tinnitus** include anxiolytics, hypnotherapy, biofeedback, control of allergy and use of tinnitus maskers.
5. **Intravenous lidocaine** help by acting as CNS depressant by inhibiting the influx of sodium and thereby reducing number of action potentials by blocking multisynaptic junctions.
6. **Various surgical measures for treatment of tinnitus** include cervical sympathectomy, cochlear nerve section, labyrinthectomy, chorda tympani nerve section and prefrontal lobotomy.
7. **Pulsatile tinnitus** is seen in glomus jugulare and arteriovenous shunts.

Section 2

Diseases of Nose and Paranasal Sinuses

Chapter 16 Anatomy and Physiology of Nose

What Students Must Know!

- **Anatomy of Nose**
  - Development of Nose
  - Commonest Anomalies of Nose
- **Anatomy of External Nose**
  - Walls of Nasal Cavity
- **Osteomeatal Complex**
- **The Olfactory System**
  - Anatomy and Physiology
  - Olfactory Nerves
- **Physiology of Olfaction**
  - Various theories of Olfaction
  - Causes of Olfactory Dysfunction
  - Clinical Evaluation of Olfactory Function

DEVELOPMENT OF NOSE

- In the 3rd to 5th week of intrauterine life, nasal placodes appear on the ventral surface of frontonasal process, which sink subsequently to form nasal pits
- With further growth of lateral and medial nasal folds, the nasal pits become deeper forming nasal sacs or primitive nasal cavities
- Nasal sacs are separated by frontonasal process or the primitive nasal septum.
- A number of elevations appear on the lateral wall of nose, which form superior, middle and inferior turbinates.

Commonest Anomalies of Nose

- Anterior nasal atresia
- Bifid nose and nasal duplication
- Congenital posterior choanal atresia
- *Proboscis lateralis:* It is a trunk-like process on the lateral side of nose
- Congenital nasal tumors, e.g. encephalcoele, gliomas, dermoids and hemangiomas.

ANATOMY OF NOSE

Nose consists of the following:

1. External nose.
2. Nasal vestibule.
3. Nasal cavity.

External Nose

- External nose is a triangular pyramid with its base continuous with the forehead and lower end is called apex or tip of the nose
- Lateral surfaces meet in the midline called bridge of nose
- External nares on the inferior aspect of the nose are separated by septum mobi nasi and are bounded laterally by rounded prominence called alae nasi (**Figure 16.1**)

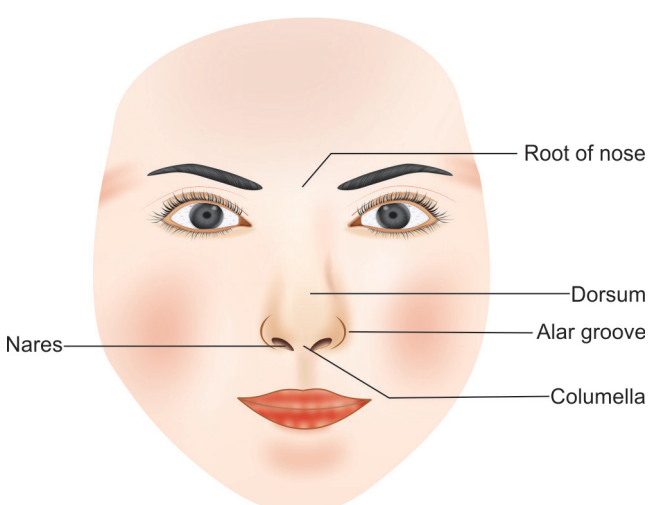


Figure 16.1 Various parts of external nose

- External nose has a bony and cartilaginous framework
- Bony framework consists of two nasal bones, frontal process of maxilla and nasal part of frontal bone
- Cartilaginous framework consists of upper lateral cartilage which articulates with nasal bones above and with lower later cartilage below
- Lower lateral cartilage has a medial crus and lateral crus Minor alar cartilages are also present.

These bony and cartilaginous portions are bound to each other by fibrous tissue, perichondrium and periosteum. Skin on dorsum of nose is quite thin as compared to skin on alae nasi (**Figures 16.2 and 16.3**).

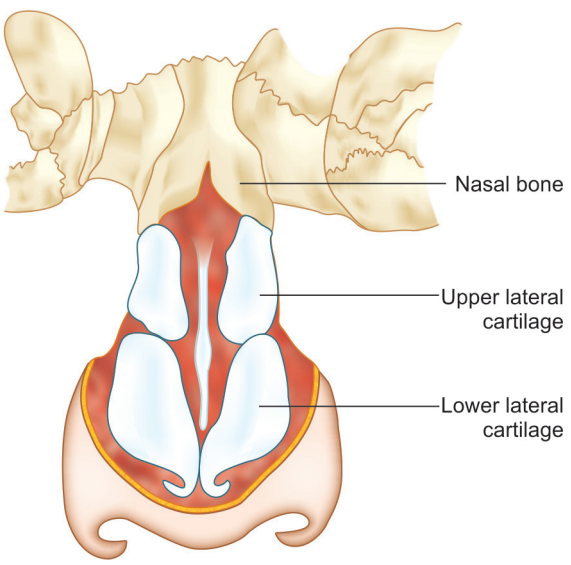


Figure 16.2 Frontal view of osteocartilaginous framework of nose

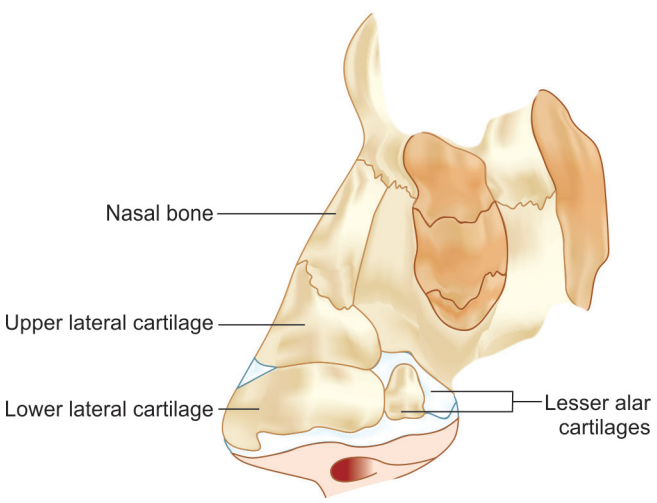


Figure 16.3 Lateral view of osteocartilaginous framework of nose

Soft Triangle

- It is a triangular area of soft tissue in front of nares occupied by scanty areolar tissue
- It lies between lateral and medial crus of lower lateral cartilage.
- Any incision here should be avoided as it may cause deformity.

Muscles of External Nose

These are procerus and nasalis consisting of compressor and dilator naris.

These muscles arise from the fascia and are inserted into the skin.

These muscles are supplied by branches of facial nerve.

Blood Supply of External Nose

- Alar and septal branches of facial artery
- Dorsal nasal branch of ophthalmic artery
- Infraorbital branch of maxillary artery.

Veins

They drain into anterior facial and ophthalmic veins, which communicate with cavernous sinus.

Nerve Supply

- Infratrochlear and external nasal branch of ophthalmic nerve
- Infraorbital branch of maxillary nerve.

Lymphatics

They drain into submandibular and preauricular group of lymph nodes.

Nasal Vestibule

- Nasal vestibule is a skin-lined entrance to the nasal cavity containing hair follicles, sebaceous glands, and sweat glands
- It is bounded by alae nasi laterally and medially by septum mobi nasi
- The columella separates two vestibules
- Each vestibule is limited above by limen nasi corresponding to the upper border of major alar cartilage.

Nasal Cavity

- Nasal cavity is 5 to 7 cm in length, 5 cm in height, 1.5 cm transversely near the floor and 1 to 2 mm only at the roof
- Posteriorly, it communicates with nasopharynx through posterior choanae
- It has four walls, i.e. roof, floor, medial and lateral wall
- Medial wall or the septum divides the nasal cavity into the left and right sides.

Nasal Valve

- Nasal valve is an area of high resistance, triangular in shape
- Bounded by septum, pyriform aperture and caudal edge of upper lateral nasal cartilage
- Minor changes in this area cause greater nasal resistance
- It is the narrowest part of nasal cavity.

Roof of Nasal Cavity

- Nasal cavity is 7.5 cm long and 1 to 2 mm wide and has a narrow space
- It is horizontal in its middle part formed by cribriform plate of ethmoid bone
- It slopes in front and behind formed by frontonasal bone and inferior surface of the body of sphenoid bone respectively
- The roof is closely associated with olfactory region.

Floor

- Floor of the nose is 5 cm long and 1.25 cm wide.
- Its anterior three-fourths is formed by the palatine process of maxilla and posterior one-fourth by the horizontal part of palatine bone.

Medial Wall (Septum)

Major contributors

- The vomer forms the lower and posterior part of septum
- The perpendicular plate of ethmoid forms upper and anterior part while the septal cartilage, quadrilateral in shape is wedged between the two bones (**Figure 16.4**).

Minor contributors

- Above and front is nasal bone and nasal spine of frontal bone
- Above and behind is rostrum and crest of sphenoid bone
- Below is crest of maxilla and palatine bone Jacobson's organ better defined in fetus but vestigeal organ in adults is a blind tubular pouch 2 to 6 mm long concerned with organ of smell in lower animals.

Nasal septal body (Kiesselbach body)

Nasal septal body is also called septal turbinate or septal cavernous body.

A widened area of the septum located superior to inferior turbinate and anterior to middle turbinate.

The area is just few mm in size and mucosa over this area is thicker than the rest of the septum.

It has a role in nasal airflow resistance and in controlling temperature and humidity of the incoming air stream.

Blood supply of nasal septum

It is supplied both by external and internal carotid system. Area above the middle turbinate and corresponding area of septum supplied by internal carotid system and below that by external carotid system.

Branches of maxillary artery as follows (Figure 16.5)

- Branches of sphenopalatine branch of maxillary artery
- Branches of greater palatine branch of maxillary
- Septal branch of superior labial branch of facial artery.

Internal carotid system supplies through branches of ophthalmic artery, i.e. anterior and posterior ethmoidal arteries (**Figure 16.6**).

Little's area is the most vascular area on the anterior inferior part of nasal septum. Vascular plexus over here is also called Kiesselbach's plexus.

Kiesselbach's plexus or Locus valsalvae

Anastomosis over here is formed by branches of:

- Anterior ethmoidal artery
- Sphenopalatine (called artery of epistaxis)
- Superior labial
- Greater palatine and their corresponding veins form anastomoses over here
- Blood vessels at this site lack cushioning effect and are liable to trauma causing epistaxis (**Figure 16.7**)
- Woodruff's plexus (nasopharyngeal plexus) is a vascular area under the posterior end of inferior turbinate
- Here posterior pharyngeal vessel anastomose with sphenopalatine vessel. It is the most common site of posterior nasal bleeding in old age and has to be managed by postnasal packing.

Lateral Wall of Nose

Lateral wall of nose is a very important wall formed by (**Figure 16.8A**):

- Below and in front by nasal surface of maxilla
- Above by ethmoidal labyrinth
- Posteriorly by perpendicular plate of palatine bone.
  - The inferior turbinate is a separate bone, while rest of the turbinates are part of ethmoidal labyrinth
  - Middle turbinate has three attachments such as anterior 1/3 (vertical) to lateral end of lamina cribrosa, middle 1/3 (oblique) with lamina papyracea and posterior 1/3 (horizontal) attached to lamina papyracea or maxilla
  - Space below each turbinate is called the meatus
  - The sphenoethmoidal recess lies above superior turbinate into which opens the sphenoidal sinus.

Superior Meatus

Superior meatus has the opening of posterior ethmoidal sinuses.

Middle Meatus

Middle meatus lies beween middle and inferior turbinates and is important because of presence of osteomeatal (OM) complex area in this meatus.

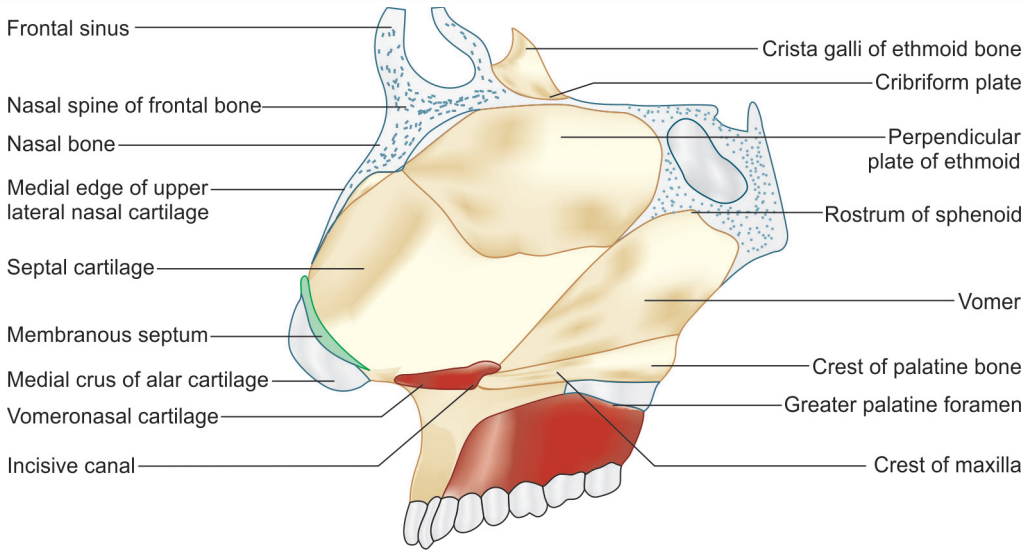


Figure 16.4 Cartilaginous and bony septum of nose

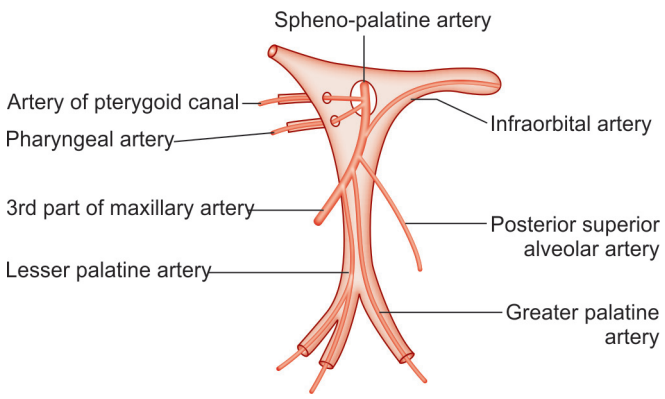


Figure 16.5 Branches of maxillary artery

Osteomeatal complex

Osteomeatal complex is an area in the middle meatus where there are the openings of anterior group of paranasal sinuses. The various important landmarks in the OM complex area, which is also called Picadli's circle are as follows (**Figures 16.8B and 16.9**):

Uncinate process

- Uncinate is a ridge of bone of ethmoidal labyrinth, which articulates with the ethmoidal process of inferior turbinate
- It partly covers the opening of the maxillary sinus and forms lower boundary of hiatus semilunaris.

Bulla ethmoidale

- Bulla ethmoidale is a round prominence formed by the bulge of middle ethmoidal sinuses, which open on above it
- It may extend superiorly to base of skull and posteriorly fuse with ground lamella
- Supra and infrabullar recesses form lateral sinus also called sinus lateralis of Grunwald.

Hiatus semilunaris

- Hiatus semilunaris is a space bounded above by bulla ethmoidale and below and in front by uncinate process
- Anterior ethmoids open into it behind the opening of frontonasal duct, which opens into anterior part of the meatus
- Opening of maxillary sinus lies below the bulla
- Accessory ostium of maxillary sinus in 40 percent cases lies below and behind the hiatus semilunaris
- Hiatus semilunaris leads into ethmoidal infundibulum.

Ethmoidal infundibulum

- Ethmoidal infundibulum is a short passage at the anterior end of hiatus and its average depth is 5 mm
- It connects the natural ostium of maxillary sinus to middle meatus
- Its floor and medial wall are formed by uncinate process
- Frontal sinus opens through frontal recess anteriorly, maxillary sinus ostia posteriorly and anterior ethmoidal sinuses also open into this passage.

Anterior and posterior fontanelles: These are membranous areas on lateral wall of nose in relation to uncinate process.

Inferior Meatus

Inferior meatus receives the opening of nasolacrimal duct at junction of anterior one-third and posterior two-thirds. This duct is guarded by a lacrimal fold called Hasner's valve (an imperfect valve).

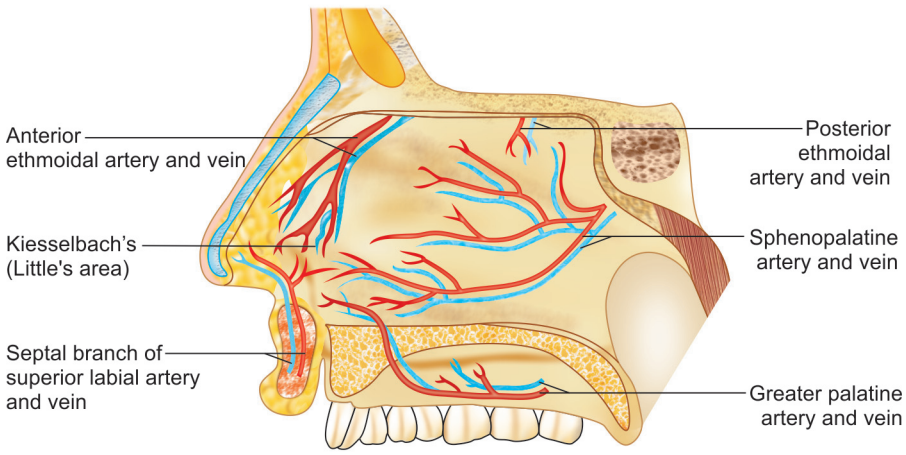


Figure 16.6 Blood supply of the nasal septum

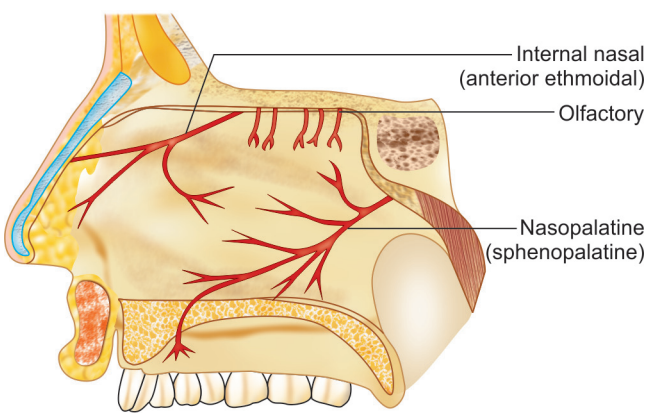


Figure 16.7 Nerves of the nasal septum

Pterygopalatine Fossa

Pterygopalatine fossa is a small pyramidal space present behind the posterior wall of maxilla below the apex of orbit.

It is bounded by the following:

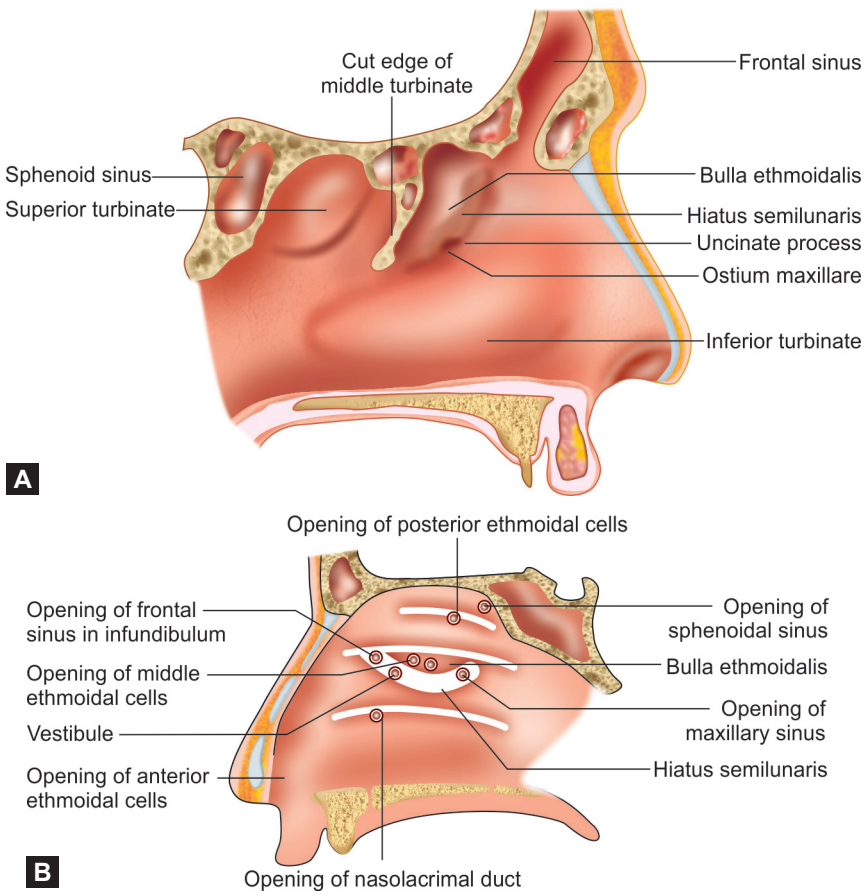
- Above by posterior surface of maxilla
- Posteriorly lies the root of pterygoid process and anterior surface of greater wing of sphenoid
- Medially by perpendicular plate of ethmoid and orbital process of palatine bone
- Superiorly there is body of sphenoid bone
- Inferiorly the space is closed by pyramidal process of palatine bone (**Figure 16.10**).

Communications

- Anteriorly—with orbit through inferior orbital fissure
- Posteriorly—with middle cranial fossa through foramen rotundum
- Medially—with nasal cavity through sphenopalatine foramen
- Laterally—with the infratemporal fossa through pterygomaxillary fissure
- Inferiorly—with the oral cavity through greater and lesser palatine canals.

Contents

i. Third part of maxillary artery and its branches such as infraorbital, posterior superior alveolar, greater palatine, artery of pterygoid canal and sphenopalatine artery.



Figures 16.8A and B Various landmarks on lateral wall of nasal cavity

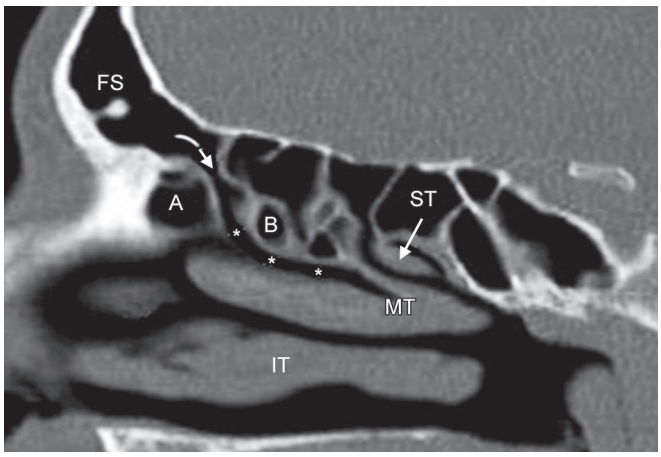


Figure 16.9 CT view of lateral wall of nose; FS: Frontal sinus; ST: Superior turbinate; IT: Inferior turbinate; ***indicates hiatus semilunaris; MT: Middle turbinate; A: Aggar cells; B: Bullar cell

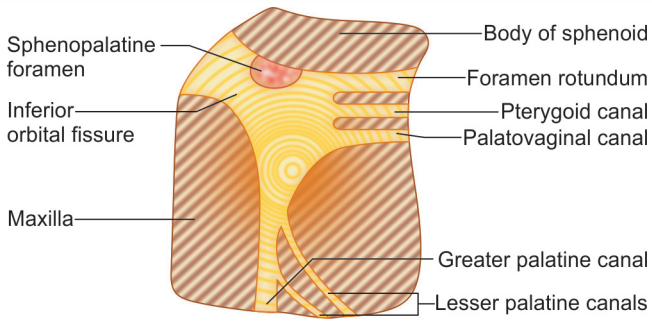


Figure 16.10 Pterygopalatine fossa

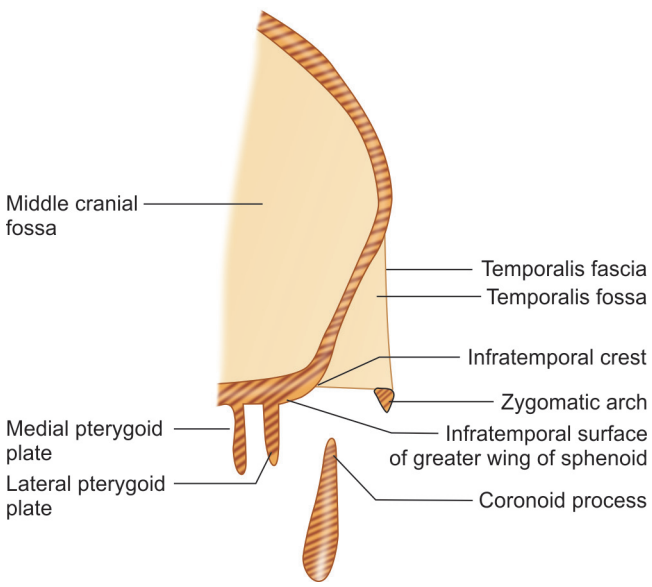


Figure 16.11 Infratemporal fossa

ii. Maxillary nerve and its branches, i.e. zygomatic and posterior alveolar.
iii. Pterygopalatine ganglion and vidian nerve (formed by greater superficial petrosal nerve and deep petrosal nerve).

Infratemporal Fossa

Boundaries

- The roof is formed by infratemporal surface of the greater wing of sphenoid and small part of squamous temporal.
- Its floor is open.
- Medial wall is formed by the lateral pterygoid plate and the pyramidal process of the palatine bone.
- Lateral wall is formed by the ramus of mandible.
- Anterior wall is formed by the posterior surface of maxilla and medial surface of zygomatic bone (**Figure 16.11**).

Contents

i. *Arteries:* First and second part of the maxillary artery and their branches and posterior superior alveolar branch of the third part.
ii. Pterygoid venous plexus and maxillary vein.
iii. Mandibular nerve, chorda tympani nerve, part of maxillary nerve and posterior superior alveolar nerve.
iv. *Muscles:* Lateral and medial pterygoid muscles, temporalis (lower part) and buccinator (posterior part).

Mucous Membrane of Nose

Mucous membrane is the thickest and very vascular over nasal turbinates and very thin in the meatuses. It is pseudostratified ciliated columnar type of epithelium with goblet cells, mucus and serous glands.

Olfactory mucous membrane

- Olfactory mucous membrane is yellowish in color and is limited to the superior concha, roof of nasal cavity and 1 cm of the upper most part of nasal septum
- It is composed of olfactory receptor cells, supporting cells, basal cells and olfactory glands of Bowman
- Olfaction is initiated when olfactory compounds soluble in water and lipid come in contact with the olfactory mucosa.

Olfactory Nerves

- These first order neurons are twenty in number
- These pass through cribriform plate of ethmoid and end in olfactory bulb which conveys secondary olfactory neurons to olfactory tract
- It further relays it to:
  - Anterior perforated substance
  - Amygdaloid nucleus
  - Area piriformis
  - Here, the tertiary olfactory neurons arise, which travel to hippocampal formation which relays to paraterminal gyrus then to the fornix and, hence, to nucleus habenular and mammillary body in thalamus.
- Sense of smell can be tested by odors like rose, lemon, garlic or clove oil with eyes closed.

Blood Supply of Nasal Cavity

- Anterior and posterior ethmoidal branches of ophthalmic artery (Internal carotid system)
- Sphenopalatine branch of maxillary artery
- Greater palatine artery
- Superior labial branch of facial artery.

Venous Drainage

- Anterior part of nasal cavity drains into anterior facial vein, which communicates with cavernous sinus and also

with veins on the undersurface of frontal lobe of brain (that is why it is called dangerous area of nose and face)
- Middle part drains into pterygoid venous plexus
- Posterior part drains into pharyngeal plexus of veins.

Nerve Supply

Sensory nerve supply
- Branches from pterygopalatine ganglion through maxillary nerve and also infraorbital branch of maxillary nerve
- Anterior superior alveolar nerve, which is a branch of maxillary nerve
- Nasociliary branch of ophthalmic supplying through anterior ethmoidal nerve.

Secretomotor supply
- Secretomotor comes through the vidian nerve (also called the nerve of pterygoid canal).
- This nerve is formed by:
  - Greater superficial petrosal branch of facial nerve joining deep petrosal nerve derived from plexus around internal carotid artery (sympathetic nerve supply)
  - Hence, the nerve of pterygoid canal carries preganglionic parasympathetic fibers and postganglionic sympathetic fibers.

Lymphatic Drainage of Nasal Cavity

- Anterior part of nasal cavity to submandibular lymph nodes.
- Posterior part drains into upper deep cervical group either directly or through retropharyngeal group of lymph nodes.

FUNCTIONS OF NOSE

- Nose performs the two important functions of respiration and olfaction besides giving a beautiful shape to the face.
- It acts like an air conditioner as the air, which is inspired filtered, heated and humidified. It also imparts vocal resonance to the voice. Voice becomes flat in obstructive lesions of nose (e.g. Rhinolalia clausa).
- Besides, it protects the lower airway and several reflexes are initiated in the nasal mucosa such as sneezing and salivary secretions.
- Nasal function is closely related to lung functions through nasobronchial and nasopulmonary reflexes.
- Nasal cycle is characteristic of each person in which rhythmical congestion and decongestion of nasal mucosa occurs.
- During expiration, eddies are produced under middle and inferior turbinates and it is then that the sinuses are ventilated.
- Air conditioning of air involves filtration and purification of inspired air followed by regulation of its temperature by large surface area of nasal mucosa and its humidification as required (**Figures 16.12A and B**).
- In mucociliary mechanism of nasal mucosa cilia beat constantly at a speed of 5 to 10 mm per minute and are in contact with serous layer of mucous blanket (sol layer) and superficial layer of mucus (gel layer), which entraps the foreign bodies, allergens and carry it to nasopharynx every 5 to 10 minutes.
- Lysosomes in nasal secretion also kill bacteria and viruses.
- The pH of nasal secretion is 7 and if it gets altered as in infections or by drugs nasociliary mechanism is adversely affected.

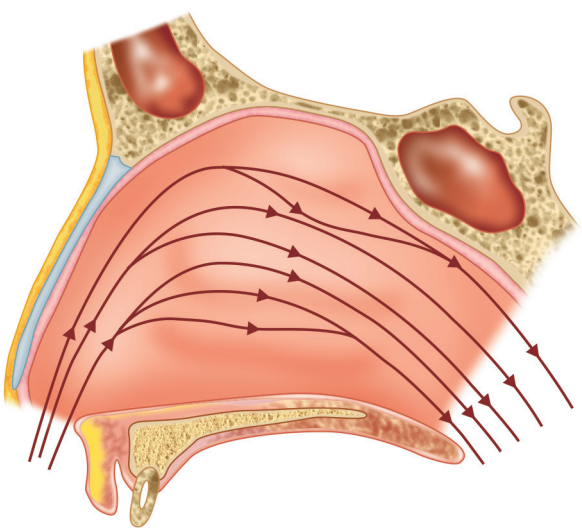


Figure 16.12A Inspiratory air currents

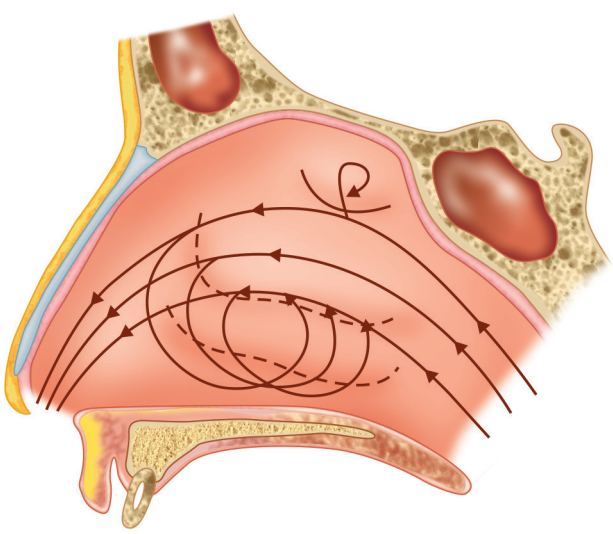


Figure 16.12B Expiratory air currents

Olfaction

Introduction

- The olfaction is important to humans as it not only determine the flavor of foods, but also provides a sensitive means for detecting dangerous environmental situations, such as the presence of fire, spoiled food and leaking gas
- Unfortunately, taste and smell have been ignored by otolaryngologists in the past
- Smell in animals has an important role as far as their behavior and reflex responses are concerned.

Olfactory System

Anatomy and physiology

- Olfaction in humans is carried out by Ist and 5th nerves
- Olfactory nerve is a pure sensory nerve and peripheral end organs for smell is olfactory mucosa
- Nerve fibers of mucosa join together to form about twenty bundles, which constitute olfactory nerves
- Six major classes of cells can be identified in this neuro-epithelium: bipolar sensory receptor cells, supporting or sustentacular cells, microvillar cells, Bow-man gland and duct cells, globose basal cells and horizontal basal cells
- The 6 million receptor cells are present, which are of central nervous system (CNS) origin
- The cilia of these cells, which extend into the mucus of the nasal lumen. The axons of these cells ultimately unite into bundles of 50 or so ensheathed by glial cells that traverse the cribriform plate to form the outermost layer of the olfactory bulb
- The sustentacular cells insulate the receptor cells from one another
- Bowman glands are a major source of the mucus in the olfactory region.

Olfactory Bulb and Olfactory Cortex

- The first processing station in the olfactory system, the olfactory bulb, is located directly over the cribriform plate
- Its six neural components are: the olfactory nerve, glomerular, external plexiform, mitral cell, internal plexiform and granule cell
- These second-order cells, send collaterals that synapse with in the periglomerular and external plexiform layer
- The olfactory bulbs of younger persons have thousands of glomeruli, older persons typically have far fewer numbers of glomeruli, reflecting the decrease in olfactory receptor cell numbers
- The primary olfactory cortex is comprised of the anterior olfactory nucleus (AON), piriform cortex, olfactory tubercle, entorhinal area, periamygdaloid cortex, and corticomedial amygdala (**Figure 16.13**).

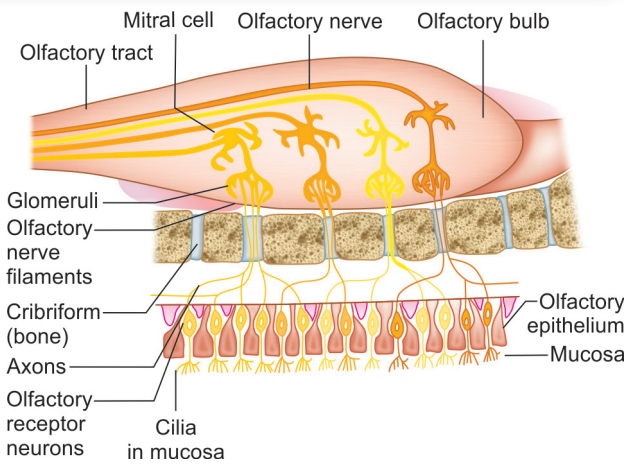


Figure 16.13 Olfactory pathways and olfactory bulb

Olfactory Transduction

- Humans can detect and discriminate among thousands of airborne odorants
- Ten to fifteen percent of the incoming air stream is shunted toward the olfactory cleft during inhalation and actively transported via odorant binding proteins to the olfactory receptors.
- This then leads to transduction that produces action potentials within the olfactory receptor neurons.

Classification of Olfactory Disorders

Smell dysfunction can be reliably classified as follows:

Anosmia: Inability to detect olfactory sensations.

Partial anosmia: Ability to perceive some, but not all sensations.

Hyposmia or microsmia: Decreased sensitivity to odors.

Hyperosmia: Abnormally acute smell function.

Dysosmia: Distorted or perverted smell perception to odor stimulation (sometimes termed cacosmia or parosmia, depending on the nature of the perversion.

Phantosmia: A dysosmic sensation perceived in the absence of an odor stimulus, i.e. olfactory hallucination.

Various Theories of Olfaction

- Stereochemical theory
- Enzymatic theory
- Particulate theory
- Electrical theory
- Vibration theory

- Selective adsorption theory
- Infrared radiation theory
- Odorant receptor theory. This is currently the most accepted theory.

Causes of Olfactory Dysfunction

Olfactory dysfunction can result from three general causes:
- Conductive or transport impairments, e.g. by chronic rhinosinusitis, polyposis, excessive mucus secretion).
- Sensorineural impairment from injury to the olfactory neuroepithelium (by viruses, airborne toxins, etc.).
- Central olfactory neural impairment from injury to CNS structures (tumors, masses impinging on the olfactory tract).

Nasal causes
Most cases of chronic anosmia or hyposmia are attributable to previous upper respiratory infections, head trauma and nasal and paranasal sinus disease.

Other causes include intranasal neoplasms such as:
- Inverted papillomas, adenoid hypertrophy, allergic rhinitis
- Atrophic rhinitis, hypertrophic rhinitis, nasal polyposis
- Rhinitis medicamentosa, deviated septum
- Hemangiomas and neuroblastomas, meningiomas, frontal lobe gliomas, multiple sclerosis, schizophrenia.

Iatrogenic Interventions
- Septoplasty, rhinoplasty, turbinectomy anterior craniotomy
- Laryngectomy, paranasal sinus exenteration, radiation therapy, arteriography, chemotherapy.

Air pollutants and industrial dusts
Cadmium/carbon disulfide, chlorine chromium coke/coal. cresol ethyl acetate, formaldehyde, lead/nickel, nitrous gases/paint solvents, peppermint oil.

Drugs
Analgesics, antipyrine, anesthetics, local cocaine
- Chlorpheniramine maleate, methotrexate
- Griseofulvin, lincomycin, streptomycin, tetracyclines, tyrothricin
- Mercury/gold salts, opiates, codeine, morphine
- Antithyroids, methimazole, thiouracil antivirals, antihypertensives, cimetidine, atorvastatin.

Miscellaneous causes
a. Endocrine
Addison's disease, Cushing's syndrome diabetes mellitus, hypothyroidism, Kallmann's syndrome, pregnancy, Sjögren's syndrome, Turner 's syndrome
b. Infections—Viral/bacterial/parasitic/fungal
Acquired immunodeficiency syndrome (AIDS), fungal, influenza
c. Head trauma
Hydrocephalus, migraine, meningitis, multiple sclerosis myasthenia gravis, Paget's disease, Parkinson's disease syphilis, syringomyelia, temporal lobe epilepsy
d. Neoplasms
Laryngeal, lung, ovary, testicular neoplasms
Intracranial Frontal lobe gliomas Pituitary adenomas Alzheimer's disease
e. Nutritional/Metabolic
Chronic alcoholism, chronic renal failure, cirrhosis of liver gout, copper Zinc
Vitamin deficiency—A, B_6, B_{12}
f. Psychiatric
Anorexia nervosa (severe form)—depressive disorders hysteria, malingering, schizophrenia.

Clinical Evaluation of Olfactory Function

Assessment comprises of following points as described below:

History
- Such as head trauma, viral upper respiratory infections, allergies, toxic exposures or iatrogenic interventions, as for renal failure, liver disease, hypothyroidism, diabetes, or dementia
- History of epistaxis, discharge (clear, purulent or bloody), nasal obstruction, allergies, including headache or irritation, history of tobacco, alcohol
- Antihypertensive and antilipid agents, antibiotics can produce smell or taste disturbances
- Sudden olfactory loss suggests the possibility of head trauma, infection, ischemia or a psychogenic condition
- Gradual loss can reflect the development of degenerative processes, progressive obstructive lesions or tumors within the olfactory receptor region
- Intermittent loss can be indicative of an intranasal inflammatory process
- Delayed puberty in association with anosmia with or without, deafness and renal anomalies suggests the possibility of Kallmann's syndrome.

Quantitative olfactory testing
Olfaction can be tested by several crude odorants such as licorice, coffee grounds or tobacco, placed under the nose, such qualitative testing, lacks reliability and is easily faked by malingerers.
- The most widely used test is the 40 item University of Pennsylvania Smell Identification Test (UPSIT);—commercially known as the smell identification test. This reliable test employs microencapsulated scratch and sniff odorants. It can be self-administered in 10 to 15 minutes in the waiting room by most patients and scored in less than a minute by most personnel.
- The electro-olfactogram (EOG) is electrophysiologic measure of the olfactory system summated generator

potentials mainly from olfactory receptor neurons. It is recorded.

- Physical examination
  - Careful otolaryngologic and neurologic assessment, visual field and acuity tests, as well as optic disk examinations to determine whether intracranial pressure, papilledema is present.
  - With nasal endoscopy, employing both flexible and rigid endoscopes, to see atrophy of the nasal mucosa. Masses, polyps and adhesions of the turbinates to the septum may all compromise airflow.
  - Blood, serum or other laboratory tests may help to identify or confirm underlying medical conditions that may relate to the dysfunction.
- Role of medical imaging
  - Magnetic resonance imaging (MRI) is the method of choice for evaluating soft tissue like olfactory bulbs, tracts and cortical parenchyma.
  - Computed tomography (CT) is the most useful and cost-effective technique to assess sinonasal tract inflammatory disorders and is superior to MRI in the evaluation of bony structures adjacent to the olfactory pathways.

Treatments

- Available for some olfactory disorders owing to conductive disorders. Mechanical obstruction secondary to polyposis, intranasal tumors, can be corrected surgically and inflammatory causes of nasal and sinus disease can often be addressed medically.
- A brief course of systemic corticosteroid therapy can be useful in distinguishing between conductive and sensorineural olfactory loss as patients with the former will often respond positively to the treatment.
- Sensorineural causes of olfactory dysfunction are more difficult to manage.

Key Points

1. **Dangerous area of nose** is drained by anterior facial vein, which communicates with cavernous sinus through ophthalmic vein.
2. **Nasal valve area** is bounded by septum, pyriform aperture and upper lateral nasal cartilage and lies 1.3 cm from the nares at the posterior part of vestibule of nose..
3. **Major constituents of the septum** are ethmoid bone (perp. plate), Vomer and the septal cartilage. Minor contribution is from nasal bones, frontal, sphenoid, maxilla and palatine bones.
4. **Little's area of nose** lies on anteroinferior part of nasal septum. Branches of anterior ethmoidal, sphenopalatine, superior labial and greater palatine vessels anastomose at this area.
5. **Osteomeatal complex (Picadli's circle)** lies in the middle meatus and is important for functional endoscopic sinus surgery (FESS).
6. **Hiatus semilunaris** is a space between uncinate process and bulla ethmoidale
7. **Anterior and posterior fontanellae** are membranous areas between inferior turbinate and uncinate process.
8. **Sluders neuralgia** is also called anterior ethmoidal neuralgia.
9. **Ciliary movements** occur at the average rate of 5 mm/minute.
10. During quite respiration **inspiratory currents** pass through middle part of nose.
11. **Frankfurt's line or Reid base line** extends from infraorbital border to tragus.
12. **Nasolabial angle** in males is 90 to 95 degree and in females it is 100 to 110 degree and nasofrontal angle is nearly 125 degree.
13. **Ammonia** is not used to test sense of smell as it stimulates fibers of trigeminal nerve
14. **Schneiderian membrane** is another name of respiratory mucosa of nose.
15. **Theories of olfaction** includes enzyme activation, radiation effect, mechanism of selective absorption or reaction with proteins of cell membrane.
16. **Odors** can be classified (Adrian's) into aromatic hydrocarbons, paraffin hydrocarbons, terpenes and amyl and ethyl acetates
17. **Primary odors** are fragrant, ambrosial, ethereal, burning, cheesy and putrid.
18. **Weber–Fuchner's law** states that concentrating of odoros substance in air must be changed by 30 percent before its change can be appreciated.
19. **Olfactory pathways** are olfactory nerves → ventral surface of olfactory bulb → Olfactory glomeruli → mitral cells → olfactory tract → olfactory cortical centres → Anterior perforated substance → hypothalamus and hippocampal area of temporal lobe and cingulate gyrus of frontal lobe.
20. As per **Kero's classification** of olfactory fossa
    Type I is low lateral lamella
    Type II is higher lamella while
    Type III is most dangerous to FESS surgeon due to high chances of injury to cranial fossa.

Chapter 17

History Taking and Method of Examination of Nose and Paranasal Sinuses

What Students Must Know!

- **History Taking of a Nose Case**
  - Biodata of the Patient
  - Chief Complaints with Duration
  - History of Present Illness
  - Past History
  - Family History
- **Examination of Patients**
  - General Physical Examination
  - Systemic Examination
  - Functional Examination of Nose
  - Local Examination of Nose and PNS
- **Investigation in a Nose Case**

Clinical diagnosis is an art and the mastery of an art has no end!

HISTORY TAKING

Biodata of the Patient

Name, age, sex, occupation and address.

Chief Complaints with Duration

There should be two to three chief complaints and should be in descending order of occurrence meaning thereby that a complaint, which occurred first must be recorded first.

History of Present Illness

- Should be recorded as per chief complaints in the patient's own words and language
- Continuous and interesting to listen
- Positive points be recorded first followed by negative points of complaints
- Any aggravating or relieving factors to be recorded
- Any treatment taken and its effect what so ever.

Various Nasal Symptoms to be Recorded or Enquired in a Nose Case are as Follows

Nasal Obstruction

- Enquire whether unilateral/bilateral
- Complete or partial
- Continuous or intermittent
- History of injury, operation, foreign body, upper respiratory catarrh (URC), allergy, bleeding
- Progress of the symptoms.

Important causes of bilateral nasal obstruction

- Deviated nasal septum (DNS)
- Nasal polyps
- Allergic rhinitis, vasomotor rhinitis
- Chronic sinusitis
- Enlarged turbinates
- Foreign bodies
- Tumors of nose, paranasal sinus (PNS)/nasopharynx
- Choanal atresia
- Adenoid
- Altered humidity and temperature.

Important causes of unilateral nasal obstruction

- Foreign body
- AC polyp
- Neoplasm of nose
- Hypertrophy of inferior turbinate
- DNS
- Congenital atresia
- Unilateral sinusitis
- Synechia.

Features of adenoid facies

- Open mouth with running nose
- High-arched palate
- Crowded upper teeth
- Vacant expression of face
- Atrophy of dilator muscles of alae nasi.

Nasal Discharge

- Nature of discharge (serous, mucoidal, mucopurulent or purulent or blood stained)
- Duration of discharge
- Color, consistency and quantity of discharge
- Anterior or posterior nasal discharge
- Unilateral or bilateral
- Foul smelling or not
- Aggravating factors or relieving factors
- Associated features with discharge.

Important causes of nasal discharge

- URC (viral infection)
- Chronic rhinitis
- Allergy of nose, vasomotor rhinitis (VMR)
- Adenoiditis
- Chronic sinusitis
- Foreign bodies
- Malignancy
- Cerebrospinal fluid (CSF) rhinorrhea.

Headache

- Exact site of pain
- Type and severity of pain
- Periodicity of headache
- Aggravating or relieving factors
- Any history of poor vision, hypertension or vomiting
- History of anxiety or emotional upsets.

Important causes of headache

- Sinusitis, migraine, neuralgias
- Costen's syndrome, hypertension
- Visual disturbances, intracranial lesions
- Cervical arthritis, temporal arteritis.

Sneezing

Sneezing is a reflex reaction initiated by abnormal stimulation of nasal mucosa.

- Number of sneezes and time of sneezing
- What brings on the attack or relieves the attack
- Relation with season, diet, dust and place
- Any other associated factor.

Important causes of sneezing

Allergic rhinitis, VMR, foreign bodies, irritative conditions of mucosa.

Nose Bleeding

Whether mild, moderate or severe.

- History of trauma, hypertension or bleeding disorder and alcohol
- History of URC/foreign body/mass nasal cavity
- Relation with season/diet
- Any known aggravating factor.

Important causes of epistaxis

- Hypertension
- Trauma
- Malignancy of nose/PNS
- Bleeding disorders
- Anemia/leukemia
- Severe infections
- URC (viral infection)

Commonest cause of nose bleeding

- Child—nose picking (Epistaxis digitorum)
- Adolescent males—juvenile angiofibroma (recurrent massive and unprovoked bleeding)
- Elderly—hypertension or malignancy

Disturbances of Sense of Smell

History of URC, history of snuff, history of trauma, history of allergy, polypi, foreign body or any mass.

Causes of cacosmia are sinus infection, tonsil infection, teeth infection and necrosis.

Snoring

It is a sound made by vibration of soft palate during sleep while the patient is breathing through the mouth. It is not seen in complete nasal obstruction such as bilateral choanal atresia.

It is seen commonly in patients with short neck, receding chin, hypertrophied adenoids, high-arched palate, underslung lower jaws, allergic swelling of nose, nasal polyps, DNS and collapse of alae nasi.

Change of Voice

In nasal obstruction, nasal resonance may be lost to the voice and it may be just a flat voice.

- Rhinolalia clausa—a flat muffled nasal voice is a known disturbances of voice and can be seen in DNS, nasal polyps, nasal allergy.

- Rhinolalia aperta (Nasal twang)—is seen in cleft palate, submucous cleft palate. Palatal paralysis, perforation of palate, scarring of palate-say after adenoidectomy or UPPP.

Certain consonants are affected such as M becomes B, N becomes D and NG becomes G operation.

Other Symptoms

- Mass in the nose, which may protrude out from the nose or into throat causing various symptoms.
- Abnormal shape of the nose may also be a presenting complaint, which may be due to marked DNS **(As goes the septum, so goes the nose)** or masses in the nasal cavity.

Past History

Past history of trauma, operation, medication, allergy and asthma.

Personal History

Personal history of alcohol, tobacco, smoking, drugs, socio-economic status, occupation details, menstruation, etc.

Family History

Family history of allergy, nasobronchial allergy, hypertension, tuberculosis (TB), diabetes, syphilis and carcinoma.

EXAMINATION OF PATIENTS

General Physical Examination

General physical examination including built, nutrition, anemia, pulse, blood pressure (BP) and lymphadenopathy.

Systemic Examination

Systemic examination of cardiovascular system (CVS), central nervous system (CNS), cranial nerves, respiratory system and eyes.

Local Examination of Nose and PNS

Inspection and Palpation of External Nose

- Shape of the nose like frog face deformity of nose (**Figure 17.1A**)
- Any swelling or ulceration
- Any congenital swelling of nose, cyst and sinus (**Figures 17.1B to E**) or saddle nose deformity (**Figure 17.1F**)
- Any scar mark indicative of trauma and surgical trauma
- Boil, abscess/ulceration or hematoma (**Figure 17.1G**)
- Tenderness on palpation and crepitus.

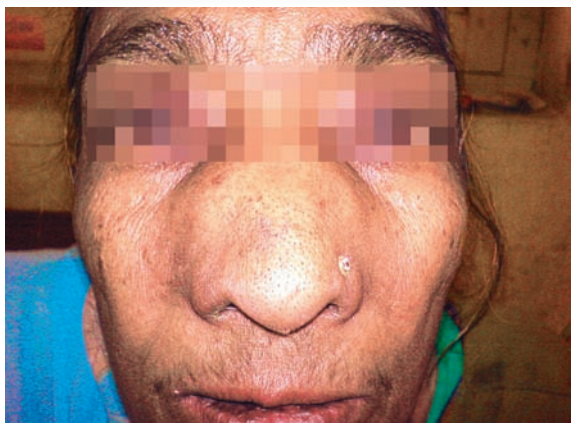


Figure 17.1A Frog face deformity of nose

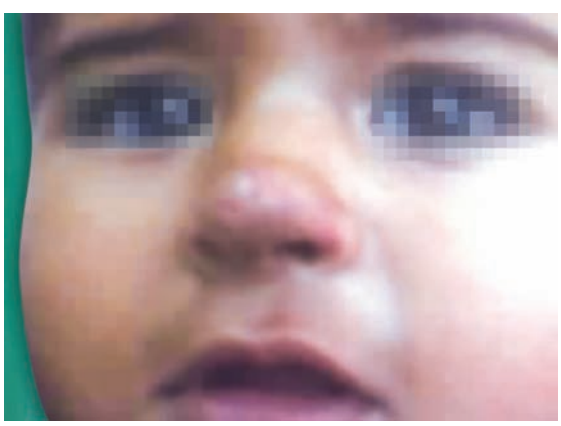


Figure 17.1B Congenital hemangioma of nose

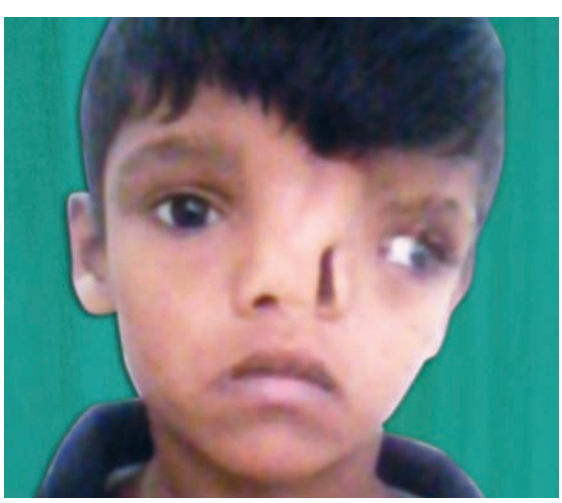


Figure 17.1C Congenital anomaly of external nose

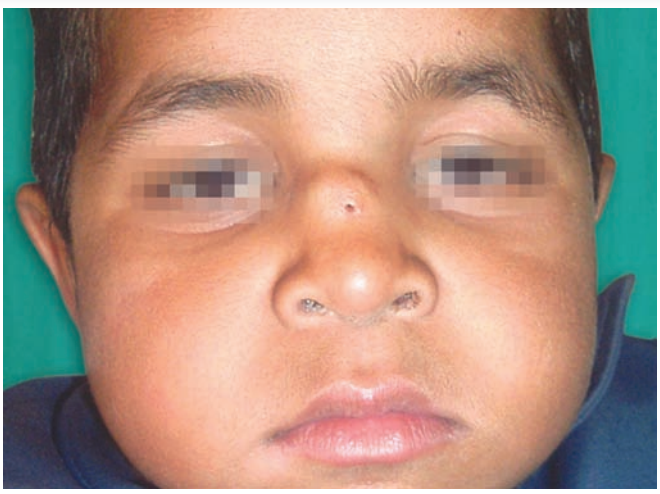


Figure 17.1D Congenital swelling with a sinus of nose

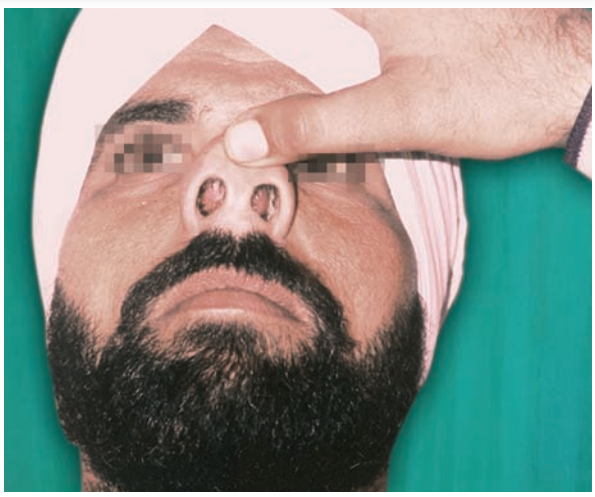


Figure 17.1G Bilateral septal swelling of hematoma

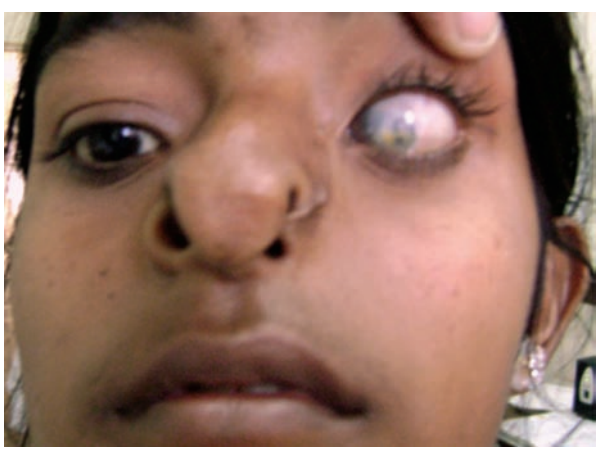


Figure 17.1E Triple nares with congenital buphthalmos

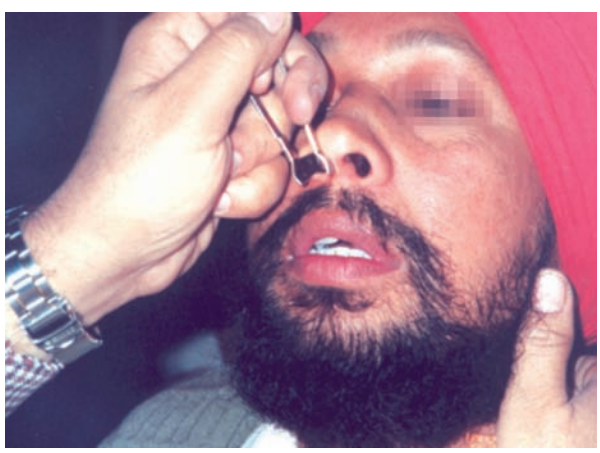


Figure 17.1H Anterior rhinoscopy in adults

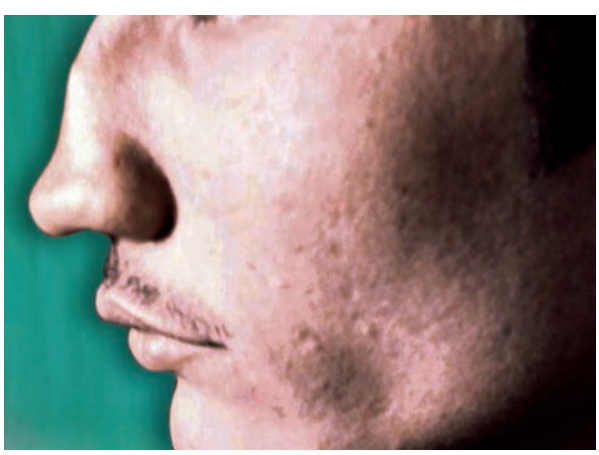


Figure 17.1F Saddle nose deformity

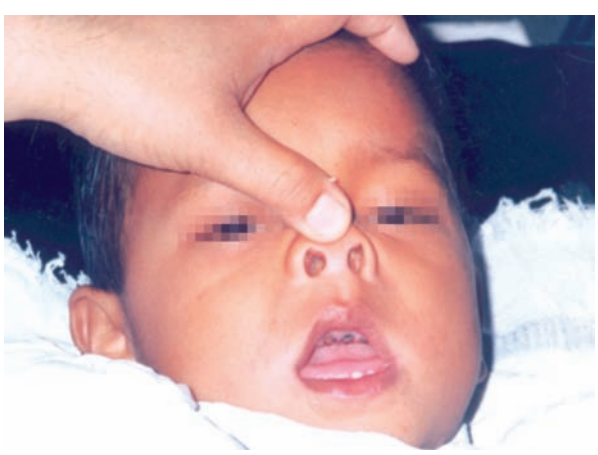
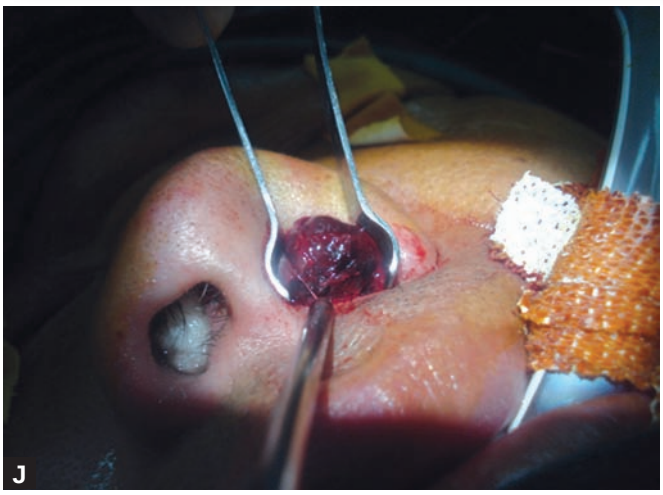
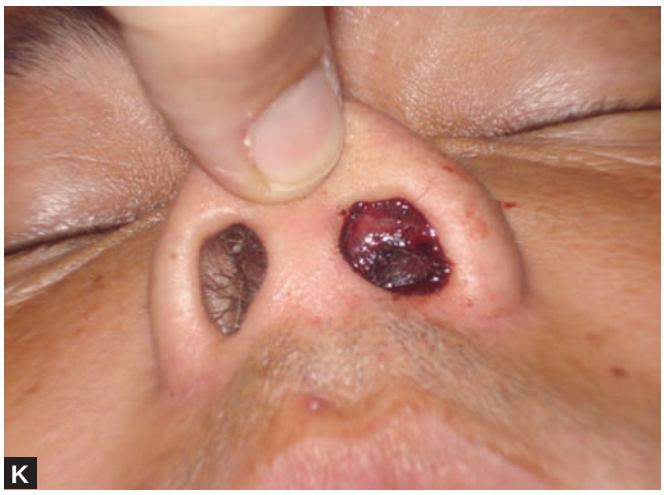


Figure 17.1I Method of examination of nose in children





Figures 17.1J and K Bleeding polypus of nasal septum

Examination of Vestibule of Nose

- Signs of inflammation, boil, abscess, carbuncle and ulceration
- Discharge, crusts and clots
- Dislocation of anterior end of septal cartilage.

Anterior Rhinoscopy

How to do it?

Procedure

- Focus your head light on the nose. Pick up the speculum with left hand, suspend the speculum on index finger with prongs of speculum towards the patient's nose and tip of left index finger towards the examiner (**Figures 17.1H and I**).
- Fix it with left thumb and put your middle and ring finger on the two arm of nasal speculum.
- Press the arms, close the speculum and introduce it into right and left nasal cavity and examine.

1. **Examination of septum:** Nasal septum for deviation whether C or S shaped, anterior or posterior thickening, hematoma, abscess, perforation, Little's area for congestion, bleeding, swelling like bleeding polypus of septum (**Figures 17.1J and K**), discharge on the septum.
2. **Examination of lateral wall of nose:** Examine inferior, middle and superior (if visible) turbinate and corresponding meatuses for any hypertrophy, atrophy, color, bogginess, swelling, discharge, congestion, pallor, crusts or any polypoidal hypertrophy of mucosa, any polypi or mass coming out of the meatuses.
3. **Examination of floor and roof of nose:** Any swelling, foreign body, discharge, ulceration or color of mucosa.

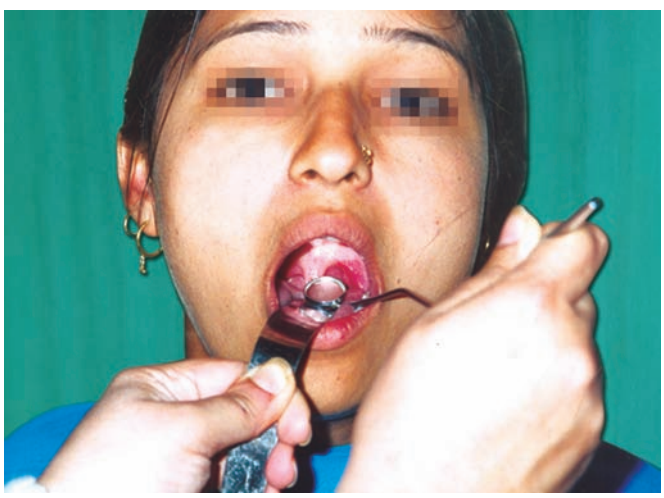


Figure 17.2 Method of doing posterior rhinoscopy

Posterior Rhinoscopy

How to do it?

Procedure

- It is done with the help of a posterior rhinoscopic mirror (**Figures 17.2 to 17.4**).
- In this procedure, tongue is depressed with a metallic tongue depressor and the warmed mirror is gently introduced behind the uvula without touching any part to avoid gag reflex. The patient is asked to breathe through the nose quietly and mirror is rotated in different directions to see all walls of nasopharynx and posterior part of nasal cavity, especially both choanae, posterior end of nasal septum and inferior and middle turbinate, adenoids,

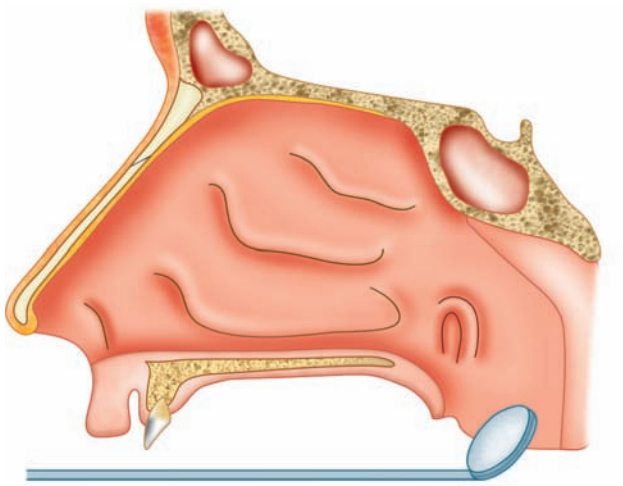


Figure 17.3 Diagrammatic representation of method of doing posterior rhinoscopy

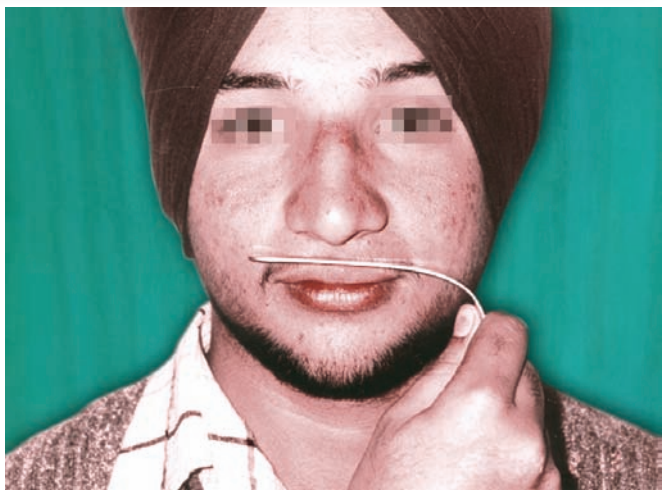
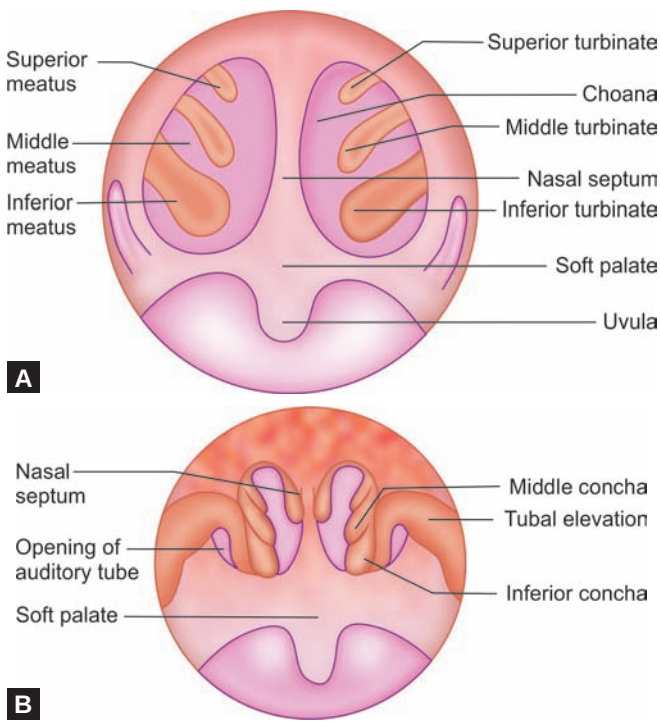


Figure 17.5 Spatula test for nasal patency



Figures 17.4A and B Structures visible on posterior rhinoscopy

opening of eustachian tube, fossa of Rosenmuller, any swelling, discharge or polypoidal mass.

- Finger palpation of the nasopharynx with a gloved finger should be done wherever required.

If a patient says that he does not like to undergo this examination so what are the other options available?

These are

- Diagnostic endoscopy
- Nasopharyngoscopy
- X-rays nasopharynx and computed tomography (CT) scan.

Probe Test

A cotton wool attached probe can be passed to find out the attachment, consistency, sensitivity, mobility and fragility of the mass in the nasal cavity.

Enlarged and hypertrophied inferior turbinate can be differentiated from the mass by following features:

- Probe cannot be passed all around if inferior turbinate
- It is sensitive to touch
- Not mobile
- Firm to feel.

Functional Examination of Nose

1. **Nasal patency tests**:
   - Metallic tongue depressor test (Cold spatula test) in the winter season to see mist formation (**Figure 17.5**)
   - Cotton-wool wisp test to see movements on both sides.
2. **Sense of smell:** It can be tested by presenting various substances to nasal cavity and asking the patient about the nature of that particular substance.

EXAMINATION OF PARANASAL SINUS

Examination of PNS is done by examination, which includes both clinical and radiological examination.

Figure 17.6 Palpation of maxillary sinus

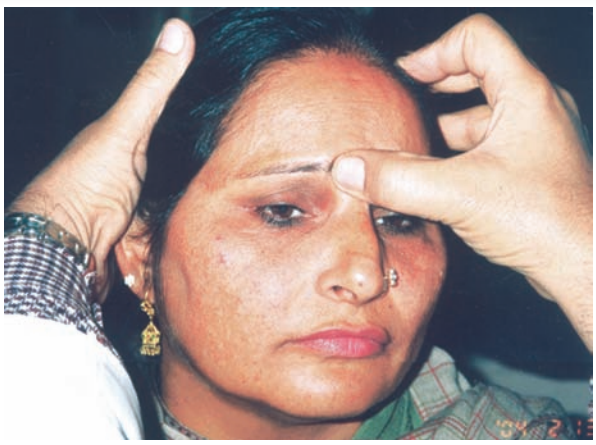


Figure 17.7 Palpation of frontal sinus

Clinical Examination

It includes both inspection and palpation of anterior group of PNS, i.e. maxillary, frontal and anterior ethmoidal. Look for any redness, swelling, mass, sinus in the area of PNS.

Palpation of Sinuses

Then the area is palpated with the thumb and index finger for any tenderness, mass or crepitus (**Figure 17.6**).

- For maxillary sinus, anterolateral wall and infraorbital margin is examined
- Frontal sinus is palpated below the supraorbital margin where floor of frontal sinus lies
- For ethmoidal sinuses, side of nose above the medial canthus is examined for any tenderness, swelling to rule out acute ethmoiditis (**Figure 17.7**).

Transillumination Tests

- Although not done these days, but is a rough guide to the condition of paranasal sinuses, especially frontal and maxillary sinus.
- A light source is placed against the floor of maxillary or frontal sinus in a dark room and in case of maxillary sinus infraorbital crescent of light and pupillary glow is seen (**Figure 17.8**).
- If it is absent it indicates maxillary sinus is opaque.

Lymph nodes draining the nose should be described like any swelling elsewhere in the neck.

Figure 17.8 Transillumination test

INVESTIGATION IN A NOSE CASE

- Blood for hemoglobin (Hb), total leukocyte count (TLC), differential leukocyte count (DLC), absolute eosinophil count, bleeding time (BT)/clotting time (CT).
- Complete urine exam.
- Culture and sensitivity of nasal discharge.
- X-ray PNS or X-ray soft tissue nasopharynx occipito-mental view.
- Photograph of nose, if indicated in cause of rhinoplasty.
- Skin test of allergy in allergic rhinitis cases.
- Nasal smear for eosinophils.
- Rhinomanometry.
- Biopsy of any mass.
- CT scan or magnetic resonance imaging (MRI), if required.
- Diagnostic nasal endoscopy.
- Liver function tests in cases of nasal bleeding.

Key Points

1. **Correct method of holding nasal speculum** is to suspend it on left index finger, fix it with the thumb and put your middle finger and ring finger around the prongs of the speculum.
2. **Structures seen on posterior rhinoscopy** are both choanae, posterior end of nasal septum, posterior end of turbinates, opening of eustachian tube, fossa of Rosenmuller and torus tubarius.
3. **Transillumination test** for maxillary sinus is done by placing a light source in the mouth against hard plate and looking for crescent of light in the inferior fornix and pupillary glow.
4. **Transillumination test for frontal sinus** is done by placing the light source in superomedial angle of the orbit and observing the light in the anterior wall of frontal sinus.
5. **Functional examination** of nose is done by metal spatula in test and cotton wool wisp test.

Chapter 18

Diseases of External Nose and Nasal Cavity

What Students Must Know!

- **Infective Conditions**
  - Dangerous Triangle of Face
- **Neoplastic Conditions**
- **Traumatic Conditions**
  - Saddle Nose
  - Fracture Nose
  - Septal Hematoma and Abscess
  - Crooked Nose
- **Foreign Bodies in the Nose**
  - Rhinolithiasis
  - Myiasis
- **Congenital Conditions**
  - Posterior Choanal Atresia

External nose may be affected by various diseases and because of the appearance factor patient, usually seeks early medical assistance.

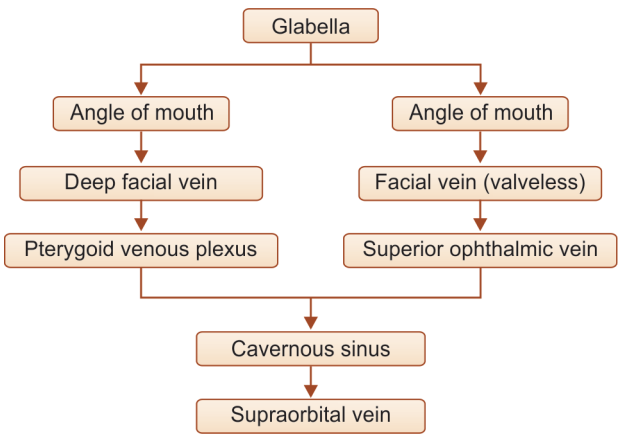
CLASSIFICATION

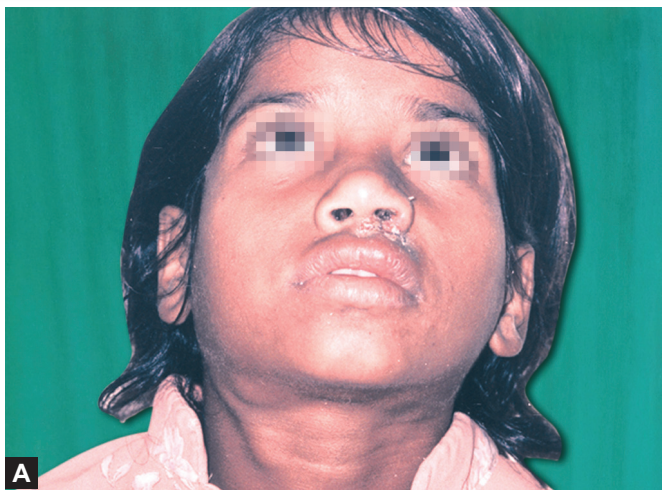
1. Infective conditions:
   a. *Acute:*
      - Furunculosis
      - Impetigo
      - Erysipelas
      - Herpes simplex and zoster
   b. *Chronic:*
      - Vestibulitis
      - Lupus vulgaris
      - Syphilis
      - Lupus erythematosus
      - Acne rosacea
2. Neoplastic conditions:
   - Papilloma
   - Rodent ulcer
   - Keratoacanthoma
   - Squamous cell carcinoma
3. Traumatic conditions:
   - Fracture nose
   - Septal hematoma
   - Saddle nose
4. Foreign bodies in the nose:
   - Rhinolithiasis
   - Myiasis
   - Rhinosporidiosis
5. Congenital conditions:
   - Posterior choanal atresia
   - Nasal dermoid
   - Gliomas
6. Bleeding from the nose
   - Epistaxis
7. Affections of septum of nose:
   - Deviated nasal septum (DNS)
   - Anterior dislocation
   - Septal perforation
   - Bleeding polypus of septum.

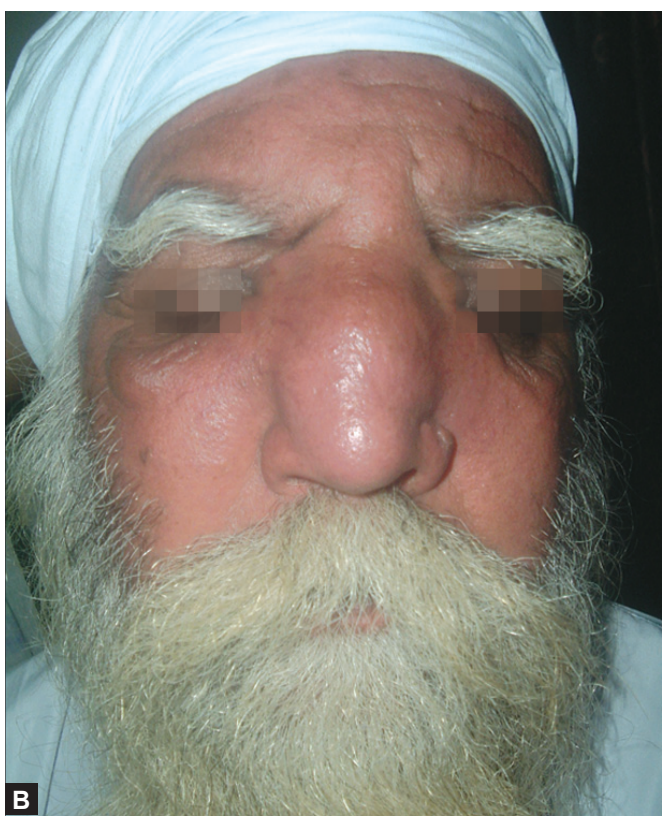
Dangerous Triangle of Face and Nose (Flowchart 18.1)

1. It is called dangerous, because infection from this area can go to cavernous sinus, which can endanger the life of patient.
2. Dangerous area of nose is the olfactory area from where infection can go to meninges along olfactory nerve sheaths causing meningitis.

Flowchart 18.1 Dangerous triangle of face







Figures 18.1A and B (A) Acute vestibulitis of nose (left side); (B) Vestibulitis nose

INFECTIVE CONDITIONS

Acute Conditions

Acute Vestibulitis Nose

Also called furunculosis of nose, it is caused by staphylococcal infection and patient presents with redness, excoriation and fissuring of skin of the vestibule, which results from infection of hair follicles (**Figures 18.1A and B**).

Symptoms and Signs

Severe pain, fever, swelling and tenderness to touch. In recurrent cases, diabetes should be ruled out.

Treatment

Broad-spectrum antibiotics, anti-inflammatory drugs and local application of antibiotic cream. Squeezing and surgery should be avoided, as it may lead to the fatal complication such as cavernous sinus thrombosis.

Impetigo

Impetigo is a vesicular skin infection of dermis caused by streptococci and staphylococci. It is a contagious infection with exudation of fluid and treatment is by antibiotics and local application of antibiotic cream.

Erysipelas

Acute inflammation of skin caused by *Streptococcus,* which enters through a fissure in the skin. The patient presents with pain, heat, swelling and vesiculation with fever and bodyaches. Skin gives typical peau d' orange appearance. Treatment is with penicillin injections.

Herpes

Herpes may be herpes zoster or herpes simplex type, caused by varicella (chickenpox) virus. Vesicles appear time and again. Antibiotics only prevent secondary infection. It is treated by acyclovir 800 mg 5 times a day.

Chronic Conditions

Chronic Vestibulitis Nose

There is repeated incidence of fissuring of vestibule with crust formation. The patient rubs his nose and bleeding may occur. Treatment is by antibiotics and steroid cream. Diabetes should be excluded.

Lupus Vulgaris

Lupus vulgaris is a tubercular infection of skin of nose with appearance of reddish brown papules on the nose. On pressing the lesion with a glass slide, the lesion becomes white and apple jelly nodules appear, as small brown translucent spots. It may be of ulcerative or non-ulcerative type. Ulcers are shallow with undermined edges and crusts followed by fibrosis and severe scars with loss of nasal tip, collumella or septal cartilage perforation. Histologically, it shows reticular endothelial cells, lymphocytes, plasma cells and giant cells.

Treatment is by antitubercular drugs with vitamin D 50,000 units daily for 6 to 8 months.

Syphilis

Syphilis is not seen commonly these days, but may be primary, secondary, tertiary or congenital. Indolent ulcers with hard, indurated and regular margins.Ulcer is painless with punched out margins. Bony bridge of nose may collapse in tertiary syphilis.

Diagnosis is made by serological tests of syphilis (STS), Reiter's complement fixation test and fluorescent *Treponema pallidum* antibody test and venereal diseases reference laboratory (VDRL).

Treatment is with long-acting penicillins.

Rhinophyma/Rosacea

There is hypertrophy of sebaceous glands, which may ultimately develop into rhinophyma. It is also called potato nose or elephantiasis of nose seen in middle-aged males. Examination of nose shows a lobulated fleshy tip of nose with dilated blood vessels.

Treatment is by pairing down or decortication of the bulbous tip avoiding injury to cartilage. Dermabrasion and LASER are other newer options.

Lupus Erythematosis

There appears butterfly distribution of patches of erythema affecting the nose and cheek. Stippling caused by filling of the orifice of sweat glands and hair follicles with horny plugs is characteristic. Presence of typical lupus erythematosis (LE) cells in the blood is characteristic.

Treatment is by local and systemic steroids, antimalarial drugs and immunosuppressants.

NEOPLASTIC CONDITIONS

Neoplasms

They will be discussed with tumors of the nose.

TRAUMATIC CONDITIONS

Fracture Nose

It may be simple with or without displacement and is very commonly seen during ENT practice due to roadside accidents or fights and boxing. Patients' nose should be examined along with gentle palpation of dorsum for crepitus or sensation of springing opposite the depressed fracture. Le Fort classification of maxillofacial injury may be transverse, vertical or of the whole complex.

X-rays confirm the diagnosis and treatment is reduction under local anesthesia (LA)/general anesthesia (GA) with plaster of Paris (POP) or any other synthetic fixture for 2 to 3 weeks to stabilize the fracture.

Septal Hematoma and Abscess

Septal hematoma and abscess may result from

- Injuries
- Follow operation of nose
- Even vestibulitis.

On examination, there is a presence of smooth bilateral bulge of the septum blocking the nose on both sides. If infection supervenes, it results in abscess formation giving rise to constitutional symptoms as well (**Figure 18.2**).

If not drained, it may lead to saddle nose due to absorption of cartilage.

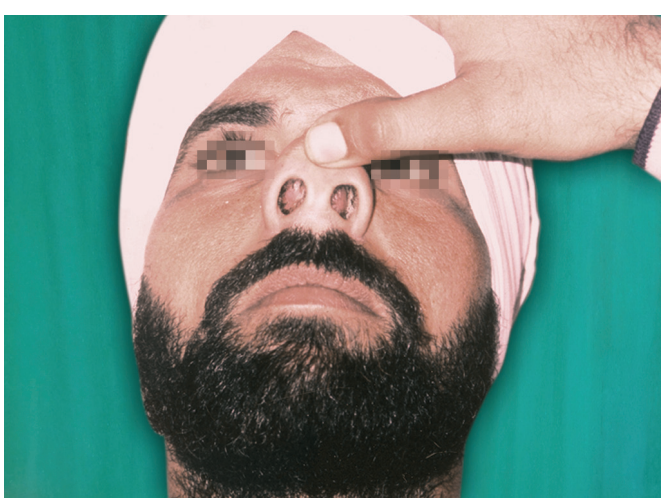
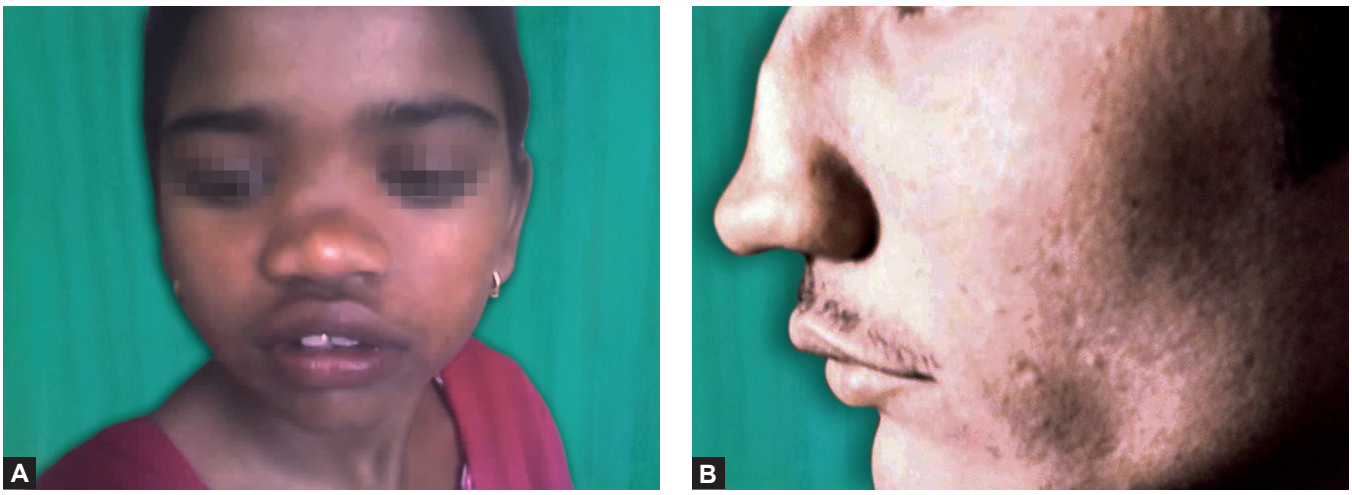


Figure 18.2 Septal abscess



Figures 18.3A and B Saddle nose deformity

Treatment

Drainage of hematoma or abscess under LA by giving an incision on one side of swelling under cover of antibiotics.

Saddle Nose

This deformity results due to sagging of bridge of nose due to injury or infection of osseous or cartilaginous part of bridge of nose (**Figures 18.3A and B**). It may also follow septal abscess or nasal syphilis.

Treatment is of the basic underlying cause in addition to augmentation rhinoplasty.

Hump nose is opposite to saddle nose and is corrected by reduction rhinoplasty including osteotomies to reduce widening of nose.

Crooked Nose

In this condition, the midline of dorsum of nose is deviated to either side giving a crooked shape or external deformity of nose. The usual cause is accidental trauma or birth trauma. The patient is worried about the deformity, especially the females near the marrigeable age. It may also be associated with deviated nasal septum giving rise to marked nasal obstruction.

Management is rhinoplasty with or without correction of septal deviation. In rhinoplasty, various osteotomies such as lateral osteotomy or medial osteotomy is done to mobilise the nasal framework, which can then be adjusted in required shape.

FOREIGN BODIES IN THE NOSE

Foreign bodies may be organic such as wood, paper, cotton foam or rubber and inorganic such as metal, button, beads, plastic. Unilateral foul-smelling discharge in a child is pathognomonic of a foreign body.

Treatment is removal under LA/GA.

Rhinolithiasis

In rhinolithiasis calcareous masses result due to deposition of salts such as calcium and magnesium carbonates and phosphates around the nucleus of a foreign body.

Treatment is removal under GA or LA and most of the time by breaking these into small pieces (**Figures 18.4A to C**).

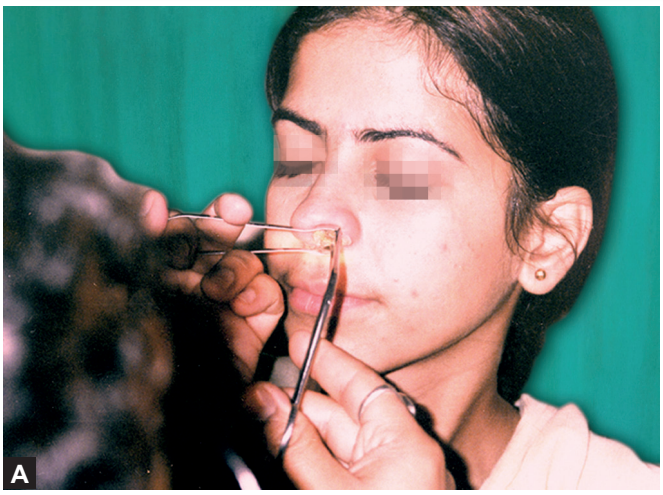
Myiasis

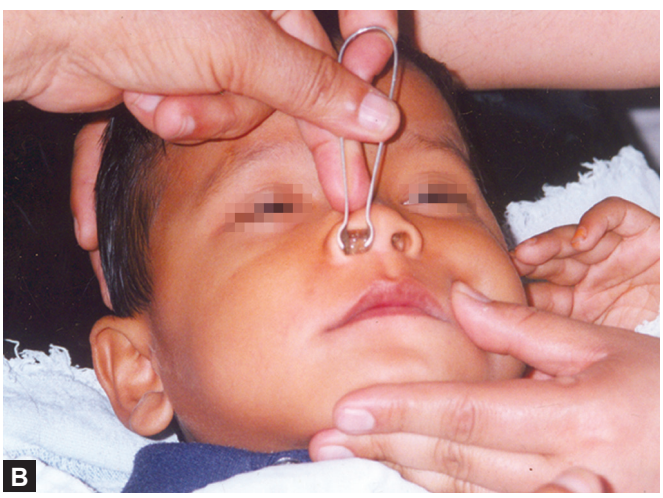
Myiasis results from the presence of ova of flies in the nose, which produce ulceration and destruction of nasal structure mostly seen in atrophic rhinitis, when the mucosa becomes insensitive to the flies laying eggs inside.

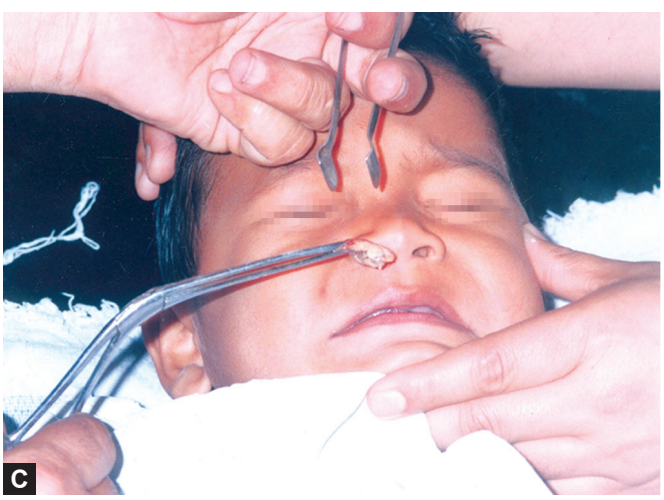
Treatment consists of putting chloroform or turpentine oil or maggot oil in the nose and plugging the nasal cavities, which makes the maggots to crawl out of the nose (**Figures 18.5A and B**).

Rhinosporidiosis

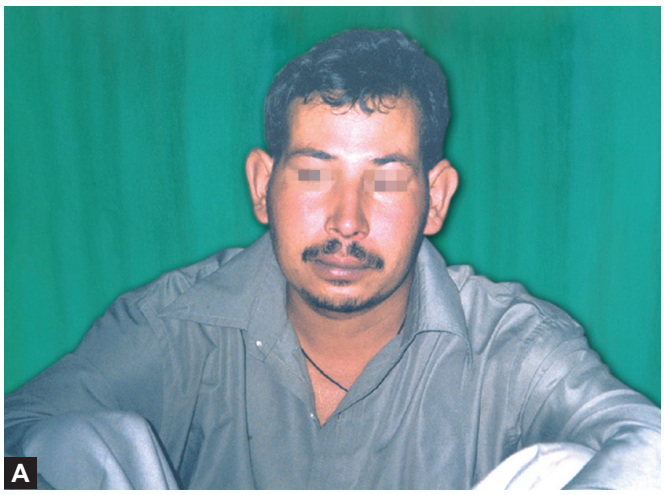
Rhinosporidiosis is caused by *Rhinosporidium seeberi* affecting the mucous membrane of nose and adjoining area. It is characterized by formation of papillomatous and polypoidal lesions in young males in South India and Sri Lanka. Mode of infection is by cattles bathing in ponds and leaving spores, which settle in nasal mucosa of man. Histologically, white sporangia are seen with round cells.

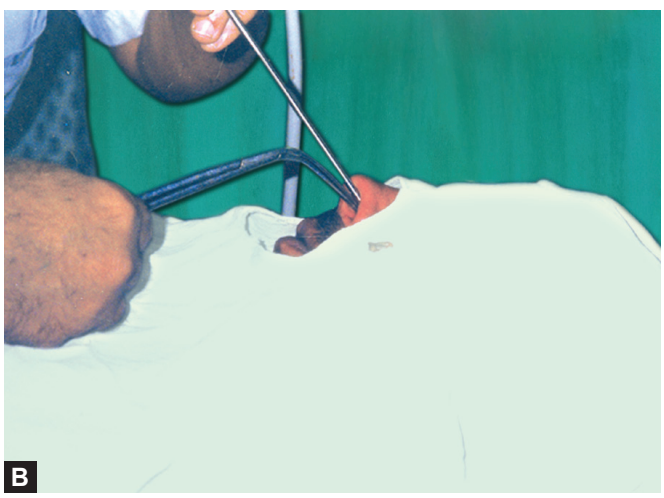






Figures 18.4A to C (A) Removal of foreign body in the nose (rhinolith); (B and C) Removal of foreign body from nose of a 3-years-old child





Figures 18.5A and B Endoscopic removal of maggot

Clinical Features

Nasal discharge, nose bleed, nasal obstruction, no lymph nodes and examination shows a friable lesion with sporangia.

Treatment

Removal of mass with cauterization of base.

CONGENITAL CONDITIONS

Posterior Choanal Atresia

Posterior choanal atresia results from failure of absorption of buccopharyngeal membrane during fetal life. Incidence is 1 in 60,000 live births. Atresia may be bony (90%) or membranous (10%), unilateral or bilateral. If bilateral, the child presents as an emergency and child may have cyanosis.

Malformations of anterior nares are also seen alone or with some other malformations. **Figure 18.6** for congenital malformation of anterior nares.

Diagnosis

Diagnosis is made by inability to pass a rubber catheter or by instilling a radiopaque dye and taking X-rays.

Treatment

1. It has to be immediate by rupture of the membrane and putting in rubber tube with a big hole cut in for passage of air and leaving it for 2 months.
2. Alternatively, airway may also be put in mouth of the infant for giving him respiration.
3. Transpalatal approach may also be used for removal of atretic bone.

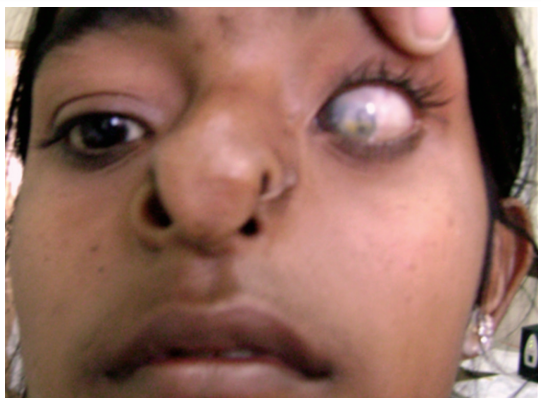


Figure 18.6 Congenital malformation of anterior nares (Triple nares) with buphthalmos of eyeball

Key Points

1. **Cavernous sinus thrombosis** may present as headache, fever, chemosis of conjunctiva, orbital swelling and proptosis.
2. **Lupus vulgaris** is a milder form of tubercular bacilli infection. Apple jelly nodules are typical of lupus and ulcers are with bluish undermined edges.
3. **Syphilitic ulcers** present with hard, indurated and regular margins. They are painless and have punched out margins.
4. **Saddle nose** may result from injury, septal abscess, syphilis or nasal surgery.
5. **Myiasis** is treated by putting chloroform, turpentine oil or maggot oil in the nose.
6. **Tuberculosis** causes perforation of cartilaginous septum, while syphilis leads to perforation of bony septum.
7. **Hebra nose** and tapir nose are feature of late stage of rhinoscleroma.
8. **Leprosy** involves anterior part of nasal septum and inferior turbinate.
9. **Mucormycosis** also called rhinocerebral phacomycosis presents as black necrotic mass in nasal cavity.
10. **Inverted papilloma** is the most common benign neoplasm of nose/sinuses and is treated by adequate local excision and may be premalignant condition in 8 percent cases.

Chapter 19 Diseases of Nasal Septum

What Students Must Know!

- **Deviations of Nasal Septum**
  - Types of Deviations
  - Causes of Deviation
  - Symptoms and Signs of DNS
  - Management of DNS
- **Septal Abscess**
  - Signs and Symptoms
  - Treatment
- **Septal Perforation**
  - Causes and Treatment

DEVIATIONS OF NASAL SEPTUM

- Septal deviations tend to run in families and are more commonly seen in males
- The septum is never found to be straight in an individual
- Localized angular deviations of the septum usually near the floor are called spurs
- Deviations are usually seen at the vomeroethmoidal junction
- It is more often seen in Europeans than Asians and Africans.

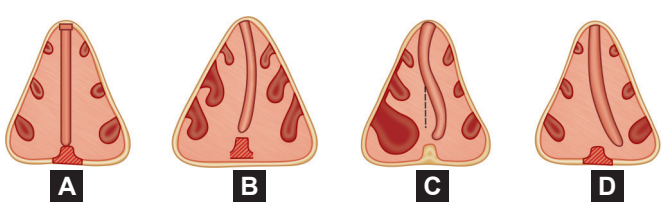
Types of Deviations

1. **Depending upon the site it may be:**
   - Anterior or cartilaginous deviations
   - Posterior or bony deviations
   - Superior deviations
   - Anterior dislocation of septum.
2. **Depending upon the shape:**
   - May be C shaped or S shaped (**Figures 19.1 and 19.2**)
   - *Impacted nasal septum:* The term is used when septum is touching the lateral wall of the nose.
3. **Cottle's classification of deviated nasal septum (DNS):**
   - Simple DNS (Mild)
   - Obstructed DNS (Moderate)
   - Impacted DNS (Severe form).

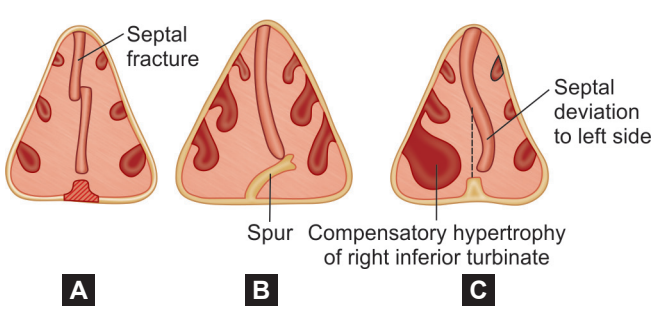
Causes of Deviation

a. *Developmental causes:* DNS may be seen in 20 percent of newborns. Due to unequal rate of growth and descent of nasal septum between the palate and base of skull there occurs buckling of cartilage and bone to one or the other side. The effect is obviously seen in cleft palate, high-arched palate and dental anomalies.

b. *Traumatic:* Accidental trauma, birth trauma and fights may result in deviation of septum.



Figures 19.1A to D Various types of septal deviations. (A) Normal septum; (B) C-shaped deviation; (C) S-shaped deviation; (D) Subluxation of septum



Figures 19.2A to C Septal deviations. (A) Fracture of nasal septum; (B) Septal spur; (C) Deviated nasal septum to the left side with compensatory hypertrophy of right inferior turbinate

c. *Racial:* It is more commonly seen in Caucasians.
d. *Hereditary:* It is also seen to run in families.
e. *Other factors:* Such as tumors of nose may also push the septum to the opposite side.

Symptoms and Signs

1. Asymptomatic.
2. Nasal blockage of one or both sides is the most common complaint. On one side, it is due to the deviation and on the other side, it is due to compensatory hypertrophy of inferior turbinate.
3. Symptoms of sinusitis such as nasal discharge, pain (may be seen due to pressing of enlarged turbinates on the ostia of the sinuses, leading to difficult drainage), vacuum headache and neuralgic pains.
4. Difficulty in perceiving the smell, which may be due to air currents not reaching the olfactory area.
5. Eustachian tube cattarh due to secondary infection causing heaviness and mild hearing problems.
6. Deformity of external nose may be present due to anterior dislocation of the nasal septum to one side, narrowing the passage. In case of marked deviation of septum, external nose may also be seen deformed (As goes the septum, so goes the nose) (**Figures 19.3 and 19.4**).
7. Nose bleed may also be seen due to excessive crusting and drying effect of secretions and the habit of nose picking causing trauma.
8. Snoring may be present.

On Examination

There may be a visible deformity of external nose and anterior rhinoscopy shows deviation of nasal septum to one side causing narrowing of the passage and of the other side of nasal cavity with hypertrophied inferior turbinate (**Figures 19.5 and 19.6**).

Effects

DNS may lead to:

- Repeated middle ear infection
- Chronic sinusitis
- Mouth breathing with dental anomalies
- Atrophic rhinitis sometimes
- Recurrent infection of lower respiratory tract.

Differential Diagnosis

Deviated nasal septum may be confused with mass in the nose usually by a general practitioner. Septal hematoma, which is seen after trauma to the nose, produces a soft bilateral swelling. It may get organized and thicken the septum subsequently.

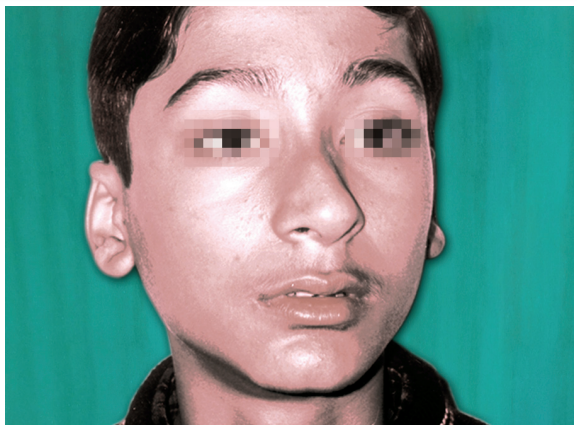


Figure 19.3A Deviated nasal septum with deviation of external nose

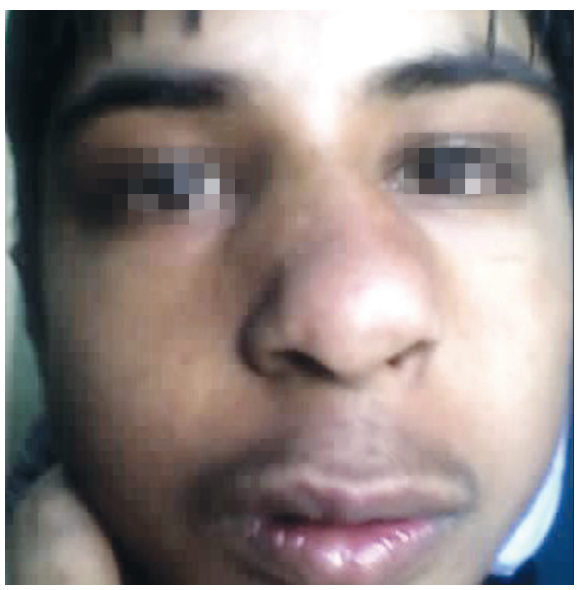
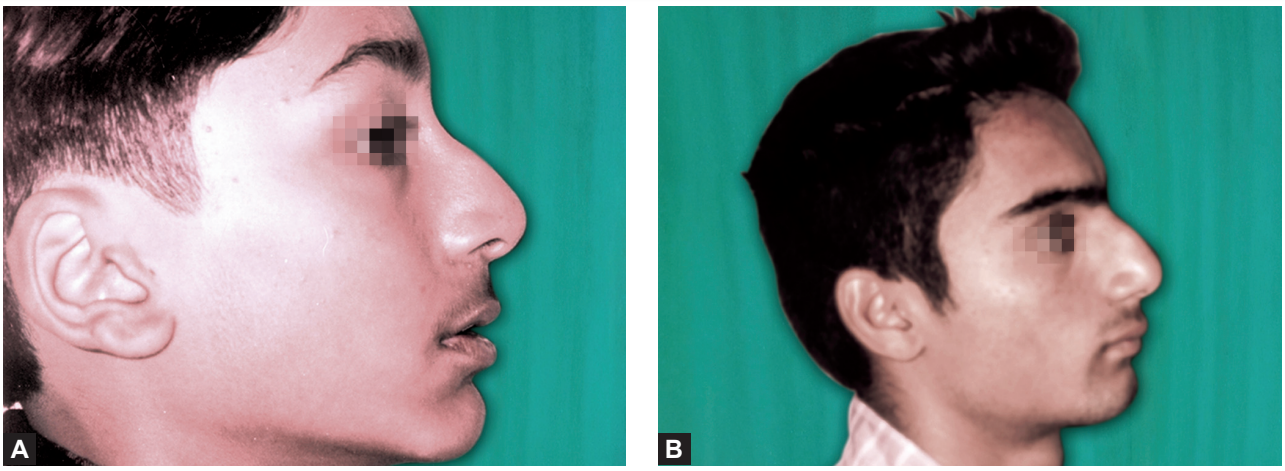


Figure 19.3B As goes the septum, so goes the nose

Management

1. No treatment is required, if it is not causing any symptoms in the nose or around the nose
2. If it is causing severe symptoms, treatment has to be done, i.e. septoplasty, which is a conservative approach with minimal side effects and is always preferred in children unlike submucous resection (SMR) operation, which will be discussed in detail subsequently.
3. Now septoplasty can also be done with the help of endoscopes, while doing functional endoscopic sinus surgery (FESS) especially, if the deviation is interfering in the proper introduction of rigid sinuscope in the nasal cavity (**Figure 19.6C**).



Figures 19.4A and B Hump on dorsum of the nose

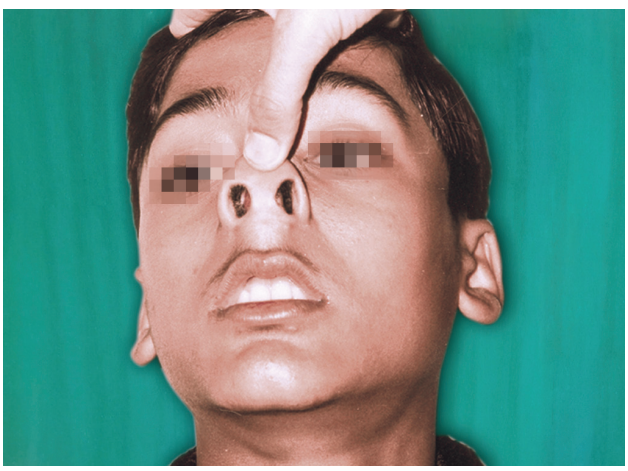


Figure 19.5 Anterior subluxation of septum

SEPTAL ABSCESS

Septal abscess is the collection of pus between the nasal septum and its perichondrium and periosteum, while septal hematoma is a collection of blood only.

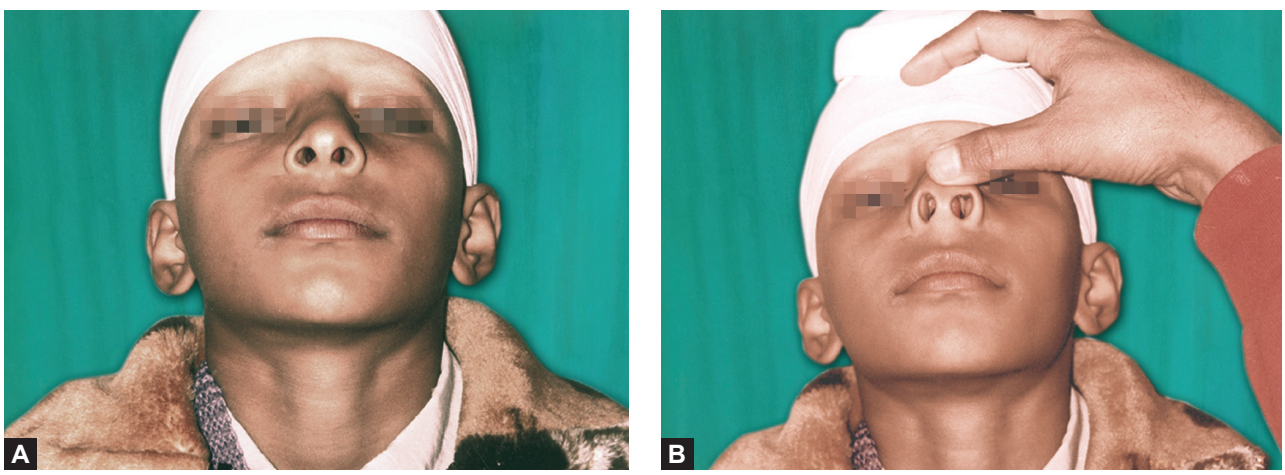
It usually follows:

- Septal hematoma, which results from blunt nasal trauma or after surgery, if infection supervenes (**Figure 19.7**)
- Other causes may be furuncle of the nose or other acute viral infections such as typhoid and measles.

Signs and Symptoms

The patient has:

- Bilateral nasal obstruction
- Pain in the nose



Figures 19.6A and B Deviated nasal septum to left side

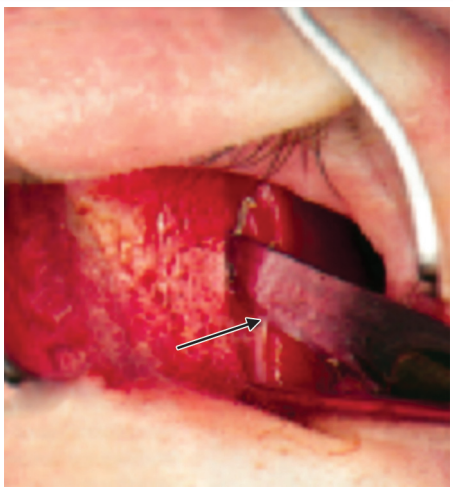


Figure 19.6C Endonasal septoplasty

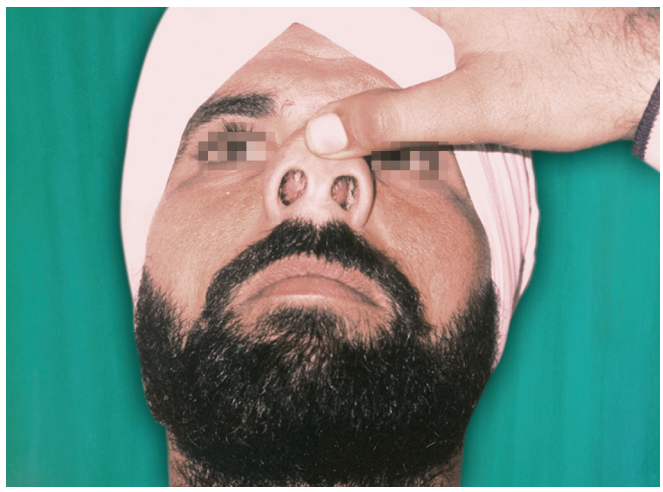


Figure 19.7 Septal abscess

- Fever
- Frontal pain.

On Examination

- Tenderness over the nose
- Redness of the bridge of nose
- Once the cartilage is necrosed, sagging of bridge on both the sides
- Rhinoscopy shows rounded bulge of septum on both sides, which is fluctuating
- Submandibular lymph nodes may be enlarged.

Treatment

- *Incision and drainage:* Incision is given on one side only, pus is taken out and a roller gauze dressing is given for 48 hours and thereafter changed to prevent reaccumulation of pus
- Broad-spectrum antibiotics for 10 days
- Anti-inflammatory drugs and pain killers.

Complications

- Supratip depression of bridge of nose
- Septal perforation (**Figure 19.8**)
- Spread of infection to meninges and cavernous sinus.

SEPTAL PERFORATION

Important Causes

1. Traumatic—which may be surgical or accidental
2. Ornamental
3. Nose picking
4. Chemical sniffing such as chromium/nickel
5. Cocaine sniffing
6. Granulomatous disorders such as syphilis, leprosy or lupus or midline granulomas
7. May follow repeated cauterization of septum
8. Complication of septal abscess, if drainage is delayed
9. Maggots in the nose
10. Foreign bodies of longstanding duration causing pressure necrosis
11. Malignancy of nose
12. Idiopathic.

Symptoms

- May be asymptomatic
- Excessive crusting causing mild nose bleed
- Whistling if perforation is small and anterior.

Signs

On anterior rhinoscopy, perforation is seen and structures on the other side of nasal cavity are visible.

Treatment

1. No treatment, if it is asymptomatic.
2. Silastic button may be used to close the perforation and lessen the symptoms.
3. Excessive crusting can be removed by alkaline nasal douches.
4. Small to medium size perforation can be closed by raising flaps and stitching on the perforation.
5. Cause of perforation must be looked into.

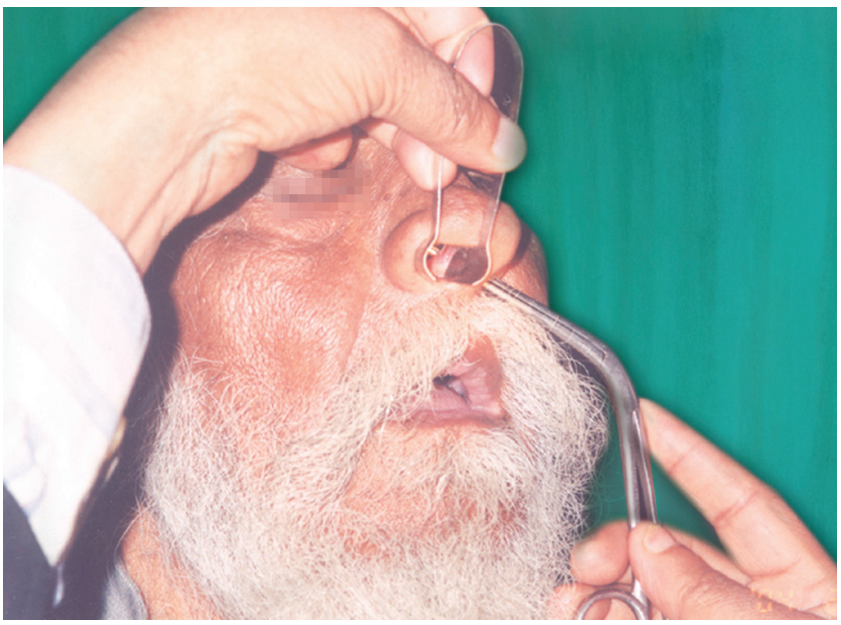


Figure 19.8 Septal perforation

Key Points

1. **Nasal septum** consists of septum proper, membranous septum and columella septum.
2. Injury to nasal septum may result in fracture, which may be of **Jarjaway or Chevallet type** of fracture. Jarjaway runs from anterior nasal spine horizontally backwards, while **Chevallet type** runs from spine to vertically upwards.
3. **Cottle test** if positive, indicates abnormality of the vestibular component of nasal valve. Test is done by drawing the cheek laterally and the patient breathes quietly. If the breathing becomes normal on the test side, it is positive cottle test.
4. Deviated nasal septum may lead to ear infections, chronic sinusitis, epistaxis, headache and external deformity.
5. **Septal surgery** should be done after 18 years of age, so not to interfere with growth of nasal skeleton.
6. Small to medium size **perforation** requires surgical treatment where as large perforation can be sealed by obturator.
7. **Bony septal perforation** is seen in syphilis.
8. **Mitomycin** after septal surgery prevents synechia formation by acting as antifibroblastic agent.
9. **Causes of septal perforation—remember mneumonic: Lets walk Thru An MRI:** L: **L**eprosy/Lupus; W–**W**egener's Ds; T: **T**raumatic; A: **A**bscess; M: **M**yiasis; R: **R**hinolith; I: **I**diopathic.

Chapter 20 Inflammatory and Other Disorders of Nasal Cavity

What Students Must Know!

- **Acute Inflammatory Conditions**
  - Acute Rhinitis or Cory za
  - Acute Nasal Diphtheria
- **Chronic Inflammatory Conditions**
  - Fungal Infections of Nose
- **Atrophic Rhinitis**
  - Definition and Types
  - Causes of Atrophic Rhinitis
  - Clinical Features
  - Management

CLASSIFICATION

1. *Acute inflammatory conditions:*
   - Acute rhinitis
   - Acute nasal diphtheria.
2. *Chronic inflammatory conditions:*
   - Specific:
     - Nasal syphilis, tuberculosis, lupus and leprosy
     - Rhinoscleroma
     - Rhinosporidiosis
     - Sarcoidosis
     - Midline granulomas.
   - Nonspecific:
     - Atrophic rhinitis
     - Chronic hypertrophic rhinitis
     - Rhinitis sicca
     - Rhinitis caseosa
   - Allergic:
     - Seasonal allergic rhinitis
     - Perennial allergic rhinitis
     - Vasomotor rhinitis.

ACUTE INFLAMMATORY CONDITIONS

Acute Rhinitis or Coryza

1. Frequently referred as common cold, it is seen in adults or children during their early stage.
2. Incubation period varies from 1 to 3 days and usually transmission occurs by droplet infection such as sneezing, coughing, talking or schooling years due to lack of resistance to infection.
3. It may also follow exposure to cold and wet season.
4. Predisposing factors may be change of climate, temperature, humidity, poor nutrition, chronic sinusitis, fatigue, diabetes, tuberculosis and dysfunction of thyroid.
5. Causative agents are the viruses such as rhinovirus, influenza and parinfluenza virus, syncytial virus, enteric cytopathogenic human orphan (ECHO) virus, coxsackie, adeno and reoviruses. Secondary invading agents are *Streptococcus, Moraxella catarrhalis, Haemophilus influenzae, Staphylococcus* and pneumococci.
6. It spreads by kissing and through food, finger and fomites.

Pathologically—first there occurs

Ischemia and vasoconstriction, then vasodilation, edema, increased activity of nasal glands and goblet cells, leading to leukocytosis and purulent discharge.

Clinical Features

1. Firstly, there is dryness and ticklish spot in the throat or nasopharynx, followed by soreness on swallowing.
2. Then there is sneezing, discharge from the nose and nasal obstruction.
3. Mucous membrane of nose and throat is swollen and congested.
4. Fever appears due to toxemia.
5. On 2nd or 3rd day, there is thick discharge, which is mucopurulent, nasal obstruction increases and on 5th day onwards, symptoms start decreasing and recovery occurs.
6. Complications of coryza may be nasopharyngitis, sinusitis, eustachian tube (ET) catarrh, otitis media, lymphadenitis, respiratory tract infection, tonsillitis, nephritis and rheumatism.

Management

- Avoidance of dusty and crowded places
- Complete isolation of patients
- Balanced and nutritious diet
- Sudden fatigue, change of temperature and humidity should be avoided
- Proper sterilization of fomites is necessary
- Role of cold (polyvalent) vaccine has not been proved.

Treatment

- Complete bed rest
- Hot water bath is quite helpful
- There is role of vitamin C, 500 mg bid for 10 days
- Antibiotics to prevent complications and secondary infection
- Antihistaminics and anti-inflammatory drugs are given symptomatically 2 to 3 times a day
- Smoking and hard drinks are avoided.

Remember, the dictum—if you do not treat cold, it takes 7 days; and if you treat it, it takes one week only. Choice is yours.

Acute Nasal Diphtheria

Causative organism is *Corynebacterium diphtheriae*. It may be primary or secondary due to faucial diphtheria. The patient presents with pyrexia, general toxemic features, lymphadenitis and palsies.

Treatment is with penicillin and antitoxin serum. Erythromycin is given in the patients with allergy to penicillin.

CHRONIC SPECIFIC INFLAMMATORY CONDITIONS

Nasal Syphilis

Although not seen very commonly, it may manifest in the form of primary, secondary, tertiary or congenital syphilis.

Acute primary nasal syphilis: It involves the vestibule of nose showing hard painless nodule 3 to 4 weeks after the contact and may disappear spontaneously in 8 to 10 weeks. Venereal diseases research laboratory (VDRL) tests may confirm the diagnosis.

Secondary syphilis of nose: It appears 8 to 10 weeks after inoculation and may manifest in the form of simple rhinitis along with crusting and fissuring of nasal vestibule and is suspected when mucous patches appear in pharynx along with lymph nodes. Wassermann's reaction becomes positive.

Tertiary syphilis: It is commonly seen in the nose and lesion found is gumma of the nose invading mucous membrane, periosteum and bone leading to sagging of bony bridge of nose and secondary atrophic rhinitis follows. Tenderness of bridge of nose is quite characteristic. Bony septum may show perforation.

Congenital syphilis: In infants, snuffles is the most common lesion in the 3rd week of intrauterine life beginning with catarrhal form of rhinitis and becomes purulent in a short time with excoriation of nasal vestibule ultimately leading to destruction of mucous membrane, periosteum and bone.

In the tertiary form, suspicion arises when there are present Hutchinson's teeth, interstitial keratitis, corneal opacities and perceptive deafness.

Treatment

- Antisyphilitic treatment, benzathine penicillin—2.4 mega units IM weekly for 3 weeks
- Discharge in the nose is removed by nasal toilet or alkaline douche.

Tuberculosis of Nose

Tuberculosis of nose may be in the form of ulcer or a nodule and affects the cartilaginous part of septum. Examination shows a bright red nodule or ulcer on the septum with rapid course of destruction.

Examination of discharge shows tubercle bacilli and biopsy will show typical tubercular lesion.

Treatment

It is routine antitubercular therapy.

Lupus Vulgaris

Lupus vulgaris is a chronic form of tubercular infection affecting skin and mucous membrane of nose. Female to male ratio is 2 : 1. Symptoms vary from crusting, nose bleed and ulceration with foetor followed by slow progressive fibrosis and contraction causing disfigurement of alae nasi. The 3 B's are important in diagnosis, i.e. blanching, bacterial examination and biopsy. Apple jelly nodules, on blanching, are typical of lupus vulgaris.

Treatment

It is with antitubercular drugs.

Leprosy of Nose

Leprosy of nose is a granulomatous lesion of nose, which affects mucous membrane, skin and peripheral nerves. It is caused by bacillus *Mycobacterium leprae*. It is treated with dapsone.

Rhinoscleroma

- Friedmann (1966) described this condition as a granulomatous disorder of the nose extending to nasopharynx and oropharynx
- It is seen mostly in poor socioeconomic conditions
- Most commonly seen in Europe, Pakistan, Indonesia and South America.

Pathology

The disease is caused by *Klebsiella rhinoscleromatis* (Frisch bacillus). It mainly affects nose, nasopharynx, oropharynx, larynx, trachea and bronchii. Histological appearance of the biopsy material shows plasma cells, lymphocytes and eosinophils. Mikulicz cells or foam cells and Russell bodies are the characteristic features.

Plasma cells get transformed into Russell bodies. There is high content of mucopolysaccharides around the walls of bacilli, which protects it against antibiotics and antibodies.

Symptomatology

- Stage of congestion and infiltration giving rise to discharge, crusting and foetor
- Granulomatous or nodular stage in which bluish red rubbery nodules appear in the anterior part of nose, which later becomes pale and hard
- Stage of cicatrization in which there is formation of adhesions, fibrosis, stenosis with distortion of nasal anatomy giving rise to so called Hebra nose. It is also called as Tapir nose. Soft palate deformity, which may follow is called Gothic arch deformity. Pain is not a feature. Lymphatics are blocked due to fibrosis so lymph nodes involvement does not occur.

Diagnosis

It is confirmed by biopsy and histological features and culture of the bacilli.

Treatment

i. Ampicillin 2 gm/day for 6 weeks or injection streptomycin or tetracycline or steroids.
ii. Radical excision of the mass and repair of the defect.

Fungal Infections of Nose

Fungal infection of nose is described under the following subheads.

Rhinosporidiosis

Rhinosporidiosis is a fungal infection of the nose caused by *Rhinosporidium Seeberi* or kinealyi. Young males from South India and Sri Lanka were found to be affected. Mode of infection is by dust or dung of animals, which carries the spores of the fungus.

Typical lesion seen in this is the bleeding polyps arising from lateral or medial wall of the nose; hence, epistaxis is the symptom along with nasal discharge, irritation and nasal obstruction. Lesion is friable resembling a strawberry with undersurface having sporangias seen as white dots. Microscopically, the spores are seen in the nasal discharge.

Differential diagnosis
Growth of nose, histological picture is typical both in growth and fungal infections.

Management
i. Wide endoscopic excision of the growth with diathermy and cauterization of the base
ii. Medical treatment is not of much use, but dapsone and antimony compounds have been tried.

Other Fungal Conditions

Aspergillosis
It may be of *Aspergillus fumigatus* or of niger type and is seen mostly in persons handling small birds.

Candidiasis
Also called moniliasis or thrush. It is caused by *Candida albicans*. Usually, it occurs in the mouth as white patches, but may be seen in the nose of the patients who have been on prolonged antibiotics, anticancer drugs or marasmic patients.

Treatment
It is local cleaning and application of nystatin locally or clotrimazole solution.

Actinomycosis
Actinomycosis is a chronic granulomatous infestation due to *Actinomyces* or ray fungus and is seen in farmers. Macroscopically, it looks like sulfur granules and microscopically polymorphs, endothelial cells and foreign body giant cells with branching acidophilic fibers radiating out are seen.

Nose is usually not involved, but may be infected secondarily from the maxilla or sinuses.

Treatment
It is with large doses of penicillin for 6 to 8 weeks.

Mucormycosis
Mostly seen in patients with uncontrolled diabetes and it is caused by *Mucor* family and differs from other fungus by the invasion of walls of blood vessels causing necrosis, ulceration and thrombosis. The patient presents with black necrotic mass in the nasal cavity.

Treatment
It is treated with amphotericin B and surgical debridement.

Sarcoidosis

Sarcoidosis is a granulomatous disorder resembling tuberculosis but without caseation of the tubercles. The patient presents with nasal obstruction, nasal bleeding and nasal discharge with lymphadenopathy. Kveim test and biopsy are diagnostic.

Treatment

It is with steroids, vitamin D and ultraviolet (UV) rays.

Midline Granuloma of Nose

Midline granuloma is a destructive condition of nose, hence, also referred to as malignant granuloma or non- healing granuloma or Stewart's granuloma. Exact etiology is not known, but it may be a manifestation of autoimmune disorder.

Histopathology

There is predominance of lymphocytes, plasma cells and histiocytes with necrosis of tissues in the midline.

Clinical Features

Of this type, they are serosanguineous discharge, swelling of nose including vestibule and septum, ulceration of these parts, i.e. cartilage and bone with necrosis and deformity and progressive destruction in spite of usual treatment. Systemic spread is not common.

Diagnosis

It is made by biopsy and radiology.

Treatment

i. Surgical debridement is very helpful
ii. Radiotherapy
iii. No role of steroids or cytotoxic drugs.

Wegener's Granuloma

Wegener's granuloma is a systemic condition of unknown etiology, which differs from Stewart's type by involvement of upper respiratory tract, lungs and kidneys; and in this, destruction of tissues is not so extensive with less tendency of cartilage and bone involvement.

Histopathology

Multinucleated giant cells closely applied to blood vessels without breakdown of elastic tissue of artery wall unlike giant cell arteritis.

Clinical Features

Blood-stained discharge, crusting and granulations, cough with hemoptysis, hematoma, saddle nose and perforation of nasal septum may be seen along with fatigue, night sweats and anemia.

Investigations

- Erythrocyte sedimentation rate (ESR) is raised, eosinophilia may be present
- Blood urea and serum creatinine show increased levels
- Urine examination shows red cells, casts, albumin
- X-ray chest may show single or multiple cavities
- Biopsy is diagnostic.

Treatment

i. Corticosteroids in high doses, they are very effective till healing occurs. 60 mg daily for 8 to 12 weeks.
ii. Cytotoxic drugs such as cyclophosphamide and azathioprine have been used with variable success.

CHRONIC NONSPECIFIC RHINITIS

Atrophic Rhinitis

Definition

- Atrophic rhinitis is a chronic inflammatory disease, which is characterized by progressive atrophy of mucous membrane of nose and turbinates
- There is also associated excessive crusting and abnormal patency of nasal passages
- It is termed as ozena, if there is associated fetor
- The disease usually starts at puberty, commonly seen in females
- More commonly seen in yellow races and American negroes
- Commonly seen in India, China and Egypt.

Types

The disease may be of two types:
1. Primary atrophic rhinitis type
2. Secondary atrophic rhinitis which may be due to
   - Syphilis
   - Tuberculosis
   - Excessive surgery
   - Chronic sinusitis
   - Trauma
   - Postradiation therapy.

Causes

Remember mneumonic HERNIA:
1. *Heredity:* It runs in families.
2. *Endocrinal:* As it is seen at puberty in females and after menopause, the disease is not common; therefore, endocrine disturbances may be the cause.

3. *Racial:* As it is seen to run in yellow races and American negroes families.
4. *Nutrition:* Poor nutrition including iron deficiency, vitamin A and D deficiency may be responsible for the disease.
5. *Immunocompromised:* Such as in diabetics, tuberculosis and patiet's on steroids.
6. *Autoimmune process:* Causing destruction of nasal, neurovascular and glandular elements may be the cause.

Other Causes

- *Bacterial:* Such as *Coccobacillus foetidus*, *Bacillus mucosus*, diphtheroid bacilli, *Klebsiella ozaenae* may be responsible for atrophic rhinitis
- *Empty nose syndrome:* It is an iatrogenic condition caused by over enthusiastic removal of nasal turbinates during nasal surgery
- Syphilis (tertiary)
- Wide nasal cavity (**Figure 20.1**)
- Lupus, leprosy and tubercular
- Extensive surgery on the nose
- Chronic sinusitis.

Pathogenesis

- There occurs metaplastic changes in columnar ciliated to cuboidal or stratified squamous epithelium
- Capillaries are dilated and size and number of glands decrease
- Periarteritis and endarteritis may be present
- There may be atrophy of bones of the turbinate along with atrophy of nerves
- In type-I, endarteritis or periarteritis is present
- In type-II, dilatation of capillaries is seen.

Clinical Features

Symptoms

It is a bilateral condition mostly in females present with:

- Nasal obstruction
- Nose bleed
- Headache
- Merciful anosmia—foul smell, which the patient herself is unable to perceive due to atrophy of olfactory nerves and excessive crusting of nose.

Signs

- Grayish black crusts in the nose
- Nasal passages are roomy
- Turbinates are shrivelled and detachment of crusts leave a bleeding and ulcerated mucosa
- In late cases, septal perforation and saddle nose may be present
- Eustachian tube catarrh is present and paranasal sinuses and pharynx may be affected.

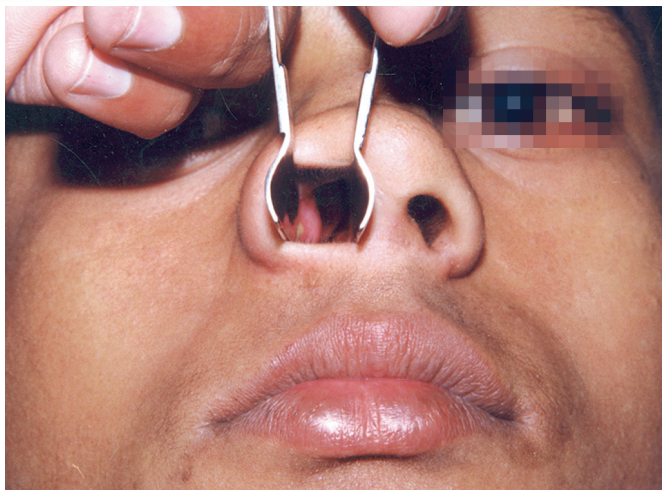


Figure 20.1 Wide nasal cavity in atrophic rhinitis

Investigations

i. Culture and sensitivity of the nasal swab
ii. X-rays PNS
iii. STS
iv. Serum iron and proteins.

Treatment

- Conservative treatment
- Surgical treatment.

Conservative

i. *Regular nasal cleaning:* By nasal douching with alkaline solution prepared by disolving 280 ml of warm water in 28.4 gm of sodabiborate and 56.7 gm of sodium chloride. It helps in removing crusts. Maggots if present should be removed by using maggot oil.
ii. Nasal plugging with cotton wool tampoons for one hour before douching also helps in removing crusts.
iii. Application of 25 percent glucose in glycerine, which inhibits the growth of proteolytic organisms, i.e saprophytes and mucosa remains moist. It is due to fermentation of Glucose to Lactic acid.
iv. Estradiol in arachis oil for its vasodilation effect.
v. Antibiotic in antiozene solution—local application in the nose to control secondary infection.
vi. Potassium iodide by mouth to increase nasal secretions.
vii. Autogenous vaccine has also been tried.
viii. Placental extract by submucosal injections.
ix. Besides above Antibiotics, High protein diet , Vitamin A and Vasodilators are also given.

Surgical

i. Submucosal injection of paraffin or teflon paste in glycerine 50 percent decreases the nasal passages.

ii. *Young's or modified Young's operation:* Folds of skin inside the nostril are raised and are sutured together with the object of complete interruption of air flow for a period of months to years. It helps by giving rest to nasal mucosa and by causing local hypoxia. In modified operation, partial interruption of the air flow is done.
iii. *Eyries operation (1953):* Placement of implants under the nasal mucosa to decrease the size of nasal cavity. Insertion of fat and cartilage or Teflon strips have been inserted after lifting the flaps of mucoperiosteum on the septum or lateral wall.
iv. *Sublabial implantation of placental tissue* have been tried with some success.
v. *Witmack's operation:* Transplantation of parotid duct (Stensen's duct) in the maxillary sinus for better lubrication but troublesome rhinorrhea may occur during meals.
vi. *Lautenslager operation* is also done for atrophic rhinitis (medialization of lateral wall).
vii. Secondary atrophic rhinitis can be prevented by being conservative in doing turbinate surgery. It is better to remove a little less and revise later than remove more and regret later.
viii. *Raghav Sharan's* operation in which maxillary sinus mucosa is transferred in nasal cavity for lubrication.

Prognosis

It is bad although spontaneous recovery has been reported.

Summarize atrophic rhinitis

- Chronic inflammatory disease with excessive crusting and abnormal patency of nasal passages
- Starts at puberty, commonly seen in females
- Primary or secondary atrophic rhinitis
- Causes of atrophic rhinitis (remember mneumonic—HERNIA)
- Heredity/endocrinal/racial/nutrition/immunocompromised/autoimmune process
- Metaplastic changes in columnar ciliated to cuboidal or stratified squamous epithelium
- Main symptoms are nasal obstruction/nose bleed/headache merciful anosmia
- Examination shows turbinates are shrivelled and detachment of crusts leave a bleeding and ulcerated mucosa
- Medical treatment includes:
  - Regular nasal cleaning
  - Antibiotic in antiozaene solution
  - Application of 25 percent glucose in glycerine which inhibits the growth of proteolytic organisms.
- Surgical treatment Young's or modified Young's operation/Lautenslager operation.

Chronic Hypertrophic Rhinitis

In this condition, there is hypertrophy of epithelial lining, glands, and turbinates. Important causes leading to this condition are chronic infections of nose, PNS, chronic irritation of nose due to smoke, fumes, dust or local use of drugs such as nasal drops.

Clinical Features

Nasal obstruction, nasal discharge, anosmia and feeling of heaviness of head. Examination shows thick mucosa with enlarged turbinate, which does not shrink with local drops.

Treatment

Size of turbinates can be reduced by electrocautery, submucosal diathermy, partial resection of enlarged turbinates or by use of laser.

Rhinitis Sicca

Rhinitis sicca is a milder form of atrophic rhinitis, which occurs in alcoholics, anemia, nutritional deficiencies and persons working in hot, dry and dusty occupation.

There is inactivity of seromucinous glands along with metaplasia of columnar ciliated epithelium to cuboidal or squamous epithelium.

Clinical Features

Irritation, dryness, crusting, bleeding some time in the anterior part of nose only, no fetor. Examination shows a glazed mucosa with thin crusts.

Treatment

- Removal of the cause whatsoever
- Lubrication of the nose with vaseline
- Alkaline nasal douche, if required.

Rhinitis Caseosa

- Rhinitis caseosa is also called nasal cholesteatoma
- It is a chronic inflammatory condition with formation of granulations and presence of offensive cheesy material
- It is seen more in males at any age group. It may be seen in chronic sinusitis infection due to streptothrix alba or the presence of a foreign body
- Microscopically, it shows caseous debris with keratinous material, organisms and sometimes cholesterol crystals
- Clinically, nose shows white debris, bone may be involved along with sinus infection.

Treatment

Thorough removal of caseous debris from nose by douching or surgical means.

Rhinitis Medicamentosa

Rhinitis medicamentosa is seen more after prolong use of nasal drops and sprays which results in rebound phenomenon causing vasodilatation and engorgement of nasal mucosa. On examination nasal mucosa is boggy and congested.

Treatment consists of:

a. Stop use of decongestants
b. Use of oral or topical steroids
c. Partial turbinectomy may be helpful.

Key Points

1. **Syphilis** affects the bone, while tuberculosis affects the cartilaginous framework of nose.
2. **Rhinoscleroma** is caused by Frisch bacillus, i.e. *Klebsiella rhinoscleromatis*. Mikulicz cells and Russell bodies are typical of the histopathological examination.
3. **Sarcoidosis** resembles tuberculosis except for caseation and Kveim test and biopsy are diagnostic.
4. **Wegener's granuloma** differs from Stewart's granuloma because of involvement of lungs (almost always), kidneys and giant cell presence along with walls of blood vessels.
5. **Atrophic rhinitis** seen in young females may be caused by *Klebsiella ozaenae* besides other factors and the best treatment is Young's operation.
6. **In Young's operation**, folds of skin are raised and sutured to reduce the size of nasal cavity.
7. **Nasal cholesteatoma** is also called rhinitis caseosa.
8. **Non-healing midline granuloma** is also called angiocentric lymphoma.
9. **Lautenslager operation** involves medialization of lateral wall in atrophic rhinitis.
10. **Hebra nose/woody nose** is a feature of rhinoscleroma.
11. **Aspergillosis** is the commonest fungal infection of nose and paranasal sinuses (PNS)
12. **ENT diseases common in females** are atrophic rhinitis, otosclerosis, postcricoid carcinoma, glomus and functional aphonia.
13. **Morula cells and Mott cells** are typical of Rhinoscleroma.
14. **Treatment of atrophic rhinitis—remember mneumonic: ATROPI in Young Girls:** A: **A**ntibiotic nose spray; T: **T**eflon paste local injection; R: **R**emoval of crusts; O: **O**estradiol spray; P: **P**lacental extract; I: **I**rrigation with saline; IN-**In**sert fat/cartilage; Young: **Young's** operation; Girls: **Girls** affected mostly

Chapter 21

Nasal Allergy and Allied Conditions

What Students Must Know!

- **Chronic Allergic Rhinitis**
  - Types of Allergic Response
  - Mechanism of Allergy (Pathogenesis)
  - Clinical Features of Nasal Allergy
  - Investigations for Allergic Rhinitis
  - Treatment of Allergic Rhinitis
- **Nonallergic Rhinitis**
  - Vasomotor Rhinitis (Intrinsic Rhinitis)
  - Rhinitis Medicamentosa
- **Differential Diagnosis of Allergic Rhinitis Versus Vasomotor Rhinitis**

CHRONIC ALLERGIC RHINITIS

What is Allergy?

1. It was Clemens Von Pirquet, a Viennese pediatrician, who used the term allergy in 1906 denoting an altered state of reactivity to an organic substance, i.e. allergen.
2. It is an immunoglobulin E (IgE)-mediated immunological response of nasal mucosa.
3. Atopy means a tendency to develop allergic diseases.

Types of Allergic Response

1. *Type I or atopic hypersensitivity:* Atopic hypersensitivity occurs in those persons who form reaginic antibodies when exposed to certain antigens. It is mediated by IgE antibodies, levels of which increase to more than 100 units/mL. This type of reaction is seen in allergic rhinitis, bronchial asthma, hay fever and eczema.
2. *Anaphylactic reaction:* Anaphylactic reaction is a severe form of allergic reaction, which occurs immediately after exposure to the antigen, e.g. injecting horse serum and it can be fatal.
3. *Delayed hypersensitivity (Type IV):* Unlike the above two types, it does not depend upon antibodies, but on sensitised T-lymphocytes.

Classification

Allergic rhinitis and its impact on asthma (ARIA) panel in association with World Health Organization (WHO) recommended a revised classification in 2001, which aims at better management of allergic patients. It classifies it into:

- Mild
- Moderare to severe
- Intermediate
- Persistent types.

Mechanism of Allergy (Pathogenesis)

The mechanism of allergy (pathogenesis) (**Figure 21.1A**) are as follows:

1. Reaginic antibodies also called IgE combine with cells such as circulating basophils or tissue mast cells.
2. Later on, whenever there is provocation allergens combine with cell bound reaginic antibodies.

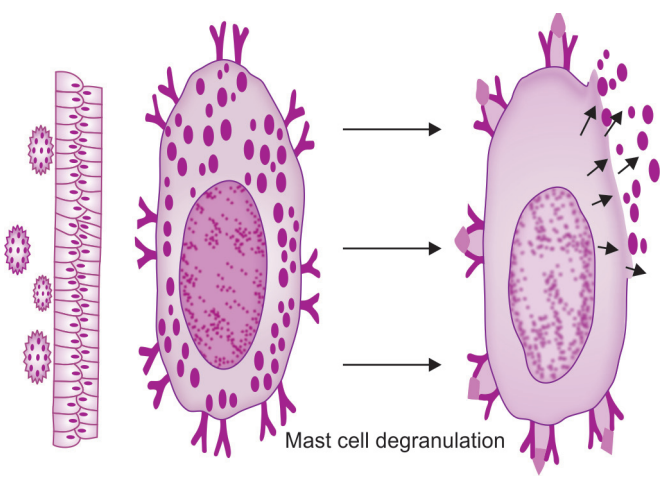


Figure 21.1A Mechanism of allergic reaction

3. This results in the release of vasoactive amines such as histamine, 5-hydroxytryptamine (5/HT)/slow reacting substance of anaphylaxis (SRS-A)/cosinaptic and chemotactic factor of anaphylaxis (ECFA).
4. The tissues where allergic reaction occurs is known as shock tissue.
5. The release of vasoactive amines causes vascular dilatation and increased permeability.
6. Edema, cellular infiltration with eosinophil and increased activity of glands resulting in various symptoms and sign of allergy.

Predisposing Factors

Following factors predispose the tissues to allergy.

Heredity

Approximately 50 percent patients give history of allergy in the family. If one parent has allergy, there are 29 percent chances of allergy; while if both parents have allergy, then there are 47 percent chances of allergy.

Infection

Infection may also predispose to allergy due to the direct effect of bacteria and their products on the tissues.

Endocrine Factors

Menstruation, menopause and ovarian dysfunction tend to increase allergic reaction. Pregnancy reduces asthma, but increases allergy. In diabetes, allergy is not seen. Castration reduces allergy. Hypothyroidism also affects allergy.

Nutritional Factors

Deficiency of calcium, vitamins C and D increases capillary permeability and edema.

pH

Alkalosis promotes allergic reaction.

Trauma

Trauma may also aggravate allergy.

Meterological and Seasonal Conditions

Changes in temperature, humidity, sunshine, movements of air and barometric pressure affects the intensity of allergic reaction.

Geographical Factors

Damp and stagnant atmosphere, especially with plenty of vegetation around is not good for allergic patients (**Figure 21.1B**).

Psychological Factors

Psychological factors also play an important role in allergy as an exciting factor.

Types of Nasal Allergy

Seasonal Allergic Rhinitis (Hay Fever)

Hay fever is season specific because of prevalence of pollens of grasses, flowers, trees or shrubs. It starts in March to May or August to September. It may affect the nasal, pharyngeal or bronchial mucous membrane.

Perennial Allergic Rhinitis

Perennial allergic rhinitis is due to exogenous allergens such as inhalants, i.e. house dust, mattress, furniture, soaps, creams, perfumes, odors of fish, egg and coffee. House dust contains feces of mites—*Dermatophagoides pteronyssinus*. Various contactants are nasal drops, sprays and perfumes. Bacterial allergens are *Staphylococcus*, Pneumococci and *Streptococcus*, etc. Drugs causing allergy include aspirin, iodides, quinine and sulfate. This type of allergic rhinitis is present throughout the year.

Clinical Features of Nasal Allergy

Symptoms

- Irritation and itching of eyes and palate
- Sneezing, 10 to 15 at a time
- Nasal obstruction
- Rhinorrhea
- Increased lacrimation
- Decreased or loss of sense of smell and (**Figure 21.1C**).

Signs

- Chronic cough
- Impairment of hearing
- Congestion and edema of mucous membrane
- Color of mucous membrane over turbinates may vary from pale to bluish or dull red
- Mucous membrane becomes very sensitive and on touching may initiate sneezing and rhinorrhea.
- Conjunctival congestion (**Figure 21.2**)
- Transverse crease on the nose due to upward rubbing of

Figure 21.1B Geographical location (for allergic rhinitis)

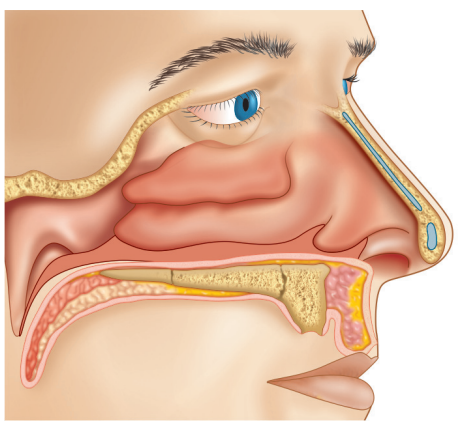


Figure 21.1C Typical features of allergic rhinitis

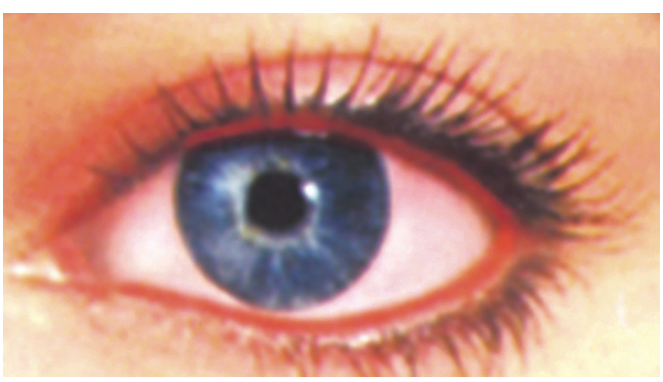


Figure 21.2 Allergic conjunctivitis

nose
- Allergic salute
- Allergic shiners, i.e. dark circles under the eyes
- Retracted tympanic membrane due to eustachian tube dysfunction.

Investigations

- Blood for total leukocyte count (TLC) or differential leukocyte count (DLC)
- Nasal smear for eosinophils
- X-ray paranasal sinus (PNS)
- Special tests for allergy
  - Diagnostic nasal endoscopy
  - Saccharin test to test nasociliary function of nasal mucosa (normal duration is 30 minute).

Nasal Provocation Test

1. Application of allergens to skin, nasal mucous membrane, bronchial mucous membrane or conjunctiva by simple application or scratch test (prick test).
2. Intracutaneous or intramucosal injection, scratch or prick test are more specific and safer for inhalants, but intradermal method is 100 times more sensitive than prick test.

Elimination of Allergies

Such as foods likely to cause allergy or allergen free chambers may be used to see the effect.

Leukopenic Index

A drop of 2,000 in white blood cell (WBC)/ml after ingestion of allergens indicates hypersensitivity.

Radioallergosorbent Test

Radioallergosorbent test (RAST) measures IgE level. It uses an enzyme instead of isotope to label anti-IgG, which is measured in spectrometery.

Antigen (radioactive) + patients serum (contains IgE) → radioactive IgE complex measured.

Paper Radioimmunosorbent Test

Paper radioimmunosorbent test (PRIST) is based on incubating IgE containing serum with radioactive labeled anti IgE and total concentration of IgE will be proportional to measured radIoactivity.

Treatment

Treatment can be discussed under the following subheads.

Avoiding the Possibly known Factor of Allergy

If the patient can find out the causative agent and avoids the contact, which may be any food article, any pet or other agent. It might need a change of job or place.

Use of nasal filters or dust masks may help to some extent.

Role of Drugs

1. **Antihistamines:** They have been the mainstay of treatment.
   - Highly sedative antihistamines are promethazine, diphenhydramine
   - Moderately sedative are chlorpheniramine, triprolidine
   - Mild sedatives are pheniramine, meclozine, cyproheptadine
   - Various second generation newer molecules, such as cetirizine, levocetrizine and fexofenadine, ebastine, etc. are being used. Advantage of these drugs is single dose convenience and no sedation.
2. **Sympathomimetic drugs:** Such as pseudoephedrine and phenylpropanolamine when used in combination with antiallergics helps in reducing nasal congestion and edema. Their topical use in the form of drops, such as oxymetazoline and xylometazoline, is good for a short time, but long-term use may lead to rhinitis medicamentosa.
3. **Role of steroids:** These can be used in the form of oral tablets for a short duration, especially if the symptoms are acute.
4. Recently, **topical nasal sprays**, such as beclomethasone, fluticasone or metaspray (mometasone), have been used with effective control of symptoms. But their continuous use may lead to fungal growth, dryness and bleeding from nose.
5. **Submucosal corticosteroids and steroid depot therapy:** In the form of methylprednisolone deep IM, they may be useful in seasonal allergy.
6. **Sodium chromoglycate nasal spray:** It is used to stabilise the mast cells and prevents their degranulation despite the formation of antigen-antibody complex.

Role of Hyposensitization or Immunotherapy

Specific hyposensitization is done when other types of treatment are not effective. Usually, subcutaneous route is used to give gradually increasing doses of known allergen (0–1 mL of 1/10th concentration). Serum antibodies take up the allergen; hence, it does not reach the shock tissue. Immunotherapy suppresses the formation of IgE and raises the titre of IgG antibodies and it has to be given for a sufficiently long time, say for a year or so, before some clinical improvement can be expected.

Role of Surgery

Surgery has no role in allergic rhinitis, as removal of the turbinate may change the target organ to some other area. However, if there is deviated nasal septum (DNS), which calls for septoplasty or removal of polyp may be done to improve the airway.

NON-ALLERGIC RHINITIS

It includes:

1. Vasomotor rhinitis.
2. Rhinitis medicamentosa.
3. Endocrinal rhinitis:
   - Seen in thyroid dysfunction
   - Pregnancy
   - Honeymoon rhinitis.
4. Drug-induced rhinitis such as contraceptive pills, antihypertensives and neostigmine.

Vasomotor Rhinitis (Intrinsic Rhinitis)

Definition

Vasomotor rhinitis occurs more in emotionally unstable persons, especially in women of 20 to 40 years. It is because of over activity of para sympathetics due to imbalance of autonomic nervous system (ANS) which is under the effects of hypothalamus.

Factors, which Disturb Vasomotor Balance

Various factors, which disturb vasomotor balance are as follows:

Psychogenic factors: Anxiety, tension, anger, hostility, humiliation, resentment or pleasurable excitement have close relationship with nasal vasomotor instability.

Endocrine factors: Imbalance does occur due to imbalance of circulating hormones causing symptoms of engorgement of nasal mucosa.

Physical agents: Such as drought of cold air, irritating smokes and extremes of temperature and humidity affect the ANS.

Drugs: Many drugs, such as hypotensive drugs, etc. disturb the vasomotor parasympathetic system.

Pathology

Nasal mucosa shows evidence of edema, vascular dilatation, round cell infiltration and increased glandular activity.

Clinical Features

1. Nasal obstruction and rhinorrhea are more pronounced than sneezing.
2. Conjunctival symptoms not present.
3. Other symptoms, such as postnasal drip, headache, fatigue and migraine, may be seen.

On examination

- Enlargement or hypertrophy of turbinates
- Mucosa of turbinate may give mulberry-like appearance and is pale to dusky red in color.

Treatment

Conservative treatment

- Physical exercise, cool baths and avoiding those factors, which initiate the symptoms
- Tranquilizers such as alprazolam may also help
- Phenylpropanolamine 25 to 50 mg/day alone or in combination with antihistamines.

Surgical treatment

- Cauterisation of turbinates helps in reduction of size
- Submucosal diathermy of the turbinates
- Cryosurgery is also helpful
- Zinc ionization: 2 percent $ZnSO_4$ solution is instilled and a current of 4 milliamp is passed for 15 minutes
- Surgical resection of inferior turbinates helps to reduce nasal obstruction. Differential diagnosis of allergic rhinitis and vasomotor rhinitis (**Table 21.1**)
- Vidian neurectomy

Advocated by Malcomson (1959): It is done in cases of intractable rhinorrhea. It may be done by transnasal, transantral or transpalatal approach.

Complications of vidian neurectomy may be hemorrhage, anesthesia of palate, impairment of lacrimation, infraorbital neuralgia, sinusitis or recurrence of symptoms.

Table 21.1: Differential diagnosis

Allergic rhinitis	*Vasomotor rhinitis*
• History of allergy to inhalants, ingestants, etc. is always present	• Usually no such history to foreign agents is present
• Usually no aggravation of symptoms due to emotional or stress factors	• Usually it is present
• Main symptoms are sneezing and rhinorrhea	• Main symptoms are no obstruction and rhinorrhea
• Conjunctival symptoms may be present	• Eye symptoms absent
• Skin tests are positive	• Skin tests are negative
• Nasal smear shows eosinophils	• No eosinophils
• Antihistamines and vaso-constrictors are helpful	• No role of these drugs
• Vidian neurectomy has no role to play in allergic rhinitis	• Vidian neurectomy may be very helpful

Rhinitis Medicamentosa

In this condition, the patient usually has symptoms of marked nasal obstruction due to excessive and continuous use of nasal decongestants and nasal drops and a stage comes when these drops do not have any vasoconstrictor effect on the nasal mucosa.

1. Strict withdrawal of nasal decongestants.
2. Use of topical steroids or systemic steroids.
3. Partial or complete resection of inferior turbinate if markedly hypertrophied

Other Forms of Rhinitis

These may be:

- Rhinitis of pregnancy
- Drug induced rhinitis
- Honeymoon rhinitis
- Endocrinal disorder rhinitis as seen in hypothyroidism
- Gustatory rhinitis as after a spicy food.

Key Points

1. **Antigen or allergen** is a protein with a size of 2 to 50 μm in diameter and molecular weight of 1,000 to 40,000 daltons.
2. **Antibody is Y-shaped structure,** which is attached with crystalline fragment to the cell and other two arms are called FAB ends or antigen-binding fragment.
3. Enzyme-linked immunosorbent assay tent **(ELISA)** is more specific.
4. Various types of **immunoglobulins** are IgG, A, M, E and D and are the products of B lymphocytes, which help in antibodies formation.
5. **Cells of specific immune system** are B-lymphocytes concerned with humoral immunity and T-lymphocytes helping in cell-mediated immunity.
6. Beneficial immunological response of immune system is called immunity and harmful response is called hypersensitivity.
7. **Rhinolalia clausa** is not seen in allergic rhinitis.
8. **Rhinolalia clausa (Hyponasality) means** lack of nasal resonance for words, which are resonated in nasal chambers such as m, n ng. It is due to blockage of nose or adjoining nasopharynx.
9. **Rhinolalia aperta** (Hypernasality) when words not requiring nasal resonance are resonated through the nose due to failure of cutting of oropharynx from nasopharynx.

Chapter 22 Nasal Polypi

What Students Must Know!

- **Ethmoidal Polypi**
  - Etiology /Pathology
  - Clinical Features
  - Investigations
  - Management
- **Antrochoanal Polypi**
  - Etiology
  - Clinical Features
  - Differential Diagnosis
  - Treatment

POLYPUS

- Polyp is Latin word meaning polypus, i.e. many footed
- The polypus is a projection of hypertrophied edematous mucous membrane
- It consists of loose fibroedematous tissue covered with columnar ciliated epithelium.

Types

They may be classified as:

1. Simple polypi
   - Ethmoidal polypi
   - Antrochoanal polypi.
2. Fungal polypi.
3. Malignant polypi.

ETHMOIDAL POLYPI

- These polypi mostly arise from ethmoidal labyrinth of cells or also from mucosa of middle turbinate and middle meatus, uncinate process, bulla ethmoidalis and ostia of sinuses.
- After their origin, these appear in the nasal cavity through the ostia as protrusions into the middle meatus.
- Polypi are seen in adults (more so in males).
- Are usually multiple, bilateral and enlarge by gravity or due to increase in their fluid content (**Figures 22.1 and 22.2**).

Etiology

- It is due to complex anatomy of ethmoidal labyrinth along with poor blood supply and adverse mucosal reactions at the cellular level

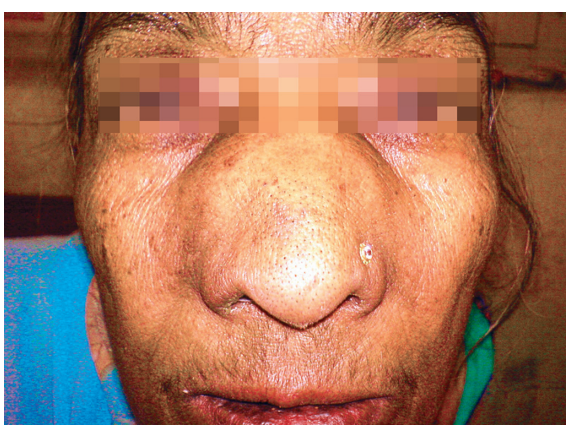


Figure 22.1A Frog face deformity in extensive nasal polypi

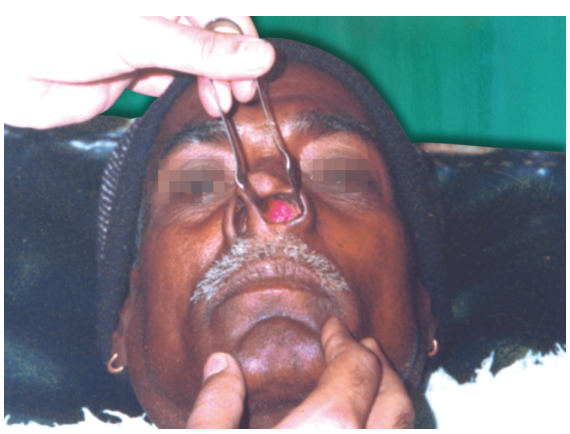


Figure 22.1B Nasal polyp (left side)

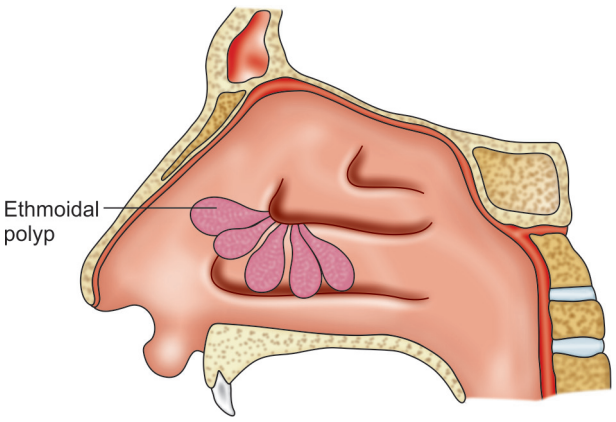


Figure 22.2 Origin of multiple ethmoidal polypi

- Allergy has been thought to be a major factor causing edema of the mucosa leading to poor ventilation and drainage of secretions. Bacterial allergy due to chronic nasal sepsis may also contribute to the formation of nasal polypi.
- Bernoulli's phenomenon also plays a major part, which states that gases or fluids passing through a constriction result in an area of negative pressure in its vicinity leading to sucking of ethmoidal mucosa in the nasal cavity. The condition do occur in cases of deviated nasal septum (DNS).
- Polypi may be seen in mucoviscidosis or cystic fibrosis or any condition resulting in the derangement of nasal mucous membrane.
- In multiple nasal polypi in a child, mucoviscidosis is always suspected unless proved otherwise.
- Other conditions associated with nasal polypi are
  - Samter triad → Asthma, aspirin sensitivity and polypi
  - Kartagener syndrome—sinusitis, bronchiectasis, situs inversus and ciliary dyskinesia
  - Young's syndrome, nasal polypi, bronchiectasis, sinusitis and azoospermia
  - Allergic fungal sinusitis which when long standing may become polypoidal mass and when examined under microscope fungal nature is confirmed. After complete removal of mass antifungal treatment may need to be added in some cases.
  - NARE syndrome—nonallergic rhinitis with eosinophilia
  - Churg Strauss syndrome (CSS)–there is asthma, eosinophilia, fever and vasculitis.

Pathology

Macroscopically polypi consist of smooth masses, translucent, white, opaque or yellowish to pink in color on naked eye examination.

Microscopically, polypi are simple edematous hypertrophied mucous membrane covered by columnar ciliated epithelium. There are plenty of dilated glands, large spaces filled with fluid; with lymphocytes, plasma cells and eosinophils. Immunoglobulin E (IgE) and IgA levels are higher in polypi fluid.

Clinical Features

Symptoms

- Nasal obstruction (unilateral or bilateral)
- Anosmia and loss of taste
- Rhinorrhea may be watery or mucopurulent
- Frontal headache
- Broadening of nose causing frog face deformity.

On Examination (Signs)

In extensive long standing case of ethmoidal polypi, there occurs expansion of nose giving it an appearance of frog face deformity (**Figure 22.1**). Frog face deformity may be seen in advanced cases of ethmoidal polyposis, malignancy of nose and paranasal sinuses (PNS) and Down's syndrome.

Anterior rhinoscopy shows smooth, glossy, multiple, mobile, bluish gray masses like a bunch of grapes. On probing, a polypus is soft, insensitive and movable, not fragile, does not bleed on touch and is nontender.

Posterior rhinoscopy unlike antrochoanal polyp may or may not show any mass since most of the polypi come anteriorly.

Investigations

1. Blood for hemoglobin (Hb), total leukocyte count (TLC) differential leukocyte count (DLC), absolute eosinophile count (AEC), bleeding time (BT) and clotting time (CT).
2. Complete urine examination.
3. Nasal smear for eosinophils.
4. Culture and sensitivity of nasal discharge.
5. Radiological examination:
   - X-ray PNS (Water's view).
   - Computed tomograhy (CT) scan PNS, particularly osteomeatal complex both coronal and axial sections.
6. Histopathological examination should be done in all cases of polypi especially in elderly patients.

Differential Diagnosis

1. Antrochoanal polypi.
2. Squamous or transitional cell papilloma.
3. Meningocele/meningoencephalocele.
4. Enlarged turbinates.
5. Malignancy of nose/PNS.

6. Nasopharyngeal fibroma.
7. Granulomatous masses.
8. Bleb of mucus plug.

Other Differential Diagnosis

Squamous Papilloma

Squamous papilloma usually arises from septum or lateral wall and excisional biopsy is confirmatory.

Meningoencephalocele

Usually, in meningoencephalocele (**Figure 22.3A**) the patient is an infant and the swelling is present since birth and it is fatal to treat it like a polyp. Cough impulse and transillumination test are useful in the diagnosis. Needle aspiration may be helpful to see cerebrospinal fluid (CSF), but CT scan confirms the defect in meninges. Neurosurgical treatment has to be undertaken.

Enlarged Turbinate

Usually, it is enormous hypertrophy of inferior turbinate. Probe test helps and use of vasoconstrictor drugs confirms the diagnosis.

Malignancy of Nose /PNS

The patient is usually above 45 years of age and there is presence of friable mass with bleeding and biopsy is confirmatory. This may look like a malignant polyp and needs to be treated like malignancy after confirming the diagnosis histopathologically.

Angiofibroma

The patient is a young boy in adolescence with massive recurrent nose bleed. Probing is not done as it may lead to bleeding. Biopsy is not undertaken, rather complete excision of mass is essential.

Granulomatous Masses

Which may be fungal; other granulomas or rhinoscleromas. Exclusion of malignancy gives suspicion of its being granulomatous.

Mucus Plug

Hard blowing or suction of mucus removes the doubt.

Treatment

It may be divided into:
- Medical treatment
- Surgical treatment.

Medical Treatment

1. **Antihistaminics** are given to control the allergy.
2. **Steroids** in the form of tablets or nasal sprays (fluticasone or mometasone nasal spray) may be very helpful if the polypi are small and these are also useful after the surgery to avoid recurrence of polypi. Steroids should be given with caution if the patient has hypertension, diabetes, peptic ulcer or tuberculosis.
3. **Immunotherapy** may help in allergic polyposis by decreasing recurrence.
4. Deep breathing exercises are very helpful by increasing the pulmonary reserve.
5. **Avoidance of known** factors of allergy helps in preventing early recurrence.

Surgical Treatment

1. **Polypectomy:** Initially it is the treatment of choice, which may be done under local or general anesthesia.
2. In case of recurrence.
3. **Ethmoidectomy:** It is the treatment of choice, which may be intranasal ethmoidectomy or external ethmoidectomy. The latter is a safe procedure, while intranasal ethmoidectomy may give rise to many orbital complications, since it is a blind procedure.
4. **Jansen Horgan's transantral ethmoidectomy:** It is done in case maxillary antra also needs to be cleared along with the ethmoids. Ethmoids are approached through medial wall of maxillary antra.
5. **Functional endoscopic sinus surgery (FESS):** It is the latest procedure for removal of small polypi under good illumination using 0° and 30° sinuscope, i.e. FESS. In this, involved ethmoidal labyrinth is cleared and proper ventilation and drainage is established giving excellent results (**Figures 22.3B and C**).
6. **Use of microdebrider** in polypectomy has revolutionized the treatment of polyp. It is a fast method with less bleeding and minimal morbidity (**Figure 22.3D**).

ANTROCHOANAL POLYPI

- Also called Killian's polyp
- It arises from mucous membrane of the floor and medial wall of maxillary sinus close to the accessory ostium, comes out of it and starts growing towards the choana and nasal cavity

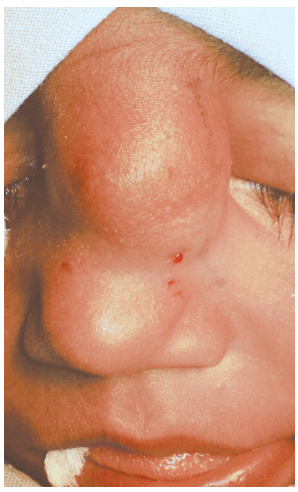


Figure 22.3A Meningoencephalocele

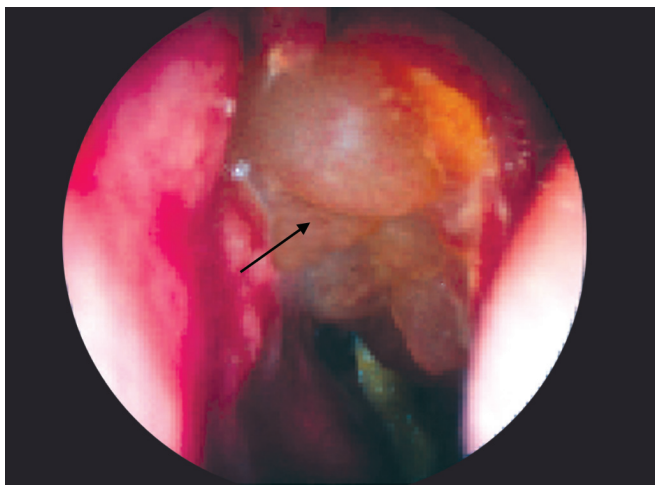


Figure 22.3C Endoscopic view of multiple polypi

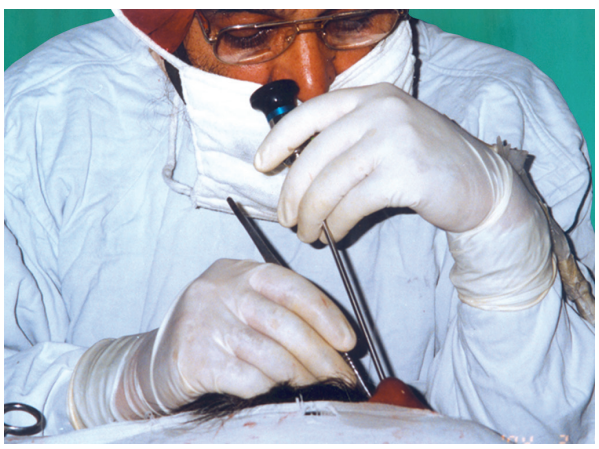


Figure 22.3B Functional endoscopic sinus surgery for nasal polypi

- It has three parts, i.e. antral, choanal and nasal parts
- It increases because of edema, fills up the choana and nasopharynx and then grows anteriorly to fill the nasal cavity
- Characteristically, the polypus is unilateral, single and commonly seen in adolescence (between 12-15 years of age) (**Figure 22.4A**).

Etiology

Chronic sinus infection is thought to be the cause of antro-choanal polypi or it may be both due to allergy and infection.

Clinical Features

- Nasal obstruction (unilateral)
- Mucoidal discharge
- Snoring
- Change of voice (hyponasality)
- Conductive deafness due to eustachian tube dysfunction.

On Examination

- Initially, anterior rhinoscopy may not show any mass; but once it becomes bilobed, it will be seen clearly
- Posterior rhinoscopy may show a smooth, greyish white, spherical mass in the choana and may be seen projecting below the soft palate (**Figures 22.4B and C**)
- Radiography will show an opaque maxillary antrum on the affected side, while lateral projection will show a polypoidal swelling in nasopharynx with a column of air behind the mass
- Investigations and differential diagnosis have already been discussed.

Treatment

1. **Polypectomy** by nasal or oral route is the treatment of choice for all age groups
2. Caldwell-Luc (CWL) operation is required, if there is a recurrence and the age of patient is more than 17 years. In this operation maxillary antrum is approached through sublabial approach, the diseased mucosa along with the

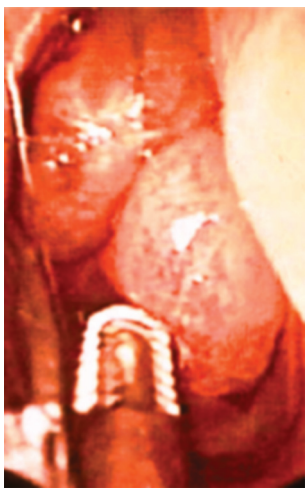


Figure 22.3D Use of debrider in polypectomy

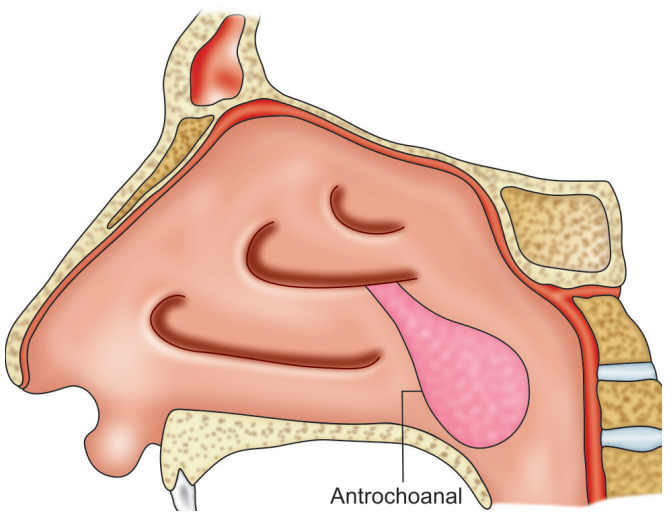
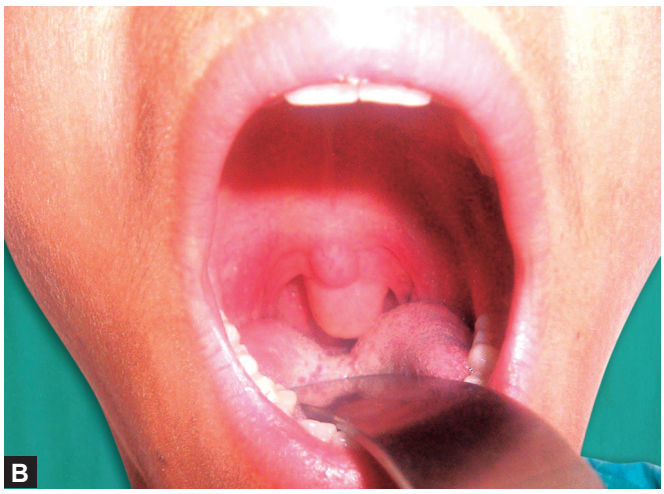
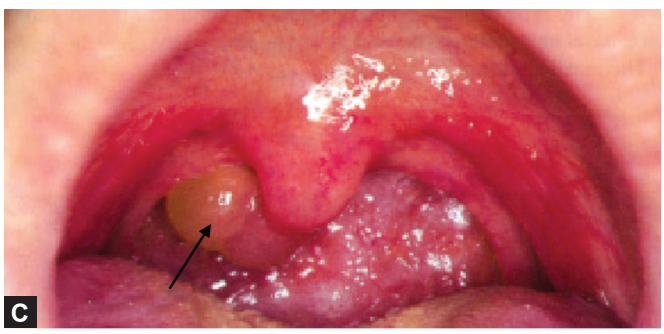


Figure 22.4A Antrochoanal polyp

polyp is removed and inferior meatal antrostomy is made for subsequent cleaning and drainage.





Figures 22.4B and C Polyp in the postnasal space

3. **FESS** is now a days the best form of treatment, which is more of a conservative approach as compared to CWL operation.

   In this using 0°/30° endoscopes, maxillary antra is entered through natural ostia, which is widened also and the disease is removed. It is more of a physiological operation with minimal postoperative complications and morbidity.
4. **Polypectomy using microdebrider** is another addition in the treatment of nasal polypi.

Comparison between ethmoid polypi and antrochonal polypi in given in the **Table 22.1**.

Table 22.1: Comparison between ethmoidal polypi and antrochoanal polypi

Ethmoidal polypi	*Antrochoanal polypi*
• It is seen in adults	• Seen in children and adolescents
• Usual cause is allergy	• Cause is infection
• Multiple like a bunch of grapes	• Single mass and trilobed
• Bilateral mostly	• Unilateral
• Arises from ethmoidal labyrinth	• Origin from mucous membrane of maxillary sinus
• Seen first on anterior rhinoscopy	• Seen first on posterior rhinoscopy
• Recurrence is common	• Recurrence uncommon if removed completely
• X-ray PNS shows hazy ethmoids and may be normal maxillary sinus; CT scan is very useful	• X-ray PNS shows opaque maxillary antra on that side CT scan is quite helpful
• Treatment is polypectomy, ethmoidectomy and FESS in cases of recurrence	• It is polypectomy and if there is recurrence. Caldwell Luc's operation or FESS is done

1. **Ethmoidal polypi** are multiple, bilateral, seen in adults and are due to allergy, while antrochoanal polypi are usually single, unilateral, seen in children and are due to sinus infection.
2. **Bernoulli's effect** states that gases or fluids passing through a narrow constriction result in a negative pressure in the vicinity causing prolapse of mucous membrane.
3. **Meningoencephalocele and gliomas** should be kept in mind in infants and small children.
4. **Polypectomy and FESS** is the treatment of choice for both types of polypi, but specific treatment for ethmoidal polypi is ethmoidectomy; and for antrochoanal polypi it is Caldwell-Luc (CWL) operation.
5. All polypi should be subjected to **histopathology** to see the nature of mass.
6. **Potential complications** of nasal polypi includes anosmia, cranial neuropathies, osteitis and proptosis.
7. **Immunotherapy** in nasal polyposis helps to decrease the chances of recurrence.
8. Nasal polypi under 2 years of age a suspicion of **meningocele or** encephalocoele must be kept in mind.
9. **Associated with Killian** are Killian's polyp, Killian's dehiscence, Killian's speculum and Killian's incision.

Chapter 23 Epistaxis

What Students Must Know!

- **Introduction to Nosebleed**
- **Causes of Epistaxis**
  - Local Causes
  - Systemic Causes of Nosebleed
  - Infections
  - Idiopathic Causes
  - Neoplastic Conditions
  - Workup of the Patient
- **Management of Nosebleed**
  - Aims of Treatment
  - Treatment in Hospital
  - Complications of Nosebleed

INTRODUCTION

- Epistaxis is also called nosebleed. It is not a disease, but a symptom, which results from local or systemic diseases of the body.
- It is one of the very commonly seen emergency in ENT practice varying from minor to a major episode, which can be life-threatening.
- It is commonly seen in children, young adults and old people. Its prevalence varies between 10 and 12 percent.
- Little's area was described by James Little in 1879 and the bleeding, which occurs is arterial. Kiesselbach described this plexus a year later. Woodruff's plexus is a venous plexus in the lateral wall of inferior meatus posteriorly, in front of eustachian tube opening.
- External and internal carotid system supply to the Little's area (**Figures 23.1 and 23.2**). External carotid contributes 80 percent and internal carotid 20 percent.
  - Posterior ethmoidal and anterior ethmoidal arteries are the branches of ophthalmic artery (branch of internal carotid system) and enter the nose through cribriform plate. Only anterior ethmoidal artery, a branch of internal carotid artery joins Little's area.
  - External carotid system supplies the nose through facial and internal maxillary artery. Sphenopalatine artery is a branch of third part or a terminal branch of internal maxillary artery and is called artery of epistaxis due to its major contribution.It enters the nose through sphenopalatine foramen from pterygopalatine fossa.
  - Middle turbinate is considered as a dividing line between external and internal carotid system.
  - Retrocolumellar vein lies behind columella crosses the floor to join venous plexus on lateral wall of nose and may be a source of bleeding in young people.
- Epistaxis may result from weakness, rupture or disease of vessel wall. It occurs more in winter due to low humidity, temperature variation leading to dryness with increased chances of bleeding.

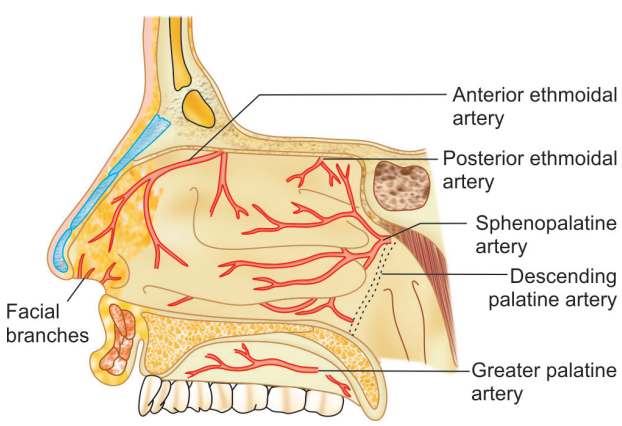


Figure 23.1 Blood supply of lateral wall of nose

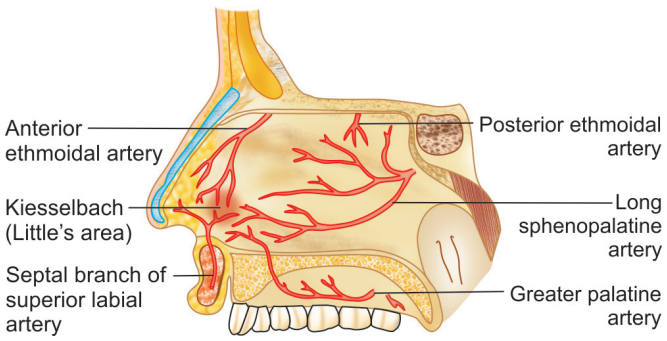


Figure 23.2 Blood supply of nasal septum

CAUSES OF EPISTAXIS

Local Causes

- Idiopathic—55 percent
- Not determined—30 percent
- Identifiable—10 to 15 percent

Traumatic

- Physical trauma such as blows or accidents or nose picking
- Operative trauma
- Chemical or thermal trauma
- Barotrauma.

Infections

Acute
- Influenza
- Acute rhinitis
- Typhoid
- Measles
- Diphtheria.

Chronic
- Chronic rhinitis
- Sinusitis
- Adenoiditis
- Atrophic rhinitis
- Rhinosporidiosis
- Tuberculosis, syphilis.

Neoplastic Conditions

Neoplastic conditions of nose, paranasal sinus (PNS) and nasopharynx.

Benign
- Angioma
- Papilloma
- Angiofibroma.

Malignant
- Carcinoma of nose, PNS and nasopharynx
- Sarcomas.

Septal Conditions

- Marked deviated nasal septum (DNS)
- Spurs
- Septal perforations.

Systemic Causes

Blood Disorders

- Severe anemia
- Aplastic anemia
- Leukemia
- Purpura
- Hemophilia
- Thrombocytopenia
- Arteriosclerosis (hypertension).

Congenital Causes

- Hereditary hemorrhagic telangiectasia also called Osler-Weber-Rendu disease. In this disease, there are congenital vascular anomalies on the mucosal surface, especially of nose, lips and tongue. Vessels lack the elastic and muscular tissue and due to lack of contractile tissue, bleeding does not stop spontaneously.

Treatment
- Estrogen therapy is useful
- Saunder's dermoplasty is also done.

Systemic Disorders

- Congestive heart failure (CHF)
- Hypertension
- Jaundice/cyanosis
- Uremia
- Toxemia.

Drugs

- Aspirin
- Phenylbutazone
- Quinine
- Anticoagulants
- Tetracyclines, chloramphenicol, ampicillin
- Immunosuppressants

Endocrine Disorders

- Diabetes
- Pregnancy
- Vicarious menstruation
- Hypothyroidism.

Idiopathic Causes

In 10 percent cases causes of nosebleed may not be seen.

Pseudoepistaxis

The pseudoepistaxis is seen in:
- Pulmonary hemoptysis
- Bleeding esophageal varices
- Hematemesis
- Bleeding from lumens of nasopharynx and trachea.

Nosebleed

1. Spontaneous epistaxis:
- Common in children and young adults
- It arises from Little's area
- It may be precipitated by infection or minor trauma
- It is easy to stop and tends to recur.

2. Hypertensive epistaxis:
- Hypertensive epistaxis affects an older age group
- It arises far back or high up in the nose
- It is often difficult to stop, and it may recur.

WORKUP OF THE PATIENT

Once the patient is stable, especially a full head and neck examination including nose, nasopharynx and PNS is essential.

Investigations

1. *Hematological investigations:*
   - Hemoglobin (Hb), total leukocyte count (TLC), differential leukocyte count (DLC), bleeding time (BT), clotting time (CT), and PBF.
   - Prothrombin time.
   - Thromboplastin generation test.
2. *Biochemical:*
   - Blood sugar
   - Blood urea
   - Liver function tests.
3. *Complete urine examination*
4. *Radiological investigations:*
   - X-ray nose, PNS and nasopharynx
   - Computed tomography (CT) scan nose, PNS and nasopharynx.
5. *Other investigations:* Depend upon the possible cause.

MANAGEMENT OF NOSEBLEED

Aims of Treatment

1. To assess general condition of patient.
2. To control hemorrhage.
3. To treat underlying cause.

First Aid Measures

1. Pinching the nostril is a time-tested method of stopping nose bleeding.
2. Applying ice cold water to head or face or giving ice packs to dorsum of nose.
3. Trotter's method of making the patient sit with open mouth with a cork between the teeth to prevent swallowing, till the pressure decreases by bleeding, but this method has been abandoned.
4. If these measures fail, the patient should be removed to a hospital.

Treatment in Hospital

Role of Sedation

A dose of 50 to 100 mg of Pethidine injection to allay the fear and anxiety of the patient.

Anterior Nasal Packing

- If bleeding continues, nose should be packed with a ribbon gauze soaked in Neosporin antiseptic cream for 24 to 48 hours
- Merocel packs can be used as an alternative to ribbon gauze packing (although costly, but gives less discomfort to the patient) (**Figure 23.3**).

Posterior Nasal Packing

- If bleeding does not stop by anterior nasal packing indicating posterior bleeding, postnasal packing should be given.
- A sponge pad of gauze approximately of the size of palm with closed fingers over it is made and one silk thread is tied on one side and two ribbon gauze on the other side, which are brought out from the nasopharynx, posterior choanae and anterior nasal aperture with the help of rubber catheters (**Figure 23.4**).
- Sponge pad is adjusted in the posterior choanae and nasopharynx with the help of index finger and by pulling the two ribbon gauzes, which are then tied with each other over a small gauze piece.
- Anterior nasal packing is also inserted depending upon the bleeding.
- Alternatively, Foley's cathetar—size 14 or inflatable bag or a Simpson balloon can be inserted. Disadvantage of this is that it may cause alar and septal necrosis and is also expensive.

Complications of posterior nasal packing
- Uncomfortable
- Essential hospitalization
- Hypoventilation leading to sudden death
- Eustachian tube dysfunction and otitis media
- Toxic shock syndrome.

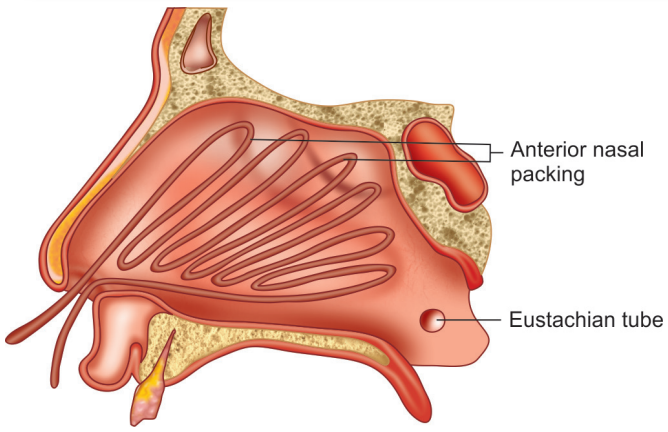


Figure 23.3 Anterior nasal packing in case of nose bleed

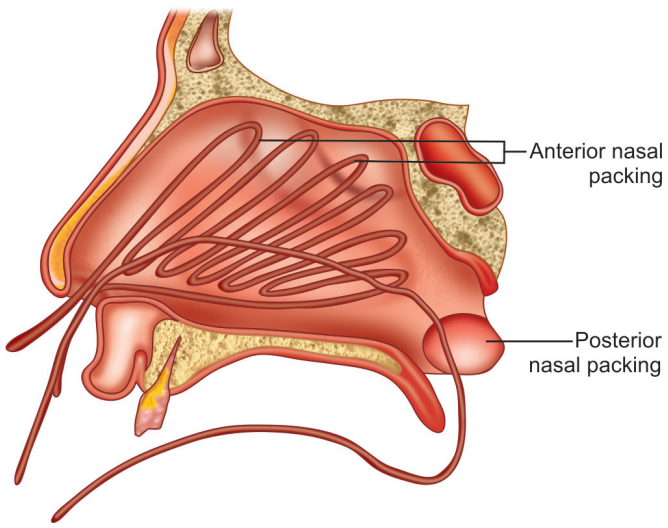


Figure 23.4 Posterior nasal packing along with anterior nasal packing

Supportive Measures Undertaken

- Vitamin C 500 mg two to three times a day
- Injection vitamin K and calcium
- Coagulants such as chromostat, ethamsylate in the form of injection or tablets
- Antibiotics to cover the infection
- Fresh blood transfusion in case of excessive blood loss.

Treatment of Underlying Cause

By taking a careful history and investigations, the underlying cause of nosebleed is treated. Hypertension, if present, must be treated likewise by antihypertensive drugs and tranquilizers.

Role of Cauterization

On removal of pack or before putting in of the packing, if the bleeding point is visible, it should be cauterized with silver nitrate stick or trichloroacetic acid or thermal cautery.

Cryosurgery and Embolization

Cryosurgery and embolization of feeding blood vessels have also been tried.

Material used for embolization

- Polyvinyl alcohol (PVA)
- Gelfoam particles
- Silicon spheres
- Tantalum powder.

Role of Ligation of Blood Vessel

Indications

- If patient continues to bleed in spite of all the measures having been undertaken
- Persistent hemorrhage when pack still in place
- Aged patient or the patient in poor health
- Since 90 percent supply comes through external carotid; usually, it is best to ligate third part of internal maxillary artery by transantral route as close to sphenopalatine foramen as possible or also anterior ethmoidal artery in the orbit by Howarth's incision, if bleeding still continues.
- Ligation of external carotid, after the origin of superior thyroid, although undertaken may or may not be effective.
- Endoscopic approach is used to cauterize sphenopalatine artery.

Important aspects in management of nosebleed

- Brief history and quick examination
- Nasal packing: Anterior and posterior nasal packing or nasopharyngeal balloon
- Cauterization of bleeding area
- Pterygopalatine fossa block
- Laser photocoagulation
- Pharmacologic treatment
- Arterial ligation
- Embolization

COMPLICATIONS OF NOSEBLEED

Death in 0.6 percent cases may be due to:

- Cerebral hemorrhages
- Aspiration
- Shock
- Septicemia
- Pneumonia
- Coronary thrombosis
- Intestinal infarction.

Key Points

1. **Kiesselbach's plexus** is formed by anterior ethmoidal branch of ophthalmic and septal branch of sphenopalatine, descending palatine and superior labial (branch of internal maxillary of external carotid).
2. **Woodruff's plexus** is a venous plexus in the lateral wall of inferior meatus posteriorly.
3. Five most important **causes of nosebleed** are trauma, hypertension, idiopathic, benign lesions and malignancy of nose and PNS.
4. **Complications of postnasal packing** may be eustachian tube dysfunction, aspiration, dysphagia, pain, hypoventilation, hypoxia and hypercapnia, arrhythmias and respiratory failure.
5. **Regarding location of blood vessel,** if bleeding is superior, anterior and posterior ethmoidal ligation is done; but if bleeding is inferior and posterior, ligation of internal maxillary artery is carried out.
6. **Anterior and posterior ethmoidal arteries are ligated** between inner canthus of eye and midline of nose. Internal maxillary artery is ligated by Caldwell-Luc approach through its posterior wall in pterygopalatine fossa.
7. **Septal turbinate** is an area of engorged mucosa on the septum that is why submucosal resection (SMR) sometimes helps to cure nosebleed.
8. Nasal endoscopy helps to identify and treat specific sites of bleeding especially posterior bleeding in the nose.
9. **Endoscopic ligation of sphenopalatine artery** below the posterior end of middle turbinate is another advantage.
10. Merocel when used as packing in nose bleed expands while jel foam (gelatin) shrinks.
11. **Anterior lacrimal crest ← 24 mm → anterior ethmoidal artery ← 12 mm → posterior ethmoidal ← 6 mm → optic nerve**
12. Third part of maxillary artery gives sphenopalatine artery besides greater and lesser palatine, infraorbital, artery of pterygoid canal and posterosuperior alveolar artery.

Chapter 24 Anatomy and Physiology of Paranasal Sinuses

What Students Must Know!

- **Development of Sinuses**
- **Anatomy of PNS**
  - Maxillary Sinus
  - Ethmoidal Sinus
- **Important Relations of Ethmoidal Sinus**
  - Frontal Sinus
  - Sphenoid Sinus
  - Functions of Paranasal Sinus

INTRODUCTION

1. Paranasal sinuses are a group of air containing spaces that surround the nasal cavity and directly open into the nasal cavity through their ostia (**Figure 24.1**).
2. Vesalius in 1543 described the anatomy of maxillary, frontal and sphenoid sinuses.
3. Clinically paranasal sinuses have been divided into two groups:
   - Anterior group consisting of maxillary, frontal and anterior ethmoids
   - Posterior group includes posterior ethmoids and sphenoid sinus.

DEVELOPMENT

Sinuses develop as small diverticula from the nasal cavity which invade the surrounding bones of the skull. Only the frontal sinus is absent at birth and most of the sinuses are fully developed by puberty.

- Maxillary and ethmoid sinuses are present at birth
- Sphenoid sinus is rudimentary at birth
- Frontal sinus is recognizable at 6 years of age.

Maxillary Sinus

Maxillary sinus appears as an ectodermal depression in the 4th month of intrauterine life (IUL) above the uncinate ridge on inferior turbinate from where it starts expanding laterally and further grows due to spaces vacated by erupting teeth and by 25 years, it is fully developed.

Ethmoidal Sinus

Small multiple ectodermal evaginations develop on lateral nasal wall in the 4th month of IUL and grow laterally into ethmoid bone.

Ethmoidal labyrinth is well pneumatized at birth and attains permanent size by puberty.

Frontal Sinus

Frontal sinus is absent at birth and becomes obvious at first year. It develops from frontal recess at the anterosuperior part

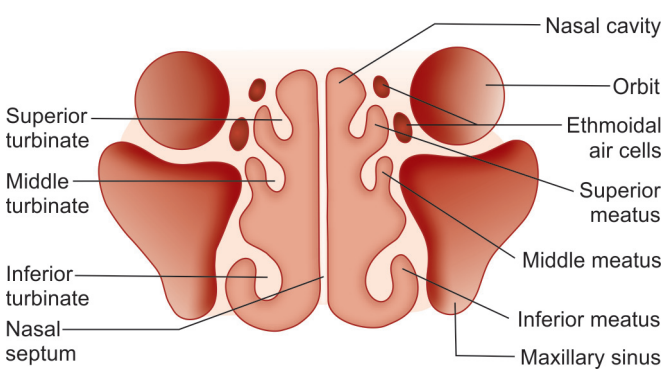


Figure 24.1 Coronal section of nasal cavity and paranasal sinuses showing the turbinates and meatii

of middle meatus from anterior ethmoidal cells, which then deepens gradually upwards to form frontal sinus.

Sphenoid Sinus

Sphenoid sinus appears as an ectodermal pit in postero-superior aspect of nasal capsule and develops by invagination of mucosa of sphenoethmoidal recess in 3rd month of IUL.

It is the first sinus to reach full size out of all paranasal sinuses and is well developed at the age of 8 years.

Clinical Application of Development

Clinical application of development is that children have more incidence of ethmoidal sinusitis, while adults have more of maxillary sinusitis.

MAXILLARY SINUSES

1. Maxillary sinuses is also called antrum of high more and is the largest sinus in the body of maxilla.
2. It is sometimes referred as conductor of the orchestra.
   - It is pyramidal in shape, its apex directed laterally into the zygomatic process of maxilla and base forming lateral wall of nose.
   - Dimensions are: height is 33 mm, width is 23 mm, anteroposteriorly is 34 mm
   - Capacity varies from 15 to 30 ml
   - Important relations of maxillary sinus

Roof

- Roof is formed by floor of orbit
- Traversed by infraorbital canal, which transmits infra-orbital nerve and the vessel.

Floor

- Floor lies 1.25 cm below the nasal floor
- It is formed by alveolar process of maxilla related to 1st premolar to third molar area.

Posterior Wall

- Thin plate of bone separating the cavity from pterygopalatine and infratemporal fossa
- Pterygopalatine fossa is a triangular space between maxilla, palatine and pterygoid process of sphenoid
- Fossa contains internal maxillary artery, vidian nerve and sphenopalatine ganglion.

Anterior Wall

- Anterior wall is formed by zygomatic process of maxilla and medially by canine ridge
- Infraorbital foramen is closely related to it.

Medial or Nasal Wall

- Medial or nasal wall is formed by nasal surface of maxilla below and in front
- Perpendicular plate of palatine bone posteriorly and uncinate process of ethmoid bone and descending part of lacrimal bone
- Maxillary sinus ostia is 3 to 4 mm in diameter and is situated high up in posterolateral wall and opens in the middle meatus through posterior part of ethmoidal infundibulum
- In 30 percent cases, accessory ostium is present which lies slightly posterior to the normal ostium.

Lining of Maxillary Sinus

- Pseudostratified columnar ciliated epithelium, which is quite thin and relatively less vascular with a few mucous glands

Blood Supply

- Supplied by branches of maxillary, facial, infraorbital and greater palatine arteries
- Veins drain into anterior facial vein and pterygoid venous plexus
- Lymphatics drain into submandibular lymph nodes.

Nerve Supply

It is by maxillary nerve through superior alveolar, anterior palatine and infraorbital nerve. Secretomotor fibers relay through pterygopalatine ganglion.

FRONTAL SINUSES

1. These are two in number and unequal size divided by a bony septum, which is seldom in the midline.
2. Measurements are: height is 3.16 cm, breadth is 2.58 cm and depth is 1.8 cm.
3. Shape of the sinus is like a pyramid and its capacity is 5 to 7 cc in adult.
4. The sinus lies behind supercilliary arches and lies in a triangular area formed by nasion, a point 3 cm above nasion and the medial third of the supraorbital margin.
5. It opens into anterior part of middle meatus either through ethmoidal infudibulum or through frontonasal duct.

Important Relations of Frontal Sinus

Anterior Wall

About 1 to 5 mm thick and strong, formed by outer table of frontal bone.

Posterior Wall

Posterior wall is thin and formed by inner table, which separates the sinus from anterior cranial fossa.

Floor

Floor separates the frontal sinus from orbital cavity and slopes downwards towards the opening of frontonasal duct into the frontal recess of middle meatus (**Figure 24.2**).

Superiorly, the sinus extends to a variable distance between the outer and inner tables of the skull.

Supraorbital artery, vein and nerve supply the sinus and lymphatic drainage is to the submandibular lymph nodes.

ETHMOIDAL SINUSES

1. The number varies from 8 to 18 and these lie within the lateral part of ethmoid bone situated between the nasal cavity and the orbit giving it a honeycomb appearance called ethmoidal labyrinth.
2. Each ethmoidal sinus has a pyramidal shape. Length is 4 to 5 cm, height is 2.5 to 3 cm, width is 1.5 cm decreasing anteriorly to 0.5 cm.
3. Ethmoidal sinuses are divided into two groups, i.e.
   - Anterior smaller group (but numerous air cells) consisting of agger nasi cells, bullar cells and frontal cells (1–8 in number), which open into upper part of hiatus semilunaris in the middle meatus
   - Bulla ethmoidale also called middle ethmoidal group of sinuses

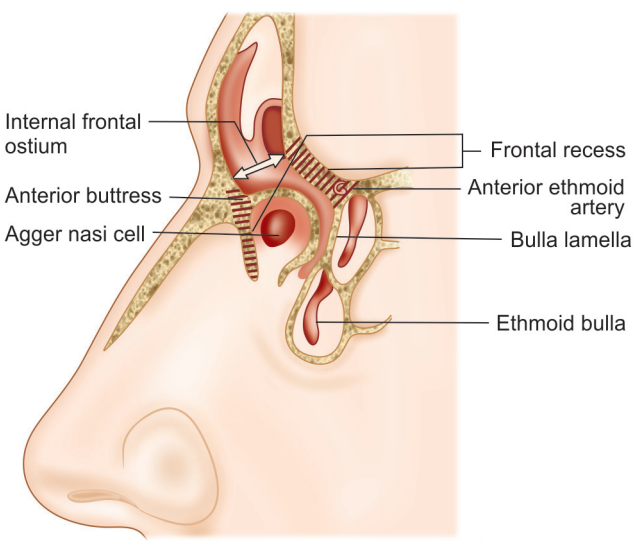


Figure 24.2 Funnel-shaped frontal recess

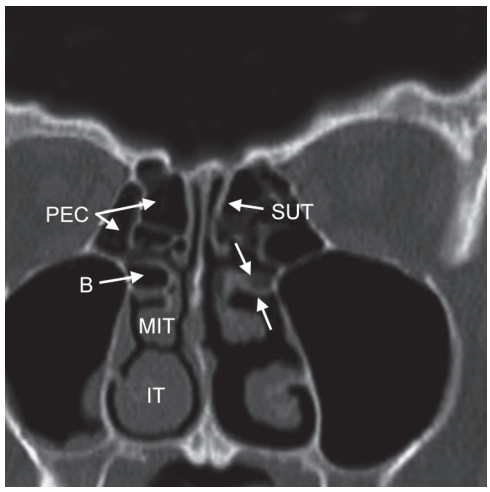


Figure 24.3 CT nose and PNS. Showing relations of various sinuses; PEC: Posterior ethmoidal cells; B: Bulla; IT: Inferior turbinate; SUT: Superior turbinate; MIT: Middle turbinate

- Anterior and posterior ethmoidal cells are separated by ground lamella
- Posterior group is larger (with a few cells). It opens into the superior meatus of nose
- Optic nerve lies in close proximity to these cells (Onodi cell).

Important Relations of Ethmoidal Sinus

Roof

- Superiorly closely related to cranial cavity and meninges
- Roof of ethmoidal labyrinth is formed medially by cribriform plate (fovea ethmoid) **(Figure 24.3)**
- Main part of roof is contributed by orbital plate of frontal bone with which ethmoid bone articulates.

Floor or Inferior Wall

It is formed anteriorly by orbital plate of maxilla and posteriorly by orbital process of palatine bone and is related to maxillary sinus.

Lateral or Orbital Wall

- It is formed by lamina papyracea, a papery-thin bone, which separates it from orbit
- Anteriorly, it is deficient and hence completed by lacrimal bone and posteriorly with lesser wing of sphenoid bone
- Lamina papyracea also articulates inferiorly with maxilla and superiorly with the frontal bone (this suture line is an important landmark as it indicates the roof of ethmoid sinuses in external ethmoidectomy).

Medial or Nasal Wall

- It is formed by middle and superior turbinate bones.
- Posteriorly separated from the sphenoid sinus by a thin bony septum.

Arterial Supply

Anterior and posterior ethmoidal branches of ophthalmic and sphenopalatine artery pass from the orbit along the roof into the nasal fossa and should be taken care of during ethmoidectomy. Venous drainage is to the corresponding veins.

Nerve Supply

It is by branches of maxillary nerve and ophthalmic nerve (nasociliary branch), which form the anterior and posterior ethmoidal nerves.

SPHENOID SINUSES

- These are contained in the body of sphenoid bone and are situated in the posterior part of nasal cavity
- Two right and left sinuses are rarely symmetrical which are separated by a thin septa
- These are rudimentary at birth but begin to grow after the third year
- Its capacity varies from 0.5 to 30 ml with an average of 7.5 ml
- Measurements are: height is 2 cm, breadth is 1.8 cm, and depth is 2 cm
- Ostium lies in the upper part of anterior wall and opens into sphenoethmoidal recess
- Bones of Bertin also called sphenoidal turbinates initially cover the anterior wall of sinus but after 10 years, fuse with it.

Various Types of Sphenoid Sinuses

They are sellar, presellar, mixed and conchal with sellar being the most common type.

Important Relations of Sphenoidal Sinus

Roof

- Posterior part is related with pituitary gland and optic chiasma
- Anterior part of roof is related to frontal lobe and olfactory tract.

Floor

Floor is related to roof of nasopharynx and vidian nerve.

Anteriorly

It is related to supraorbital fissure, III, IV and VII cranial nerves and ophthalmic division of V nerve.

Posteriorly

Thick wall separates it from pons and basilar artery.

Laterally

There is cavernous sinus, internal carotid artery, cranial nerves III, IV, VI and all division of trigeminal nerve.

Blood Supply

It is by the posterior ethmoid and sphenopalatine artery. Veins drain into veins of nasal cavity.

Nerve Supply

It is by branches of sphenopalatine ganglion.

Lymphatics

They go to retropharyngeal lymph nodes.

FUNCTIONS OF PARANASAL SINUS

Possible functions of paranasal sinus (PNS) are:

1. Air conditioning, i.e. warming and moistening.
2. Reduction of skull weight.
3. Increases the olfactory area (in animals).
4. Heat insulation.
5. Vocal resonance.
6. Provides mechanical rigidity to skull.
7. Pressure dampening.
8. Secretion of mucus to keep nasal chambers moist.
9. Absorption of shock to face and skull during injuries.
10. Regulation of intranasal pressure.

Key Points

1. Sinuses	Maxillary	Frontal	Ethmoidal	Sphenoid
Number	Two	Two	8-18	Two
Height	33 mm	31 mm	25–30 mm	20 mm
Width	23 mm	25 mm	40–50 mm	18 mm
Depth	34 mm	18 mm	15 mm	20 mm
Capacity	15 ml	5–7 ml	Variable	3–6.5 ml
Development	2–3 months of IUL At birth significant Radiologically significant at 4–5 months	4th month of IUL Radiologically significant at 6 year	3–4 months of IUL At birth significant (3–4 cells) Radiologically significant at 1 year	4th month of IUL At birth not significant Radiologically significant at 4 years
Roof	Floor of orbit	Two tables of frontal bone	Anterior cranial fossa lateral to cribriform plate to ethmoid	Related to pituitary gland, optic chiasma, olfactory tract and frontal lobe of brain
Floor	Alveolar process of maxilla	Superior orbital wall separating it from orbit	Orbital plate of maxilla and palatine bones	Roof of nasopharynx and vidian nerve
Anterior wall	Zygomatic process of maxilla and canine ridge	1–5 mm thick outer table of frontal bone	Lateral wall by lamina papyracea	Laterally related to cavernous sinus, optic nerve, internal carotid artery
Posterior wall	Thin bone separates it from PP and IT fossa	Thin base separates it from anteror cranial fossa	Posteriorly related to sphenoid sinus	Thick wall separates it from brainstem and basilar artery
Medial wall	Formed by maxilla, palatine,	Septum between the ethmoid and lacrimal bones	Formed by middle two sinuses between the two sinuses	Medially lies the septum and superior turbinates
Arterial supply	Infraorbital and greater palatine branches of maxillary and facial artery	Supraorbital and anterior ethmoidal	Anterior and posterior branches of sphenopalatine artery	Posterior ethmoidal and sphenoidal artery
Venous drainage	Anterior facial and pterygoid venous plexus	Supraorbital and superior ophthalmic vein	Anterior and posterior ethmoidal vein	Posterior ethmoidal and sphenoidal veins
Nerve supply	Inferior orbital and posterior alveolar nerves	Supraorbital and nasociliary nerves	Anterior and posterior ethmoidal nerves	Posterior ethmoidal nerve and branch of sphenopalatine ganglion
Lymphatics	Submandibular, retropharyngeal lymph nodes	Submandibular lymph nodes	Submandibular, retropharyngeal lymph nodes	Retropharyngeal lymph nodes

(IUL—Intrauterine life, PP—Pterygopalatine, IT—Infratemporal)

2. **Accessory ostia** of maximum sinus mostly found in posterior fontanels.
3. **Frontal sinus** are absent at birth and are significant radiologically at 6 years of age.
4. **Sphenoidal sinuses** are best seen in Water's view with mouth open or also on full axial view.
5. **Sphenoidal sinuses** are absent at birth and radiologically seen at 4 years.
6. **Radiologically maxillary sinus** can be identified at 4–5 months and ethmoids at 1 year of age.
7. **The foramina of Breschet** are venous drainage channels located in the posterior wall of the frontal sinus.
8. **Frankfurt's line** passes through infraorbital border and tragus.

Chapter 25 Acute Sinusitis

What Students Must Know!

- **Introduction**
- **Acute Sinusitis**
  - Etiology
  - Pathology
  - Bacteriology
- **Clinical Features**
- **Investigations**
  - Differential Diagnosis
- **Treatment**
  - Complications of Acute Sinusitis

INTRODUCTION

There are four pairs of sinuses, which develop as small diverticula from the nasal cavity, which invade the surrounding bones of the skull. Only the frontal sinus is absent at birth and most of the sinuses are fully developed by puberty.

ACUTE SINUSITIS

1. Acute sinusitis means acute infection or inflammation of the paranasal sinuses of less than 4 weeks duration.
2. It results once the normal defences of mucociliary blanket or lysozymes are breached by viruses and secondary invasion by bacteria takes place.
3. Pansinusitis is the term applied to inflammation of all the paranasal sinuses, whereas individual sinus involvement is named accordingly such as acute maxillary sinusitis, acute ethmoiditis, acute frontal sinusitis or acute sphenoiditis in order of occurrence.
4. The sinus is said to be closed if the contained inflammatory exudate cannot escape, because the viscosity of the exudate is high or because the sinus ostium is closed.
5. It is said to be open if ciliary action and overflow permit escape of the exudate from the sinus.

Etiology

Infections

- *Nasal infections:* Acute rhinitis associated with common cold spreads to the sinuses by way of their natural ostia, which open into the nasal cavity. Foreign bodies in the nose may also set up acute rhinitis and further lead to sinusitis.
  Pharyngeal infections such as tonsillitis and adenoiditis may cause sinusitis in children.
- *Tooth infections:* The 1st and 2nd molar teeth are separated from maxillary sinus by a thin bone and it may be absent in cases; therefore, chronic dental infections may spread either directly or through lymphatics. Periodontal abscess, which is an inflammation of the membrane, which surrounds the root of tooth and infection may spread either directly, by lymphatics or through bloodstream. Sometimes tooth extraction may lead to infection of maxillary sinus, especially if fracture of tooth occurs during extraction and it is forced into the antrum.

Swimming and Bathing

Swimming and bathing in infected ponds or pools, especially if jumping feet down. Even if water is uncontaminated, chemical rhinitis and sinusitis may be sufficient to cause bacterial sinusitis.

Trauma to the Sinuses

1. Compound fracture of the sinuses.
2. Contusion of the sinuses.
3. Foreign bodies.
4. Barotrauma of the sinuses (aerosinusitis) during flight, especially during the descent of aeroplanes (if the ostia are blocked).

Mechanical Obstruction

Mechanical obstruction to the ostia of sinuses such as by Marked deviated nasal septum (DNS) Concha bullosa, polyps, foreign bodies and hypertrophied turbinate.

General Diseases

Influenza, measles, whooping cough and pneumonia may lead to sinusitis.

Other Contributing Factors

1. Poor general environment.
2. Low resistance, especially in children with little immunity.
3. Undue exposure to crowded cities/people.
4. Anatomical obstructions such as DNS hypertrophied turbinates, enlarged bulla or enlarged adenoids. Infective and allergic conditions of the nose also lead to mucosal swellings causing obstruction of the natural ostia of the sinuses. Polyps and tumors also cause sinusitis.
5. Association with chest conditions, e.g. chronic bronchitis, asthma, bronchiectasis and cystic fibrosis. Kartagener syndrome includes dextrocardia, chronic sinusitis and bronchiectasis and is due to faulty cilia.

Bacteriology

Viruses

- Rhinovirus
- Parainfluenzae I and II
- Enteric cytopathogenic human orphan (ECHO) 28
- Coxsackie A21
- Respiratory syncitial virus.

Bacteria

- Pneumococci (29%)
- Streptococci
- Staphylococci (6.6%)
- *Haemophilus influenzae* (48%)
- *Escherichia coli*
- *Micrococcus catarrhalis*
- *Bacillus pfeiffer*
- *B. freidlander*

Specific Infections

Due to fungi, syphilis, tuberculosis and leprosy.

Pathology

Sinusitis passes through five stages:
1. Catarrhal stage
2. Exudative stage
3. Suppurative stage
4. Stage of complications
5. Stage of resolution.

Inflammatory changes include hyperemia with outpouring of serum and polymorphs associated with local swelling, redness and edema (due to obstruction of vein and lymphatics). If obstruction and edema persist for a long time, cell degeneration with cloudy swelling and necrotic changes will occur. Clinically, it may be:
- Catarrhal type
- Suppurative type.

Acute Catarrhal Type

It is the earliest change in which there is edema and mucus secretion with a few leukocytes, but no destruction of mucous membrane.

Acute Suppurative Type

There is severe inflammation with leukocytes and pus pouring out with necrosis of mucus membrane or it may become polypoidal.

Clinical Features

General Symptoms

Malaise, headache, fever (not very high), sore throat, facial pain and periorbital edema.

Local Symptoms

1. Feeling of discomfort in postnasal space.
2. Nasal obstruction.
3. Loss of vocal resonance (dead voice).
4. Loss of sense of smell.
5. Nasal or postnasal discharge or drip.
6. Cough
7. Pain in the sinuses.
   a. **Antral pain:** It is along the infraorbital margins and referred to upper teeth or gums on affected side.
   b. **Ethmoidal pain:** It is localized over bridge of nose and inner canthus of eye and is referred to parietal eminence.
   c. **Frontal sinus pain:** It is localized to forehead and pain is periodical in nature, i.e. starts an hour or two after getting up from bed and vanishes during afternoon.
   d. **Sphenoidal pain:** It gives rise to occipital or vertical headache and sometimes is referred to mastoid process. Pain may be felt behind the eyeball due to close proximity with Vth nerve.

Signs

1. Anterior group—maxillary, anterior ethmoidal and frontal.
2. Posterior group—posterior ethmoids and sphenoid.

3. Anterior group drains into middle meatus, while posterior group drains into superior meatus and sphenoethmoidal recess.

External signs

1. Flushing of cheek with swelling of cheek, which may spread to lower lid in maxillary sinusitis. Upper lid may be swollen in frontal sinusitis. Ethmoiditis may give rise to swelling at the inner canthus of same eye.
2. Tenderness over the affected sinus.
   a. Cheek: Maxillary sinusitis.
   b. Floor of sinus: Frontal sinusitis.
   c. Inner canthus: Ethmoids.

Anterior rhinoscopy and sinuscopy

Shows red, shiny and swollen mucous membrane near the ostium of the sinus, and trickle of pus may also be seen (**Figure 25.1**).

Investigations

1. Hematology—Total leukocyte count (TLC) and differential leukocyte count (DLC) are increased.
2. Culture sensitivity test.
3. Transillumination test.
   a. Maxillary sinus—absence of infraorbital crescent of light and pupillary glow absence indicate sinusitis.
   b. Frontal sinus transillumination is not very informative.
4. X-ray paranasal sinuses (PNS) to demonstrate fluid level, pus or opacity (**Figure 25.2**).
5. Computed tomography (CT) scan—coronal CT may show thickening of mucosa or opacification with occlusion of maxillary infundibulum.

Differential Diagnosis

1. Dental neuralgias, caries, apical infection or abscess.
2. Temporomandibular neuralgia (TN) (Costen syndrome) due to stress and strain of TM joint pain aggravated by movements of joint such as by opening and closing of mouth.
3. Trigeminal neuralgia—it is severe and paroxysmal.
4. Migraine—unilateral and frontal pain.
5. Temporal arteritis—pain over the course of temporal artery, which is palpable and tender to touch.
6. Nasopharyngeal tumors.
7. Brainstem lesions.
8. Herpetic or postherpetic neuralgia may simulate sinusitis.
9. Insect bite.
10. Neoplasm of the sinuses.

Treatment

Treatment can be discussed under three headings:

Prophylactic Treatment

1. Strengthen the first line of defence, i.e. mucous/ciliary blanket.
2. Sunshine, good ventilation, and proper humidity.
3. Good diet rich in vitamins.
4. Avoid flying and swimming with cold.
5. Use of vaccines (autogenous vaccines).

There is a difference in opinion regarding the use of vaccine in preventing URC.

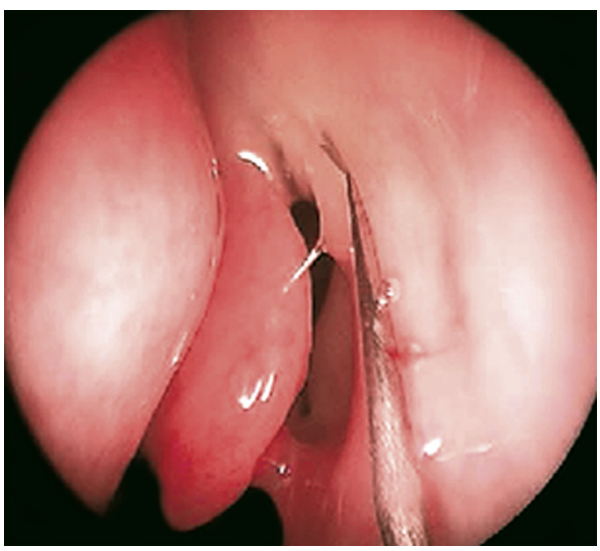


Figure 25.1 Endoscopic view of a case of acute maxillary sinusitis

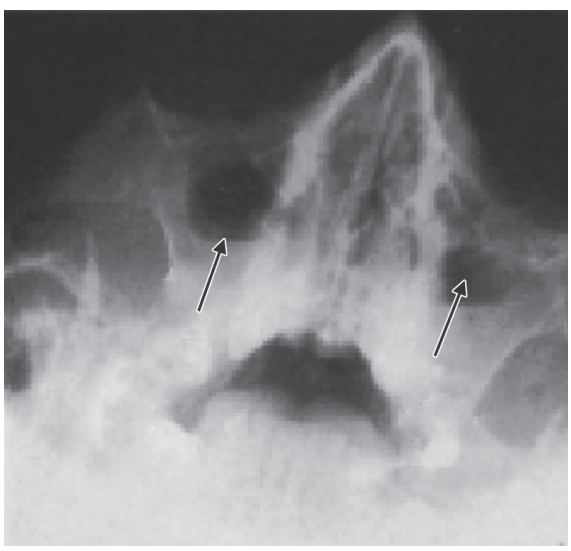


Figure 25.2 X-ray paranasal sinuses (PNS) showing air-fluid levels in both antra

Medical Treatment

Antibiotics Amoxicillin 500 mg three-times daily (TDS) or any other broad spectrum antibiotic (BSA) for 10 to 14 days and not one week to avoid recurrence. If there is no response in 3 to 5 days, change over to clarithromycin/azithromycin/cefixime.

- **Local decongestants:** Ephedrine in saline nasal drops or oxymetazoline/xylometazoline nasal drops followed by steam inhalation (which liquefies the thick viscid secretions).
- **Analgesics:** Aspirin and codeine preparation. Local application of heat by hot water bottle for about 10 minutes, three times a day is comforting, relieves pain and promotes drainage.

Surgical Treatment

It is usually not undertaken in acute sinusitis for fear of complications such as osteomyelitis. It is done only to a limited extent and that too under cover of antibiotics. If no response is seen after a sufficient trial of antibiotics have been given, a limited drainage operation may be undertaken for maxillary or frontal sinusitis. Limited surgery is also done in case of impending complications such as orbital cellulitis.

Complications of acute sinusitis

- Osteomyelitis of maxilla and frontal bone.
- Orbital cellulitis.
- Orbital abscess formation.
- Intracranial complications like cavernous sinus thrombosis, meningitis and intracranial abscess.
- Chronic sinusitis.
- Middle ear infection.
- Pharyngitis.
- Laryngitis/tracheobronchitis.
- Mucocele/pyocele.
- Oroantral fistula

1. **Ethmoidal sinuses** are well-developed at birth, hence infants and children below 3 years of age are more likely to have acute ethmoiditis; but above this age, maxillary antra infections are more commonly seen.
2. **Periodicity** is a characteristic feature of frontal sinus infections in which the pain increases gradually on waking up and becomes maximum by midday, starts diminishing by evening, hence also called office headache.
3. **Trephination** of frontal sinus is done if pain and pyrexia persist despite of medical treatment for 48 hours.
4. **Antral lavage** in acute maxillary sinusitis is done only, when medical treatment has failed and the patient has started showing signs of complications. This is done only under cover of antibiotics, otherwise osteomyelitis of the maxilla may setin.
5. **Dental infections** are important causes of maxillary sinusitis, because of relation of roots of molars and premolars with the floor of maxillary sinus.
6. **Maxillary sinusitis** causes evening headache.
7. **In children most common sinusitis is ethmoidal sinusitis.**

Chapter 26

Chronic Sinusitis and Its Complications

What Students Must Know!

- **Chronic Sinusitis**
- **Etiology**
  - Clinical Features
  - Conservative Treatment
  - Surgical Treatment
- **Fungal Sinusitis**
- **Complications of Chronic Sinusitis**
  - Methods of Spread of Infection
  - Orbital Complications
  - Cavernous Sinus Thrombosis

CHRONIC SINUSITIS

Introduction

- Chronic sinusitis is a chronic inflammation of mucous membrane of paranasal sinuses, which has resulted in irreversible degenerative changes.
- It usually follows acute sinusitis, which has not been treated adequately or it may also follow a cold or tooth infection.
- It occurs when the self cleansing mechanism of nose and paranasal sinuses gets impaired.
- Maxillary sinus is most commonly involved.
- Duration of symptoms is more than 3 months.

Etiology

Chronic sinusitis follows acute sinusitis, the causes of which have already been described, briefly, the causes are:

1. Infection of nose, pharynx and molar teeth.
2. Trauma to the sinuses and barotraumas.
3. Local factors such as deviated nasal septum (DNS), nasal polypi and allergy.
4. In addition, chest conditions, such as asthma, chronic bronchitis and chronic bronchiectasis (Kartagener syndrome), may be responsible for chronic sinusitis.

Factors Predisposing to Chronic Sinusitis

- Usual cause of failure of self-cleansing mechanism is viral infections
- Anatomical DNS
- Congenital (Kartagener's syndrome)
- Hypersensitivity
- Dental sepsis
- Poor resistance
- Alcohol
- Dusty environment
- Allergy—allergic subjects are more prone to secondary bacterial infections. Inflammatory products itself may act as allergens inducing further changes in the mucosa of nose and paranasal sinus (PNS)
- Fungi also may be responsible for chronic sinusitis
- Iatrogenic factors—nasal packing, nasogastric or naso-tracheal tubing.

Pathology

Chronic sinusitis according to histological changes in the sinus mucosa may be as follows.

1. **Hypertrophic (or polypoidal or catarrhal) sinusitis:** In this, the inflammation mainly affects the efferent vessels and lymphatics. If repeated attacks occur, the venous and lymphatic changes produce edema and polypoidal mucous membrane, polypi, edema of periosteum and rarefaction of bone.
2. **Atrophic (or sclerosing or suppurative) sinusitis:** The main change occurs in afferent vessels causing cellular reaction around the arterioles and arteries and later the vessel wall becomes thickened and narrowed resulting in endarteritis and thrombosis. In this condition, usually,

there is much less edema. Both these types, hypertrophic and atrophic may occur side by side in the same sinus producing atrophy at one place and polypoidal hypertrophy at a nearby place.

3. **Papillary or hypertrophic sinusitis:** Here, occurs metaplasia of ciliated columnar epithelium to stratified squamous type and throughout the papillary hyperplastic epithelial cells or stroma may be seen inflammatory cells. It is a viral infection.
4. **Follicular type:** In this condition, small follicles are seen in the mucous membrane of the sinuses.
5. **Glandular sinusitis:** In this, the glandular elements increase markedly in the submucosal tissue lining of sinuses.

Clinical Features

There are two types of chronic sinusitis.

Simple Chronic Infective Sinusitis

- In simple chronic infective sinusitis, vasomotor rhinitis and allergy are absent.
- It usually follows a single or repeated attacks of acute sinusitis.

Mixed Infective and Vasomotor Chronic Sinusitis

- The vasomotor factor is probably primary in most of these patients
- A secondary infection results from chronic obstruction of the ostium and polyposis or as a sequel of acute infection.

Fungal Sinusitis

What is fungus?

- Fungi are plant-like organisms that lack chlorophyll and so, absorb food from dead organic matter
- When body's immune system is weak, fungi take the opportunity to invade the body
- Fungi prefer to grow in damp and dark environment and there is nothing better than the sinuses providing a natural home to the fungus causing fungal sinusitis

Fungal infection occurs mostly in:

- Traumatic cases with compound fractures
- Uncontrolled diabetics
- Debilitated patients, such as carcinoma
- Patients on immunosuppressants, antibiotics or steroids.

Types of Fungal Infections

Presentation of fungal sinusitis may be in the form of:

1. **Invasive form** by *Aspergillus* variety of fungus seen in chronic immunocompromised patients, computerized tomography (CT) shows opacification of sinus with bone erosion.
   i. Acute fulminant type.
   ii. Sclerosing type.
   iii. Granulomatous type.
2. **Noninvasive form includes:**
   i. Allergic fungal sinusitis seen in atopic or asthmatic patients and is due to allergic reaction to the fungus. Eosinophils, Charcot–Leyden crystals and fungal hyphae are characteristics of allergic fungal sinusitis. CT may show bone erosion or expansion due to pressure.
   ii. Fungal ball or mycetoma is a clump of spores caused by *Aspergillus* giving rise to a ball-like a clay studded with sporangia. CT shows a hyperdense area with no bony erosion or expansion (**Figure 26.1**).
   iii. Fulminant type of chronic fungal sinusitis seen in immunocompromised patients such as in diabetics, cancer or acquired immunodeficiency syndrome (AIDS).

Organisms

- *Aspergillus fumigatus*, niger and flavus.
- Actinomycosis which may result in granuloma of antrum.
- Mucormycosis with *Mucor*, *Rhizopus* or *Absidia* species of fungus.

Clinical Features

- Patient presents with nasal airway obstruction
- Symptoms of chronic sinusitis
- Purulent blackish discharge
- Headache
- Diplopia and blurring of vision, asthma

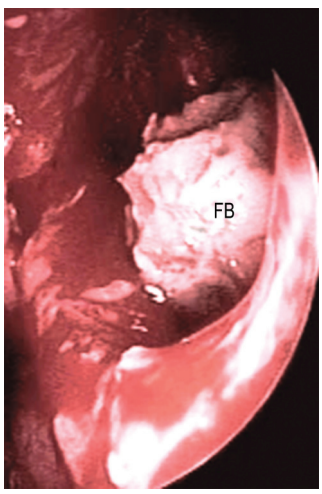


Figure 26.1 Fungal ball (FB) in maxillary sinus

- On examination—nasal polyposis, facial disfigurement and ocular abnormalities.

Investigations

1. Total immunoglobulin E (IgE) levels more than 1,000 u/ml. Normal is less than 50 u/ml.
2. Nasal cytology.
3. Chest X-rays.
4. Pulmonary function test.
5. Allergy test.
6. CT scan is very helpful to assess the volume of disease. It shows erosion or expansion of sinus.
7. Fungal culture is done on brain-heart infusion agar incubated at 37°C or Sabouraud dextrose agar media.

Treatment of Fungal Sinusitis

Treatment may be complete surgical clearance by endoscopic sinus surgery and antifungal therapy such as itraconazole/fluconazole with or without steroids. Amphotericin B in the dose of 2 to 3 gm is also given. Noninvasive form of fungal sinusitis does not require antifungal treatment.

Complications of Antifungal Therapy

- Renal failure
- Anemia
- Agranulocytosis
- Hepatotoxic
- Cardiopulmonary hypertension
- Urticaria.

Clinical Features of Chronic Sinusitis

1. Nasal symptoms
   i. Nasal obstructions, nasal discharge and postnasal drip due to chronic rhinitis and hypertrophic mucosa of nose, especially the turbinates. The nature of nasal discharge depends upon the type of bacteria.
   ii. Postnasal drip (PND) is the most common and most annoying symptom giving rise to dryness and burning at the back of nose together with an unpleasant taste in the mouth.
   iii. Epistaxis due to inflammatory vasodilators.
   iv. Smell abnormalities—cacosmia, hyposmia or parosmia.
   v. Vestibulitis or excoriation of skin of nose may be present.
2. Pharyngeal symptoms
   - Pharyngitis
   - Dryness of throat
   - Tonsillitis
   - Lymphadenitis.
3. **Ear symptoms:** Signs and symptoms of eustachian tube obstruction or even otitis media.
4. **Headache:** Periodicity of headache is due to secretions accumulating in the sinuses during night and then draining away as the patient takes up erect posture. Different pain areas are noticed in involvement of various sinuses.
5. **Eye symptoms:** Conjunctivitis.
6. **Respiratory symptoms:** Cough, hoarseness of voice.
7. Other symptoms
   - Low-grade gastritis with nausea
   - General ill health and tiredness
   - Fever off and on.

Signs

Anterior Rhinoscopy

Anterior rhinoscopy shows red swollen mucosa with pus in the middle meatus, which can be made to appear by putting the head between the knees with infected sinus upward and then raising the head again.

- In ethmoiditis, the middle turbinate may be hypertrophied and polypi may be present
- In sphenoid sinusitis, the pus may be seen in the olfactory cleft.

Posterior Rhinoscopy

Pool of pus in the upper surface of palate indicates infection of anterior group of sinuses and even pus at the posterior end of inferior turbinate is pathognomonic of anterior group of sinuses involvement.

Examination of Pharynx

Pus may be seen in the lateral pharyngeal gutter, swelling of the lateral lymphoid tissue, but a trickle or curtain of pus in the posterior wall suggests infection of sphenoid or posterior ethmoidal cells.

Investigations

- Besides routine tests like total leukocyte count (TLC), different leukocyte count (DLC), eosinophil count
- Urine examination
- Culture sensitivity of postnasal discharge (PND) including examination for fungal cytology and potassium hydroxide (KOH) staining.

Other investigations include the following.

Transillumination Tests

Transillumination tests are done for maxillary and frontal sinuses by a special torch in a darkened room. They are 15 percent less accurate than X-rays (**Figure 26.2**).

Figure 26.2 Transillumination test

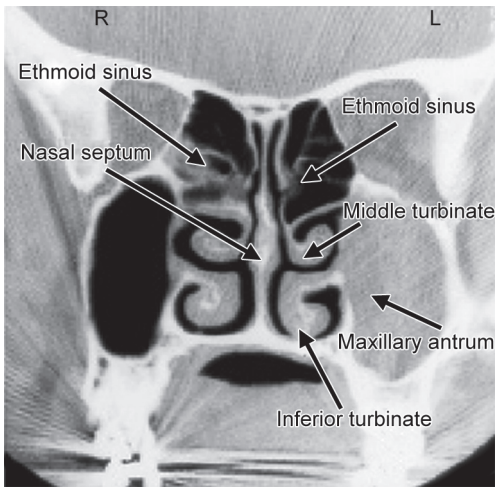


Figure 26.3 CT paranasal sinuses with left maxillary sinus hazy

X-ray Examination of Sinuses

Occipitomental or Waters view is specific for maxillary sinus, but Caldwell view (Occipitofrontal view) is specific for frontal sinus.

CT Scan of Nose/PNS

Especially of osteomeatal complex both coronal and axial sections (**Figures 26.3 and 26.4**).

Differential diagnosis of opaque maxillary sinus

- Traumatic (collection of blood/edema of walls)
- Infective causes, allergic causes including polypi
- Neoplasm
- Miscellaneous-like fibrous dysplasia, dentigerous/dental, cysts, overtilted position.

Sinus Sounding or Puncture of the Sinus

- Sinus sounding is more appropriately carried out for maxillary sinus (proof puncture), sphenoid and ethmoidal (through bulla ethmoidale) sometimes.
- Remember, for puncturing the sphenoid, anterior wall of sphenoid is situated at 7 cm from anterior nasal spine
- Vomerine ridge on septum also leads to the rostrum of sphenoid (i.e. anterior wall) crossing the center of middle turbinate.

Diagnosis and Assessment

- Signs and symptoms
- Proof puncture
- Radiography, rarely leave any doubt in diagnosis

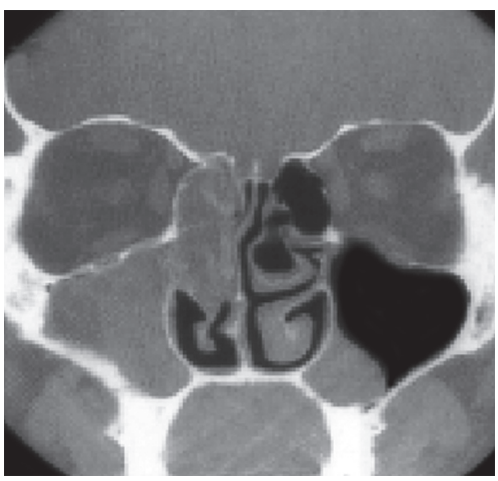


Figure 26.4 CT picture of chronic ethmoidomaxillary sinusitis

- Bacteriological state should be assessed.
  - The presence of any predisposing factor, such as infected teeth, DNS and nasal polypi should be noted.
  - Length of time of signs and symptoms and treatment taken in the past should be noted as these help to decide the future line of management of the case.

Treatment

It depends upon the condition of lining mucosa of the sinuses.

- **If the changes are reversible,**
  - Treatment is conservative and consists of adequate drainage by medical and minor surgical procedures (i.e. antral washouts)

- **If the mucosa has undergone irreversible changes,**
  - Treatment is only surgery, i.e. in the form of radical surgery and obliterative operation in which the sinus ceases to exist as a cavity
  - Besides, any associated factors, such as DNS, polypi, and enlarged middle and inferior turbinates, should also be treated.
- **Irreversible changes are presumed when**
  - Conservative treatment has failed.
  - Radiological changes in sinuses.
  - Nature of pus obtained on antral wash.

Conservative Treatment

1. **Medical management**
   i. **Antibiotics:** Broad-spectrum antibiotics, such as ampicillin or cephalosporins or depending upon culture and sensitivity test. They should be given for at least 10 to 14 days. Anaerobes should be kept in mind even if the report of the culture is sterile. In such cases, the organism may be present in the tissues and not in the pus.
   ii. **Antihistamines:** These do have a value because many cases may be associated with allergy. Antihistamines should be given in adequate doses large enough to relieve the symptoms.
   iii. **Decongestants and steam inhalation:** These can give relief of symptoms, but do not cure the chronic sinusitis and hence, may be used as a supportive measure along with I and D. Their long-term use may give rise to chemical rhinitis.
   iv. **Displacement therapy (Proetz method):** It was introduce in 1939. In this, the patient lies supine with nose and orbit in one vertical plane. About 5 ml of solution (ephedrine hydrochloric acid [HCl] 0.5% + saline) is instilled in one nostril and suction is applied, while the patient says KKK. This method is abandoned now, because infection may be introduced into the otherwise healthy sinus. This therapy may have some role in ethmoiditis, which is difficult to drain and in children who have failed to respond to antibiotics.
   v. **Enzymes and mucolytic drugs:** They are also used and have a doubtful value in the treatment of chronic sinusitis (serratiopeptidase/chymotrypsin).
   vi. **Role of steroids:** These have been found useful at times when other treatment fails, because of their anti-inflammatory effect, which helps in the better drainage and aeration of the sinuses.
2. **Surgical management**
   It has been described in detail in operative section. Various options are as follows:
   i. Maxillary sinusitis
      - Antral irrigation
      - Functional endoscopic sinus surgery (FESS) (**Figure 26.5**)
      - Intranasal antrostomy
      - Caldwell-Luc operation (CWL) (or its modifications like Canfield and Denker operation)
      - McNeil obliterative operation.
   ii. Frontal sinusitis
      - Functional endoscopic sinus surgery
      - External frontal operation (Howarth's)
      - Osteoplastic flap operation
      - Obliterative operation on frontal sinus.
   iii. Ethmoid sinusitis
      - Intranasal ethmoidectomy
      - Transantral ethmoidectomy (Jansen-Horgan procedure)
      - External ethmoidectomy (Lynch-Howarth procedure)
      - Transorbital ethmoidectomy (Patterson operation)
      - Functional endoscopic sinus surgery.
   iv. Sphenoid sinusitis
      - Functional endoscopic sinus surgery
      - Intranasal drainage
      - Via external ethmoidectomy.

COMPLICATIONS OF CHRONIC SINUSITIS

Methods of Spread of Infection

- By direct continuity
- Thrombophlebitis of diploic veins leading to infection of the bone marrow
- Embolism
- Perivascular lymphatics
- Perineural sheath.

Figure 26.5 Functional endoscopic sinus surgery

Complications of Anterior Group

- Orbital complications, e.g. orbital cellulitis/abscess
- Mucocele/pyocele
- Fistulae (oroantral or sublabial)
- Intracranial complications:
  - Thrombophlebitis
  - Brain abscess
  - Extradural abscess
  - Basal meningitis.
- Osteomyelitis of bone (frontal and maxillary)
- Pott puffy tumor—described by Sir Percival Pott in 1760, it is doughy swelling of forehead due to osteomyelitis of frontal sinus, which gives moth-eaten appearance on X-rays.

Complications of Posterior Group

- Superior orbital fissure syndrome/orbital apex syndrome
- Cavernous sinus thrombophlebitis
- Oroantral fistula/sublabial fistula, it is common after extraction of first molar tooth, because of root penetrating the floor of maxillary antrum
- Optic neuritis with impaired vision.

Other Secondary Effects

- Ear complications like acute suppurative otitis media (ASOM), chronic suppurative otitis media (CSOM) and atelectasis.
- Pharyngitis/laryngitis/tracheitis
- Bronchitis/bronchiectasis
- Asthma
- Focal sepsis:
  - Polyarthritis
  - Tenosynovitis
  - Fibrositis
  - Dermatological conditions.

  Only the important ones are described here in detail.

Orbital Complications

Such as orbital cellulitis or subperiosteal abscess occurs from the ethmoidal and frontal sinuses by direct spread.

Infection extends between orbital muscles, nerves and blood vessels.

Clinical Features

- High fever
- Pain in the eye on the side of lesion
- Chemosis and edema of eyelids
- Proptosis and diplopia
- Eye displaced laterally or inferolaterally depending upon the sinus involved
- Headache
- Vision may be diminished.

> Orbital cellulitis differs from cavernous sinus thrombosis in being unilateral, onset gradual, moderate fever, no involvement of retina and cranial nerves.

Treatment

- Immediate drainage of subperiosteal abscess
- Systemic antibiotics
- Drainage of the sinus from where infection has spread
  - **Orbital apex syndrome:** Superior orbital fissure syndrome + optic nerve and maxillary nerve involvement
  - Orbital cellulitis may lead to meningitis and cavernous sinus thrombosis
  - **Superior orbital fissure syndrome:** It is due to infection of sphenoid sinus and includes deep-seated orbital pain, frontal headache and VIth, IIIrd and IVth nerve involvement.

Mucocele of the Paranasal Sinus

Mucocele is either a retention cyst of mucous glands of sinus or may be due to blockage of sinus ostium, resulting in thinning and expansion of sinus wall. **Frontal and ethmoidal sinuses are the usual sinuses involved.** If infection is superadded, it is called pyocele.

Clinical Features

- Dull headache
- A swelling in the floor of frontal sinus above the inner canthus
- Eye is displaced downwards and laterally
- Swelling has tense cystic consistency or like egg-shell crackling
- Ultimately may result in fistula formation near supraorbital margin.

Radiology

Radiology is diagnostic. There is enlargement of sinus, the floor of frontal sinus will be flattened and then bulges into the orbit. There is loss of scalloping of the superior border of the frontal sinus.

Treatment

Howarth incision and exploration of frontal sinus, removing the mucocele and establishing a drainage into the nose from the affected sinus.

Osteomyelitis

Osteomyelitis usually follows infection of frontal sinus or maxilla leading to sequestrum formation. Usual organisms responsible are anaerobic streptococci or staphylococci.

Pathology

The lesion is essentially thrombophlebitis of diploeic bone. The lesion may spread rapidly. A subperiosteal abscess may form over the forehead (Pott puffy tumor) once it is localized.

Clinical Features

- Usually, children or young adults are affected
- Fever, malaise, headache, etc.
- Edema of upper eyelid or puffy swelling over frontal bone
- Fistula and sequestration over frontal bone in late cases.

Radiology

Radiology is diagnostic.

Treatment

Exploration of the sinus by osteoplastic flap operation. Unhealthy granulation tissue and sequestra have to be removed. Frontal sinus is drained through frontonasal duct. Heavy doses of systemic antibiotics are administered.

Cavernous Sinus Thrombosis

Cavernous sinus thrombosis usually results from infection of ethmoid and sphenoid sinuses or from infection of the vestibule of nose.

Symptoms

Important symptoms are:

- Involvement of IIIrd, IVth, Vth and VIth cranial nerves
- Chemosis of conjunctiva
- Proptosis of the eye with limited movements
- Papilledema
- Papillary light reflex remains present.

Treatment

Cavernous sinus thrombosis is treated by antibiotics, anticoagulant therapy besides treating source of infection.

Key Points

1. **Chronic sinusitis** is diagnosed by the presence of postnasal discharge, nasal obstruction, headache of more than 12 weeks duration besides positive findings in the lateral wall of nasal cavity and is confirmed by radiological investigations.
2. **CT scan of PNS,** especially of the osteomeatal complex, is very valuable in chronic sinusitis to find out the extent of pathology and to carry out the functional endoscopic sinus surgery.
3. **Lamina papyracea** separates the ethmoid from the orbit and the infection may spread to the orbit either by osteitis or by thrombophlebitic process of veins.
4. **Osteomyelitis of the maxilla** is most commonly seen in infants and children, because of the presence of spongy bone in children, while osteomyelitis of the frontal bone is more commonly seen in adults as it is not developed in infants and children.
5. **Mucocele of the ethmoid sinuses** displaces the eyeball forwards and laterally, while mucocele of the frontal sinus displaces the eyeball forwards, downwards and laterally.
6. **Maxillary sinusitis** is characterized by evening headache, while frontal sinusitis causes office headache.
7. **Postural test** is useful for chronic maxillary sinusitis.
8. **Superior orbital fissure syndrome** is a rare complication of sphenoioditis.
9. Mucocele of frontal sinus in super medial quadrant of orbit displaces eyeball forward and downwards.
10. **Pott puffy tumor** is subperiosteal abscess due to frontal sinusitis.
11. Maxillary sinus infection may reach **cavernous sinus** through infraorbital vein.
12. Most common site of **mucocele** formation is frontal sinus.
13. **Stain of choice** in fungal sinusitis is Gomori methenamine.

Chapter 27 Faciomaxillary Injuries

What Students Must Know!

- ❖ **Maxillofacial Fractures**
  - Care of Patient in Emergency
- ❖ **Classification of Maxillofacial Injuries**
  - Fracture Nasal Bones
  - LeFort's Classification
  - Lateral Fracture of the Middle Third
  - Fractures of Lower Third of Face

MAXILLOFACIAL FRACTURES

Fractures of the facial skeleton including the nose, mandible, zygoma and orbit are most commonly due to:

- Accidental trauma
- Physical combat or
- Sports injuries.

Maxillofacial fractures, besides causing cosmetic deformity, loss of function and brain damage can also result in endangerment to the airway.

Care of Patient in Emergency

The first priority is securing the airway and controlling bleeding when the patient presents in the emergency. For this, the following factors for care of patient in emergency include:

1. Airway is to be maintained by alignment of neck and endotracheal intubation is undertaken in unconscious patient.
2. Breathing—to assess and establish breathing to ensure adequate ventilation.
3. Circulation—to maintain and improve blood circulation and to control blood loss by anterior nasal packing (ANP), suction, suture or arterial ligation.
4. Dysfunction—to assess levels of consciousness and neurological deficit.
5. To carefully expose the patient to identify all other injuries.

Clinical examination includes that of eyes, nose, maxilla, mandible, mucosa and dentition. Any lacerations should be cleaned and sutured. The fractured fragments should be accurately reduced, immobilized and maintained free of infection by antibiotics and anti-inflammatory drugs.

CLASSIFICATION

The faciomaxillary injuries can be divided into:

1. Fracture of upper third of face.
2. Fracture of middle third of face—central/lateral.
3. Fracture of lower third of face.

FRACTURES OF UPPER THIRD OF FACE

The upper third of face includes the region of face above the supraorbital ridge. In this region, there can be trauma to frontal sinus, supraorbital ridge and fracture of frontal bone.

Main Features

They are as follows:

1. If frontal sinus is involved:
   i. Dural tears/brain injury
   ii. Cosmetic deformity on forehead
   iii. Cerebrospinal fluid (CSF) rhinorrhea.
2. If supraorbital ridge is fractured, it results in:
   i. Periorbital ecchymosis
   ii. Proptosis/downward displacement of eye.

Management

- Reduction of fracture through an open wound/brow incision/turnovers skin line on forehead

- If dural tears present, these can be covered by temporalis fascia
- Neurosurgical consultation for brain injury and/or cerebral edema.

FRACTURES OF MIDDLE THIRD OF FACE

- Middle third of face includes region between supraorbital ridge and upper teeth
- Depending on the site of involvement, fractures of middle third of face can be:
  - Central (nasomaxillary) includes fracture nasal bones/naso-orbital fracture
  - Lateral (malar-maxillary).

Central (Nasomaxillary) Fractures

Fracture Nasal Bones

Fracture of the nasal bones is the most common fracture in the human body and occurs due to severe direct trauma. It occurs due to direct trauma to nose, due to fall or blow or as a part of maxillofacial injury. The proximal part of the nasal bone is extremely thick and heavy and resistant to fracture. The distal parts are very thin and very vulnerable to injury. The extent of the fracture depends on the direction of force and its velocity.

Clinical features

1. Epistaxis is the common symptom. It may be temporary or continuous.
2. External nasal deformity due to dislocated bony fragments and edema of tissues due to trauma or hematoma.
3. Nasal obstruction is present due to blood clots, septal hematoma or septal deformity.
4. Palpation over the nasal bridge will elicit tenderness and bony crepitations.
5. Edema usually sets in within 4 to 6 hours of injury. So fracture can be best assessed within 2 to 4 hours of trauma or after 6 to 8 days when edema subsides.
6. Watery nasal discharge is indicative of CSF leak due to fracture of cribriform plate in the roof of nose.

Investigations

1. Anterior rhinoscopy should be carried out to ascertain nasal patency and to remove any blood clot. Any septal dislocation/septal hematoma can be noted.
2. X-ray lateral view and anteroposterior (AP) view of nasal bones demonstrate the fracture line (**Figure 27.1**).
3. X-ray skull and computed tomography (CT) scan are done to detect associated head injury, if suspected.
4. Examination of eyes to rule out subconjunctival hemorrhage.

Forced duction test

After application of local anesthesia (LA) to the conjunctiva, the inferior rectus is grasped with forceps. Limitation of upward rotation indicates herniation of orbital contents through the orbital floor.

Classification of fracture nasal bones

Frontal and lateral types according to the direction of force. Frontal blow leads to flattening of nose and widening of bridge.

In severe forms, fracture of nasal bones may be associated with fracture of frontal process of maxilla and of ethmoid and lacrimal bones producing a flat profile of face (dish-faced deformity).

Class 1 fracture

Fractures involving nasal bones and septal cartilage. The fracture line runs parallel to the dorsum of nose and naso-maxillary suture, joining at the point where the nasal bone becomes thicker. Cartilaginous septum attached to the dorsum is involved and this fracture extends posteriorly into perpendicular plate of ethmoid (Chevallet fracture).

Class 2 fracture

It causes significant cosmetic deformity. In this type along with fractures of nasal bones, the frontal process of maxilla is also involved. Ethmoidal labyrinth is intact.

The fracture begins beneath the nasal tip in the quadrilateral cartilage and runs forward through the lower part of perpendicular ethmoid (Jarjavay fracture).

Class 3 fracture

The fractures extend to include the ethmoidal labyrinth. It is currently known as naso-orbitoethmoid (NOE) fracture.

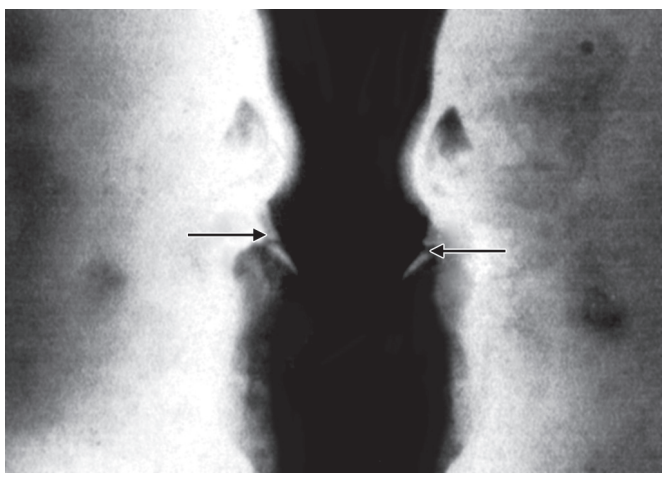


Figure 27.1 X-rays showing fracture nasal bones

Naso-orbitoethmoid fracture—subtypes

1. In this type, anterior skull base, posterior wall of frontal sinus and optic canal remain intact. The ethmoidal labyrinth collapses or telescopes on itself causing a classical pig-like appearance to the face with foreshortening of nose and increased space between the eyes (telecanthus).
2. In this type, there is disruption of posterior frontal sinus wall, multiple fractures of roof of ethmoid and orbit extending as far back as sphenoid and parasellar region. It may result in dural tears, CSF leakage and cerebral herniation.

Management of nasal fractures

- In case of head injury or vehicular accidents, maintain the vital parameters of the patient
- Epistaxis, if present, is treated by anterior nasal packing
- Any open wounds are to be cleaned and sutured
- Antibiotics and anti-inflammatory analgesics to be given to the patient
- If the patient is seen within 1 to 2 hours of trauma, the fracture can be reduced under LA using Asche's or Walsham's forcep
- If edema has already set in, it is better to wait for 7 to 8 days to allow the edema to subside and then to reduce the fracture under general anesthesia (GA)
- If there is septal deformity, septal hematoma, it is to be treated at the same time as fracture reduction.

Fractures of orbit floor

Result from direct trauma to the orbit, usually occur when a large blunt object strikes the globe resulting in blow out fractures. In this, the orbital contents may herniate into the antrum.

Clinical features

Ecchymosis of lid, conjunctiva and sclera, epiphora, subconjunctival hemorrhage and diplopia.

Fractures of maxillary sinuses

There is step deformity of infraorbital margin due to fracture, edema of soft tissues and anesthesia or numbness over cheek due to involvement of infraorbital nerve.

LeFort's classification for central fractures

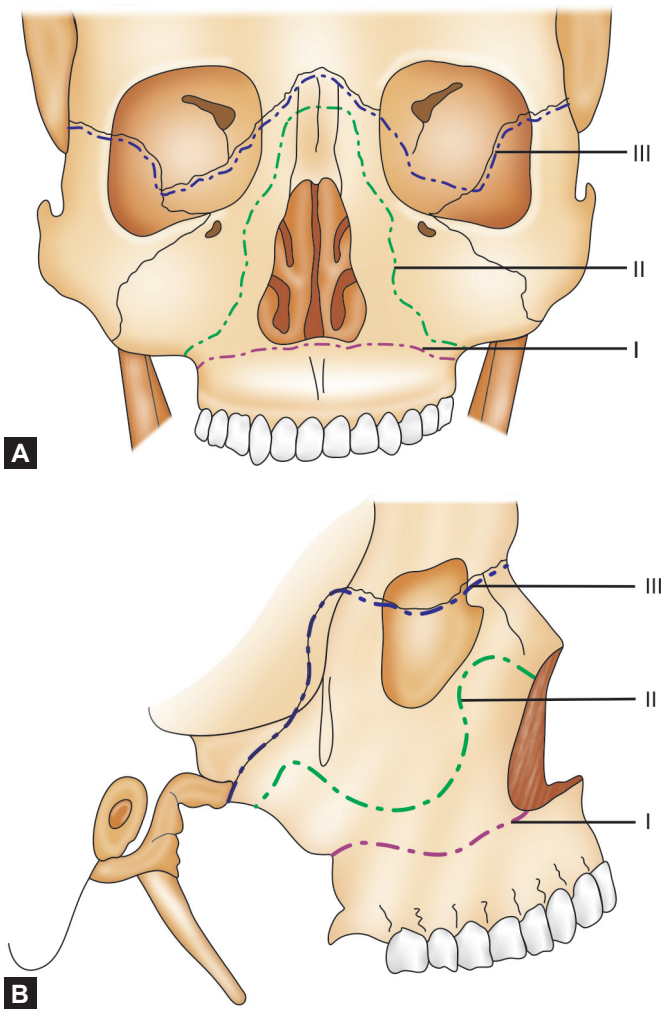
It is based on the extent of bone involvement (**Figures 27.2A and B**).

LeFort I (Transverse)

In this, there is transverse fracture of maxilla involving the palate only, running above floor of nasal cavity through the nasal septum and maxillary sinus.

LeFort II (Pyramidal)

Runs from floor of maxillary sinuses superiorly to the infraorbital margin, through the zygomati-comaxillary suture and through the orbit. The infraorbital nerve is often damaged in this.



Figures 27.2A and B LeFort fracture types I, II and III

LeFort III (Craniofacial dysostosis)

In this, there is disconnection of facial skeleton from the cranial base. Fracture line extends from medial wall of orbit to superior orbital fissure and exits across greater wing of sphenoid and zygomatic bone to the zygomaticofacial suture. It passes through the pterygomaxillary fissure and sphenopalatine foramen.

CSF rhinorrhea is seen in LeFort II and LeFort III fractures due to injury to cribriform plate of ethmoid.

Lateral Fracture of the Middle Third (Malar Maxillary)

These are due to blow from side of face. Direct trauma causes lower segment of zygoma to be pushed medially and posteriorly causing flattening of malar prominence and step

deformity of infraorbital margin. Fracture line passes through zygomaticofrontal suture, orbital floor, infraorbital margin and anterior wall of maxillary sinus (**Figure 27.3**).

Clinical Features

They include flattening of malar prominence, trismus, anesthesia in distribution of infraorbital nerve, step deformity of infraorbital margin and diplopia. Diagnosed by X-ray PNS (Water's view) and in case of CSF rhinorrhea. CT might also be undertaken to show site of leakage.

Treatment

Fracture is reduced under GA and the fractured fragments are kept in contact with the help of steel wires, splints and rods using various techniques of external or internal fixation.

FRACTURES OF LOWER THIRD OF FACE

These include fractures of mandible. Subcondylar region fractures are the most common (35%) followed by those of angle, body and symphysis. Most fractures are caused by indirect trauma to chin.

Clinical Features

- If undisplaced fracture, pain and trismus are mainly observed and there is tenderness at the site of fracture

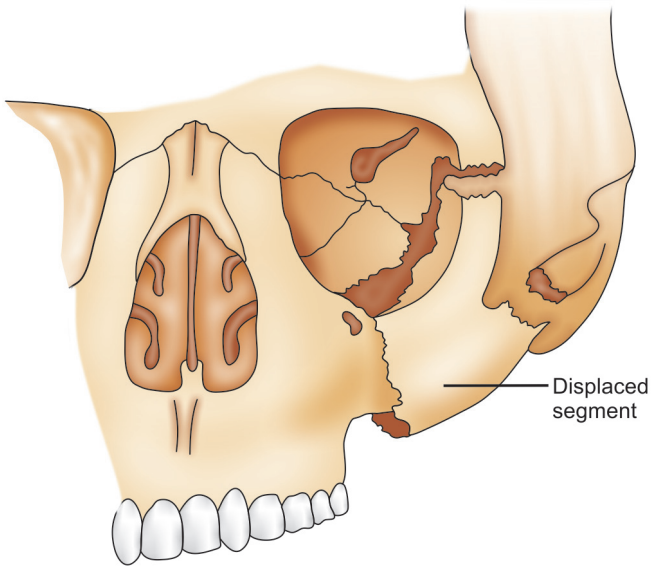


Figure 27.3 Fracture zygoma

- Displaced fragments of mandible result in malocclusion of teeth and deviation of jaw to opposite side
- Diagnosis is by X-ray skull (posteroanterior [PA] view) and X-ray right and left oblique view of mandible.

Management is by interdental wiring, intermaxillary fixation, transosseous wiring and bone plates by both open or closed reduction techniques.

Key Points

1. **Most common fracture** of faciomaxillary region is that of nasal bones followed by zygoma.
2. Reduction of fracture nasal bones should be undertaken within 1 to 2 hours of trauma (before onset of edema) or after 7 to 8 days when edema subsides.
3. Subcondylar fractures of the mandible are the most common fractures of lower third of face.
4. **ABC of resuscitation** are to be followed as soon as the patient presents in the emergency.
5. Forced duction test is to test for herniation of orbital contents through the orbital floor into the maxillary antrum.
6. **Site of CSF leakage** can be detected by CT scanning.
7. Interdental wiring, bone plating, transosseous wiring and intermaxillary fixation may be required to reduce the fracture segments in fracture zygoma and mandible.
8. **LeFort II fracture** is also called "floating maxilla."
9. **Zygomatic fracture** is also known as tripod fracture, which is a misnomer, actually it is tetrapod fracture.
10. **Tear clip sign** seen in fracture orbital floor in CT scan.
11. **Chevallet fracture** (class I fracture) of nose does not involve nasal septum.
12. **Tripod fracture or zygomatic fracture** step deformity is seen in infraorbital margin along with anesthesia of infraorbital nerve.

Chapter 28 Tumors of Nose and Paranasal Sinus

What Students Must Know!

- **Classification**
- **Congenital Tumors of Nose**
  - Gliomas and Encephalocele
- **Benign Tumors**
  - Rhinophyma
  - Hemangioma
- **Malignant Tumors of Nose**
  - Basal Cell Carcinoma of Nose
- **Tumors of Paranasal Sinus**
- **Carcinoma of Maxillary Sinus**
  - Diagnosis
  - Treatment

INTRODUCTION

- Tumors of nose and paranasal sinus are rare and account for 0.2 to 0.8 percent of head and neck malignancies.
- In nasal cavity 50 percent each are benign and malignant.
- Maxillary sinus involved in 70 percent cases, ethmoids in 20 percent cases, sphenoid in 3 percent and frontal sinus in 1 percent only.

CLASSIFICATION

1. *Congenital tumors*
   - Glioma
   - Encephalocele
   - Dermoid cyst.
2. *Benign*
   - Rhinophyma
   - Papilloma
     - Squamous
     - Transitional
   - Hemangioma
   - Fibroma/Fibrous dysplasia
   - Adenoma
   - Osteoma
   - Retention cysts.
3. *Malignant*
   - Sarcoma
     - Rhabdomyosarcoma
     - Fibrosarcoma
     - Chondrosarcoma
   - *Carcinoma*
     - Squamous cell carcinoma
     - Adenocarcinoma
     - Adenoid cystic carcinoma
     - Mucoepidermoid carcinoma
   - Melanoma
   - Plasmacytoma
   - Lymphoma.

CONGENITAL TUMORS OF NOSE

Gliomas

- They may be seen externally or inside the nasal cavity due to a defect in foramen cecum
- Gliomas are solid masses consisting of neuroglial tissue and astrocytes
- Size does not change on crying of the baby
- Treatment is complete removal and neurosurgical closure of the defect.

Encephalocele

- Encephalocele is herniation of dura mater in the nose through foramen cecum or a defect in cribriform plate of ethmoid
- It contains cerebrospinal fluid (CSF) and may be brain tissue
- It is fairly mobile, readily compressible and increases in size on crying (Frustenberg sign).

- Intracranial infection may occur if it is injured. Computed tomography (CT) scan helps in diagnosis
- Treatment is neurosurgical and closure of the defect in the floor of skull.

Dermoid Cyst

Dermoid cyst may be seen in midline on dorsum of nose, contains hair and amorphous material and may have a sinus opening on the surface.

Treatment is surgical excision.

BENIGN TUMORS

Rhinophyma

Rhinophyma is seen in old age due to hypertrophy of sebaceous glands of the tip of nose causing bulbous appearance. Skin appears coarse and oily with blue or red color because of vascular engorgement (**Figures 28.1A and B**).

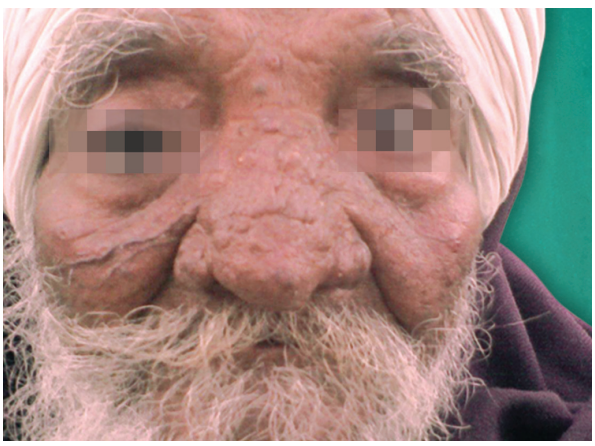


Figure 28.1A Early rhinophyma

Figure 28.1B Late rhinophyma

Treatment

It consists of shaving off the excess tissue to have a suitable size after which skin graft may be required.

Papillomas

Those arising from skin of vestibule are called squamous papillomas, while those of mucous membrance are called transitional cell papillomas. These are wart-like growths treated by excision followed by cauterization of base.

Hemangioma

Hemangioma is also called bleeding polypus of the nasal septum, because it arises from bleeding area of the septum. These may be cavernous or capillary type. It is single, dark red, often pedunculated, causing frequent bleeding from nose (**Figure 28.2**).

Treatment is excision and cauterization of the base.

Fibromas and Neurofibromas

Fibromas and neurofibromas arise from fibrous tissue and nerves of the nasal cavity and may form polypoidal masses.

Treatment

It is by excision of the mass by lateral rhinotomy approach.

Fibrous Dysplasia

It is seen between 10 and 20 years old females causing facial disfigurement, exophthalmos and proptosis and sometimes nasal blockade. The fibroosseous lesion tends to stabilize with cessation of growth. Calcium metabolism disturbances have no role to play. Enlargement is hard, diffuse, smooth, painless and unilateral.

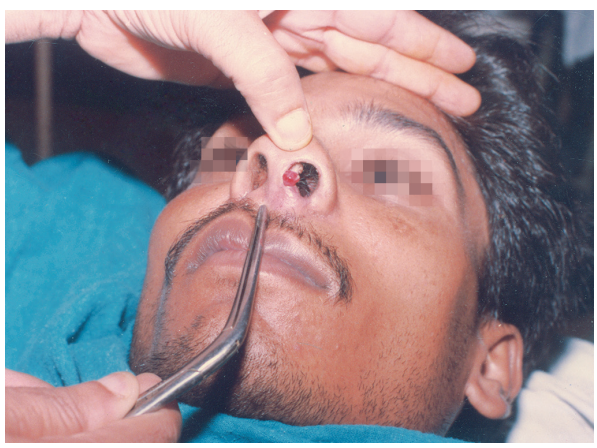


Figure 28.2 Hemangioma

Treatment

Although lesion stops after 20 years or so, the line of treatment is pairing down of excessive tissue. Once lesion has stopped growing, further radiotherapy is not given.

Adenomas

Adenomas are rare tumors arising from nasal septum and are treated by wide surgical excision.

Osteomas

Mostly arise from frontal, ethmoidal or maxillary sinus. Histopathology may show compact or cancellous osteomas. These osteomas are slow growing and may cause nasal obstruction, pain or cosmetic deformity.

Treatment

It is by adequate exposure and removal.

Retention Cysts

Retention cysts arise due to retention of secretions in the mucous glands in the floor of nose.

Treatment

It is by excision of the cyst.

MALIGNANT TUMORS OF NOSE

Basal Cell Carcinoma of Nose

It has already been discussed (**Figure 28.3A**).

Sarcomas

Most commonly seen tumor of nose and it may be fibrosarcoma, myxosarcoma, rhabdomyosarcoma and so on. It gives rise to nasal obstruction, nose bleed or pain. On examination, there is a reddish, sloughing friable mass.

Treatment
It is radiotherapy, but resection may also be done.

Carcinoma of Nose

Carcinoma of nose (**Figure 28.3B**) is seen in elderly age group while sarcomas are seen in younger age group. Symptoms and signs are like sarcoma.

Treatment
In early cases, excision may be the best; but in advanced stages, radiotherapy or major surgical excision may have to be done followed by prosthesis or plastic repair.

Melanoma

Melanoma is an extremely lethal tumor arising from lateral wall of nose as a smooth dark rounded growth, which bleeds readily on probing.

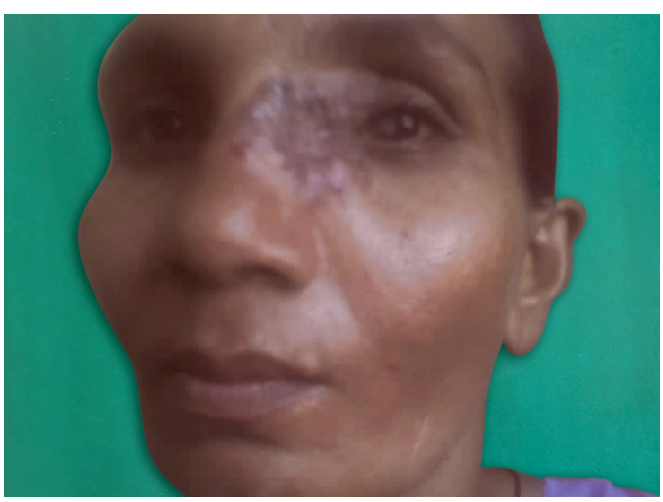


Figure 28.3A Basal cell carcinoma nose

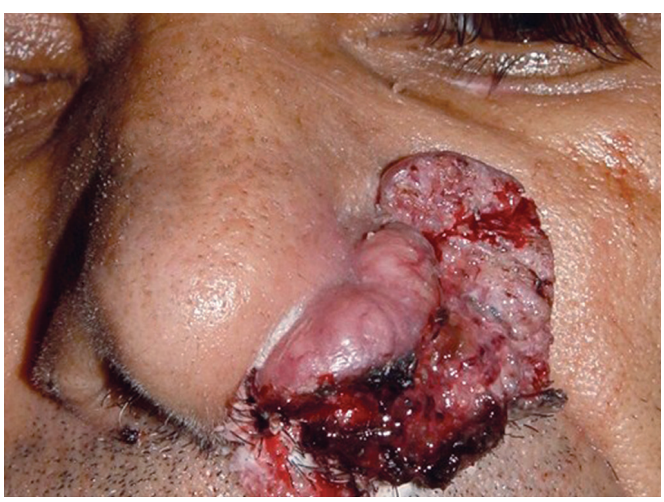


Figure 28.3B Carcinoma nose

Treatment

It is local excision with diathermy followed by radiotherapy with or without block dissection of neck.

Plasmacytoma and Lymphoma

Plasmacytoma and lymphoma are rare tumors of nose and PNS but these are fatal in outcome.

TUMORS OF PARANASAL SINUS

- Tumors of paranasal sinus (PNS) are not very common and may be only 0.5 percent of the head and neck malignancies
- Tumors of nose and PNS were first described by Hippocrates and Galen and it was a French surgeon who performed the first total maxillectomy in 1827
- Many occupations are at more risk for development of sinonasal tumors such as nickel refiners, hardwood furniture industry workers, leather workers, chrome and alcohol manufacturers
- Squamous cell carcinoma is seen mostly in nickel workers while adenocarcinoma in wood workers (ethmoidal sinuses)
- Most commonly involved sinuses in order of frequency are maxillary sinus, ethmoid, frontal and sphenoid
- About 80 percent of malignant tumors are squamous cell carcinomas.

CARCINOMA OF MAXILLARY SINUS

Although not very commonly seen malignancy; but once present, it is diagnosed quite late due to anatomical factors, hence carries a poor prognosis. Squamous cell carcinoma of maxillary sinus is the most commonly seen malignant tumor in the age group between 50 and 70 years of age (**Figure 28.4A**).

Symptoms and Signs

- Nasal bleeding in elderly persons
- Nasal obstruction
- Neuralgias
- Facial or palatal swelling
- Symptoms of chronic sinusitis
- Orbital symptoms such as diplopia, proptosis and diminished vision
- Loosening of teeth or ill fitting of dentures
- Trismus
- Paraesthesias
- Neck swelling.

On Examination

- Anterior rhinoscopy may show a friable mass in the nose or bulge of medial wall
- Floor of maxillary sinus (**Figure 28.4B**), swelling of cheek and proptosis.
- Retropharyngeal nodes are first involved, which cannot be palpated.
- Swelling may extend into the orbit giving orbital symptoms (**Figure 28.5**).

Diagnosis

1. Clinical history and examination of the patient having blood-stained nasal discharge.
2. *Role of radiography*:
   - Plain X-ray shows opacity of the involved sinus.
   - Polytomography is better than plain X-ray, because it demonstrates better details of destruction.
   - CT scan has greatly improved the preoperative diagnosis as we can know the extent of tumor with bone destruction.
3. *Biopsy:* If mass is present in the nose, biopsy should be taken; and if not visible, Caldwell-Luc (CWL) operation should be done to take the biopsy.

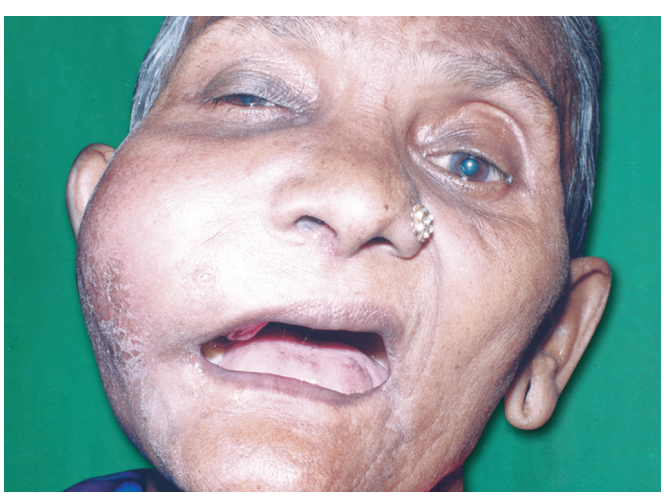


Figure 28.4A Carcinoma maxilla

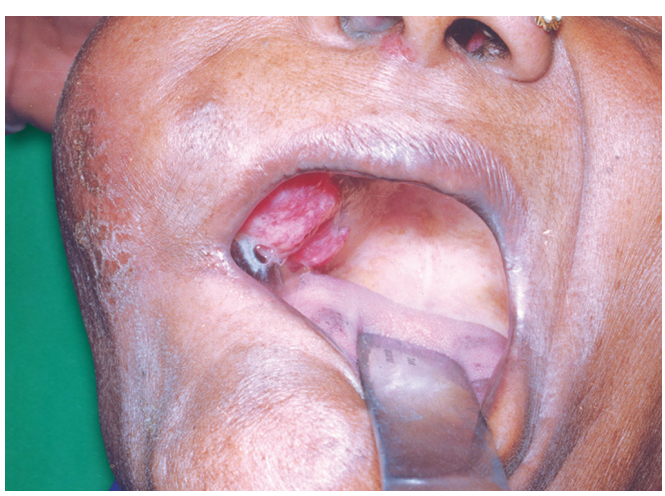


Figure 28.4B Carcinoma maxilla with extension into the oral cavity

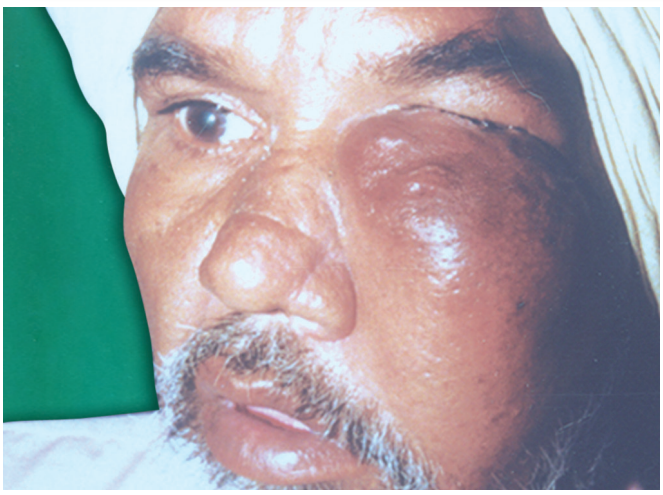


Figure 28.5 Carcinoma maxilla with extension into the orbit

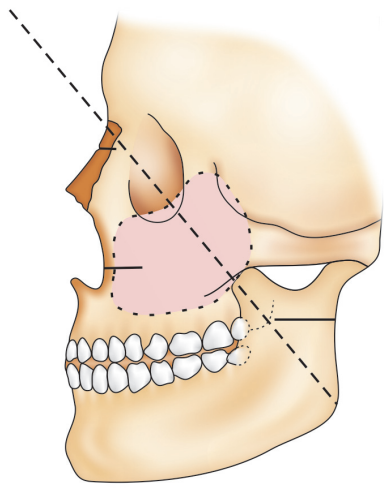


Figure 28.6 Ohngren's line for classification of tumors of maxilla

4. *Role of functional endoscope sinus surgery (FESS)*: It can be done to visualize the growth and also to take a biopsy with a 30° sinuscope.

Staging of Tumor

The American Joint Committee on Cancer (AJCC) has formulated tumor, nodes and metastasis (TNM) staging of malignant tumors of maxillary sinus.

Ohngren's Classification

Ohngren's line drawn from medial canthus of the eye to the angle of mandible divides maxillary antra into infrastructure and suprastructure (**Figure 28.6**). Growths in suprastructure have a poor prognosis.

Tumor

- T_1: Confined to mucosa of infrastructure with no bony erosion.
- T_2: Mucosa of suprastructure with erosion of inferior or medial wall.
- T_3: May involve orbit, anterior ethmoid sinus, pterygoid muscles or skin of cheek.
- T_4: Lesion involving cribriform plate, posterior ethmoid or sphenoid sinus.

Nodes

- N_0: No clinically positive palpable nodes.
- N_1: Single homolateral node up to 3 cm.
- N_{2a}: Single homolateral node 3 to 6 cm.
- N_{2b}: Multiple nodes up to 6 cm.
- N_{3a}: Single or multiple nodes homolateral of > 6 cm.
- N_{3b}: Has bilateral nodes of > 6 cm.
- N_{3c}: Has contralateral nodes of > 6 cm.

Distant metastasis

- M_0: No known distant metastasis.
- M_1: Presence of distant metastasis.

Lederman's Classification

In Lederman's classification, two horizontal lines (**Lines of Sebileau**) are used, one passing though the floor of orbit and the other through the floor of antra. Another vertical line is drawn along the medial canthus downwards.

This divides it into:

a. Suprastructure containing ethmoid, sphenoid and frontal sinus.
b. Mesostructure containing maxillary sinus and respiratory part of nose.
c. Infrastructure containing alveolar process.

Staging of tumor

- Stage I : $T_1 N_0 M_0$
- Stage II : $T_2 N_0 M_0$
- Stage III : $T_3 N_0 M_0$ or T_1 or T_2 or T_3 with $N_1 M_0$
- State IVA : $T_2 N_0 M_0/T_4 N_1 M_0$
- State IVB : T_1 to $T_4 N_2 M_0$ or T_1 to $T_4 N_3 M_0$
- State IVC : T_1 to T_4, N_1 to N_3 M1

Treatment

Carcinoma of maxilla is treated by surgery and radiotherapy given usually in combination either preoperatively or post-operatively. Five year cure rate with combination therapy is more than 30 percent.

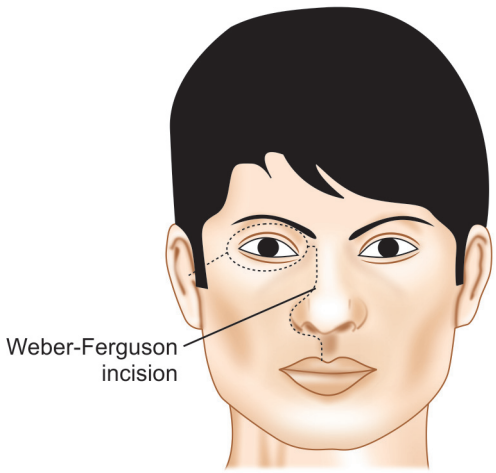


Figure 28.7 Weber-Ferguson incision in maxillectomy operations

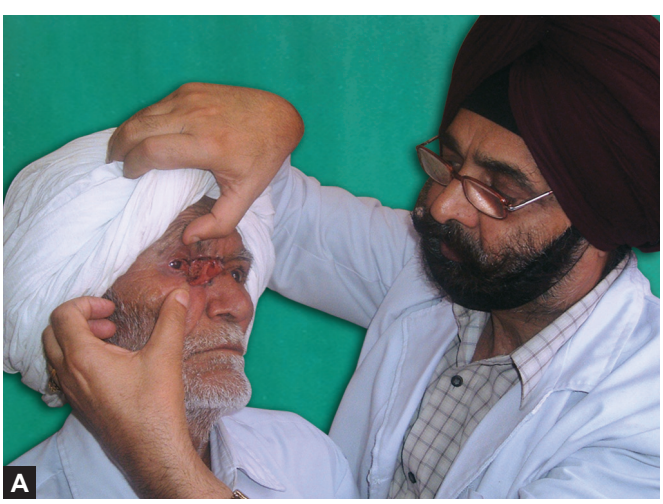
Radiation Therapy

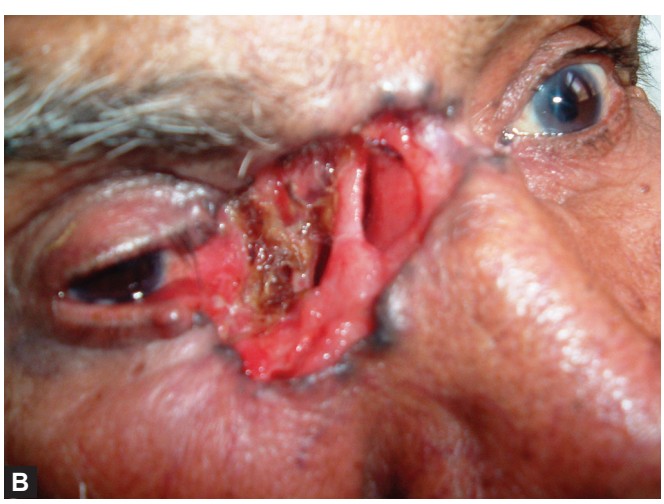
It is given if:

- The patient is unfit for surgery
- Growth is unresectable
- The patient refuses surgery
- Dose for radiotherapy is 5,000 rads and this dose is safe and dose not cause ocular damage such as maculoretinal degeneration or conjunctivitis.

Surgical Treatment

- Surgical treatment for malignancy of the maxillary antra is maxillectomy, which may be total maxillectomy or partial maxillectomy
- Maxillectomy means the removal of maxilla and also (if required) orbit, palate or soft tissues of the face depending upon the extent of tumor
- Classic **Weber-Ferguson** incision is used for maxillectomy, which starts at the inner canthus along the nose on to splitting of lip (**Figure 28.7**)
- After lifting the skin and soft tissue, maxilla is separated by bone cut from nasal bone, palate, frontal process of maxilla, pterygoid plates zygomatic process and the lateral orbital wall with Gigli's saw or osteotome
- Specimen is removed *en bloc* and afterwards temporary palatal prosthesis is given to diminish facial deformity in about 10 days and a permanent prosthesis is fitted in 6 to 8 weeks to minimise cosmetic deformity.





Figures 28.8A and B Squamous cell carcinoma ethmoids

- In partial maxillectomy, medial wall of antrum, superior wall and ethmoidal complex is removed *en bloc* and it is done when the growth is limited to these areas only
- Craniofacial resection is done when cribriform plate and anterior cranial fossa are also involved.

MALIGNANCY OF OTHER SINUSES

Ethmoids, frontal (**Figures 28.8A and B**) and sphenoid sinus are not commonly involved primarily by malignant lesions, but may get involved secondarily by lesions of the adjacent areas.

Diagnosis is confirmed by CT scan and biopsy.

Treatment is done either by surgical resection or radiotherapy of a combination of both.

Prognosis is not very good.

Key Points

1. **Gliomas and encephalocele** are seen in infants and children. The latter increases in size on crying.
2. **Bleeding polypus** also called hemangioma of the nasal septum is an important cause of nose bleed.
3. **Squamous cell carcinoma** is seen in nickel workers, while adenocarcinoma in wood workers.
4. In **Ohngren's classification** of tumors of PNS, a line is drawn from medial canthus to angle of mandible; while in Lederman's, two horizontal lines and a vertical line is drawn.
5. Whenever **lymph nodes metastasis** occurs, minimum stage III malignancy is present.
6. **Weber-Ferguson incision** is used for total maxillectomy in carcinoma maxillary sinus.
7. **Commonest benign tumor** of nose and PNS is osteoma.
8. Case associated with **nickel workers** in ethmoidal carcinoma.
9. Max carcinoma **stage T3 N1M0** is treated by radical surgery and radiotherapy.
10. **Sebileau lines** are the ones drawn in Lederman classification in maxillary sinus malignancy.

Section 3

Diseases of Oral Cavity and Salivary Glands

Chapter 29 Surgical Anatomy of Oral Cavity

What Students Must Know!

- **Oral Cavity Anatomical Consideration**
  - Floor of Mouth
  - Retromolar Trigone
  - Tongue
  - Taste Pathways
- **Applied Anatomy**
- **Salivary Glands**
  - Hard Palate
  - Soft Palate

ORAL CAVITY

Oral cavity comprises of mouth, where mastication and mixing with saliva takes place (**Figure 29.1**).

Embryology

- It develops from primitive stomatodeum
- Hard palate develops from horizontal processes of maxillary and palatine bones.

Anatomical Consideration

- Oral cavity starts at the lips and opens into oropharynx at oropharyngeal isthmus
- It is bounded by lips, soft palate, cheeks, buccal mucosa, hard palate superiorly and muscles of floor of mouth covered by mucous membrane inferiorly
- It is supplied by 5th cranial nerve through maxillary and mandibular branches (**Figure 29.2**).

Vestibule

Vestibule is a slit like space bounded externally by lips and cheek and internally by the gums and teeth. Opening of the parotid gland opens in the vestibule opposite the crown of second upper molar tooth.

Gingivae (Gums)

- Gingivae cover the upper and lower alveolar ridges and roots of teeth
- Gingivolabial and gingivobuccal sulcii are the grooves formed between the gums and mucosa covering the lips and buccal mucosa.

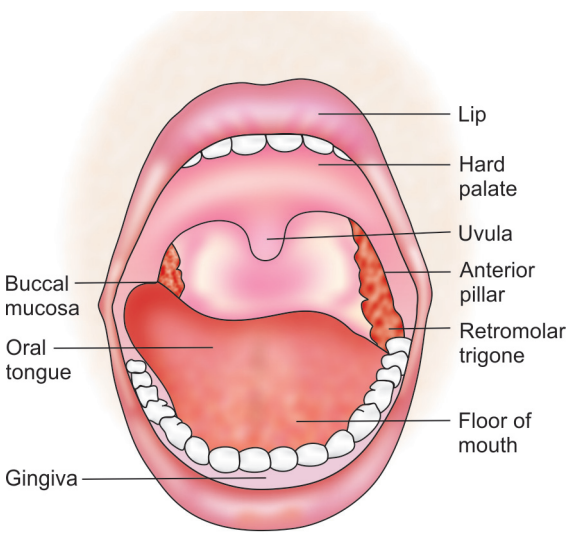


Figure 29.1 Contents and boundaries of oral cavity

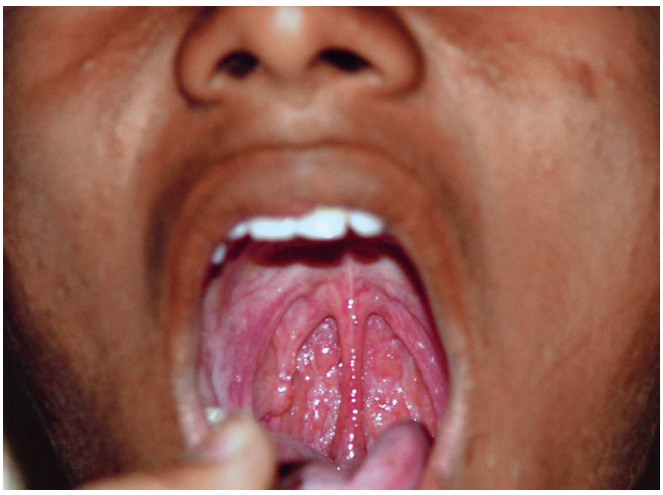


Figure 29.2 Enlarged uvula

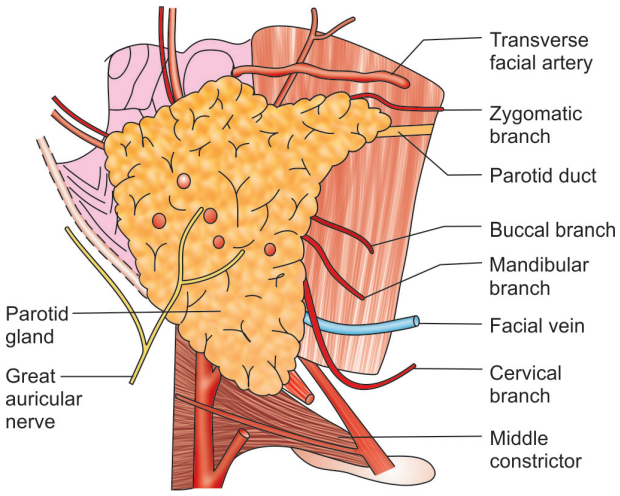


Figure 29.3 Surgical anatomy and relations of parotid gland

Oral Tongue

- The anterior two-thirds of tongue, which lies in the oral cavity
- It has tip, dorsum, lateral sides and undersurface.

Floor of Mouth

Floor of mouth lies under the tongue and contains the sublingual papillae with the opening of sublingual ducts and the frenulum with lingual vein on either side.

Retromolar Trigone

1. Retromolar trigone is a triangular area behind the last molar.
2. Its apex is near maxillary tuberosity while base lies just behind the last molar tooth.
   Surgical importance of this area is that:
   a. The malignancy of this trigone is difficult to treat since adequate surgical margin is not available.
   b. The malignancy here rapidly involves the base of skull making surgical treatment difficult.

Salivary Glands

- There are three major salivary glands.
- These glands produce saliva which helps in the:
  - Digestion of food
  - Acts as a lubricant and buffer.

Parotid Gland

- Parotid gland lies lateral to the ramus of mandible.
- It is the largest gland (25 gm) and produces serous secretions.
- Its duct 5 cm long after crossing the masseter muscle and pad of fat in the cheek (Stensen's duct) opens in the cheek opposite upper second molar.
- It has a superficial and a deep lobe separated by facial nerve branches
- Deep cervical fascia splits to enclose the parotid gland.
- Anteroinferior part of stylomandibular ligament separates parotid from submandibular gland.
- External carotid artery pierces the posteromedial surface of gland and divides into maxillary artery, superficial temporal artery and posterior auricular artery. Transverse facial artery is a branch of superficial temporal artery.
- Retromandibular vein formed by joining of superficial temporal vein and maxillary vein lies deep to facial nerve.
- Deep part of the gland is in close relation to parapharyngeal space.
- Parasympathetic supply originates in inferior salivary nucleus and travels with Glossopharyngeal nerve to Jacobson nerve and finally synapse in the otic ganglion (**Figures 29.3 and 29.4**).

Submandibular Gland

- Submandibular gland lies in the digastric triangle of neck and is about the size of a walnut (weight 10 g).
- It has a large superficial and a small deep part enclosed by deep cervical fascia.
- Its duct, Wharton's duct, about 5 cm long emerges from the middle of deep surface to open into the floor of mouth on the summit of sublingual papillae.
- Hypoglossal nerve passes deep to the tendon of digastric muscle running anteriorly deep to mylohyoid muscle.
- Facial artery enters the submandibular gland and leaves at the inferior border of mandible marked by facial notch.

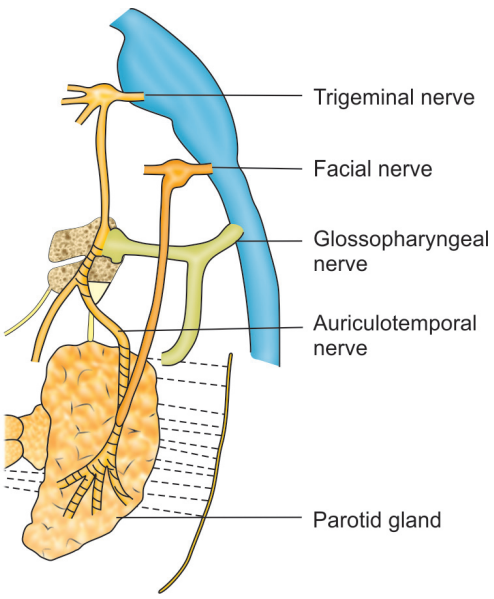


Figure 29.4 Nerve supply of parotid gland

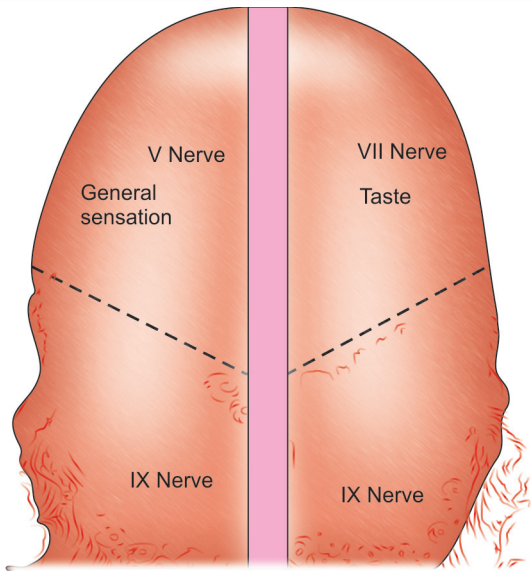


Figure 29.5 Nerve supply of tongue

- Lingual nerve lies between medial pterygoid and ramus of the mandible before entering the mouth below the third molar.
- It is supplied by branches from submandibular ganglion via nervous intermedius and chorda tympani.
- It produces both serous and mucous types of secretions as it contains both types of alveoli.

Sublingual Salivary Gland

- Sublingual salivary gland lies below the mucosa of floor of mouth and is the smallest gland (3–4 g).
- It is shaped like an almond.
- Ducts of Rivinus are 8 to 20 in number and open in the floor of mouth close to sublingual fold.
- It also produces both types of serous and mucinous secretions.

Functional Tests of Salivary Gland

- Sialography by giving low viscosity water soluble contrast
- Computed tomography (CT) and magnetic resonance imaging (MRI)
- Radio-sialography to see the concentration of radioisotope
- Diagnostic ultrasound
- Salivary gland endoscopy
- Fine needle aspiration cytology and biopsy
- Labial biopsy is best for diagnosis of Sjögren's syndrome.

Teeth

Deciduous or milk teeth are 20 in number, i.e. four incisors, two canines and four molars, while permanent teeth are 32, i.e. four incisors, two canines, four premolars and six molars in each jaw.

Each tooth has a crown, root, neck, pulp and dentine which form the main bulk.

Tongue

- Tongue is a muscular organ connected with the function of taste, speech and deglutition.
- It has a root, tip, dorsum and inferior surface.
- Root of tongue is attached to hyoid bone and mandible.
- Dorsum is convex, divided into anterior two-thirds and posterior one-third separated by sulcus terminalis.
- Anterior two-thirds have an apex, free lateral margin, superior surface with filiform and fungiform papillae.
- Lingual nerve (branch of mandibular) supplies ordinary sensations, while chorda tympani nerve carries taste sensations (**Figure 29.5**).
- Posterior one-third of tongue is supplied by glosso-pharyngeal nerve through its lingual branch.

Taste Pathways

Taste buds → via 7th, 9th and vagus to nucleus of tractus solitarius → to thalamus → post-central gyrus.

Applied Anatomy

- Attachment of genioglossi to the symphysis of mandible prevents the tongue falling backwards.
- The anesthetist pulls the mandible forward in obstructed respiration to take full benefit of this attachment.

Hard Palate

Hard palate is formed by palatine processes of the maxilla and horizontal part of palatine bones and is covered with a dense tissue formed by periosteum and mucous membrane.

Soft Palate

- Soft palate is a fold suspended from posterior border of hard palate.
- It consists of a fold of mucous membrane enclosing an aponeurosis, muscular fibers, vessels, nerves, lymphoid tissue and mucous glands.
- Mucous membrane is stratified squamous epithelium.
- Muscles of soft palate are levator palati, tensor palati, palatoglossus and palatopharyngeus.
- They are supplied through pharyngeal plexus by cranial part of accessory nerve except tensor palati, which is supplied by branch of mandibular nerve.
- Its blood supply comes through greater palatine branch of maxillary artery, ascending palatine branch of facial artery and palatine branch of ascending pharyngeal artery.
- Veins drain into pterygoid and tonsillar plexus.
- Sensory nerve supply is derived from greater palatine, lesser palatine and sphenopalatine nerves.

Key Points

1. In the **development process**, parotid gland forms at 4th week followed by submandibular gland (6th week) and sublingual gland (9th week).
2. Importance of **retromolar trigone** is that the malignancy in this area is difficult to treat because adequate margin is not available.
3. **Salivary calculi** are commonly seen in Wharton's duct due to the mucinous secretion of the gland and the position of the duct itself.
4. Attachment of **genioglossus muscle** to symphysis of mandible is made use of in cases of tongue falling backward by pulling the mandible forward.
5. Floor of mouth, tonsillolingual sulcus, vallecula and pyriform fossa are called **Surgeon's graveyard** as malignancy in these sites may be missed.
6. All **muscles of tongue** (intrinsic and extrinsic) are supplied by Hypoglossal nerve except palatoglossus which is supplied by accessory nerve through pharyngeal plexus.
7. **Sensory supply of tongue;** Lingual nerve is sensory and chorda tympani is gustatory to anterior 2/3 of tongue. Glossopharyngeal nerve is both sensory and gustatory to posterior 1/3 of tongue.
8. **Four basic tastes** are—sweet, sour, bitter and salt.
   - Bitter-posterior part of tongue
   - Sour-along the edges
   - Sweet-on the tip
   - Salt-on dorsum anteriorly
9. Pharynx and epiglottis can taste all the four basic sensations.
10. **Total amount of saliva** produced is 500–1500 cc and maximal stimulation for saliva production is done by 10 percent citric acid.

Chapter 30 Diseases of Oral Cavity

What Students Must Know!

- **Lesion of Oral cavity**
  - Aphthous Stomatitis
- **Behcet's Syndrome**
- **Oral Submucous Fibrosis**
  - Leukoplakia and Erythroplakia
  - Trismus
- **Ludwig's Angina**
- **Other Lesions**
  - Benign Lesions
  - Malignant Tumors

LESIONS OF ORAL CAVITY

Oral epithelium may be affected by a number of conditions producing various lesions, which may be due to local or systemic causes.

Aphthous Stomatitis

1. Aphthous stomatitis are small, shallow, very painful ulcers with a clean base and surrounding erythema.
2. These are found anywhere on tongue, buccal mucosa, palate or pharynx (**Figures 30.1A and B**).
3. These are rarely seen after 50 years of age. On examination multiple necrotic ulcers with surrounding erythema is typical of this disease.

Etiology

Etiology is not known but may be due to vitamin deficiency, viral, psychogenic and autoimmune factors. These may be associated with Behcet's syndrome or Sutton's disease, in which there are major recurrent aphthous ulcers.

Treatment

- Orodental hygeine
- Vitamin B complex and vitamin C
- Steroids locally
- Analgesic lozenges
- Cauterization of base of ulcer with silver nitrate or trichloroacetic acid gives relief of pain
- Levamisole an immunopotent drug has also been found to be quite beneficial.

Infective Stomatitis

Infective stomatitis may be due to viral infections such as herpes simplex or herpes zoster. There are small, multiple vesicles on lips, buccal mucosa and palate. Emotional stress, fatigue, fever, pregnancy, acquired immunodeficiency syndrome (AIDS) and immune deficiency may predispose to this.

Treatment

Acyclovir 200 mg, 5 times a day for 5 to 6 days.

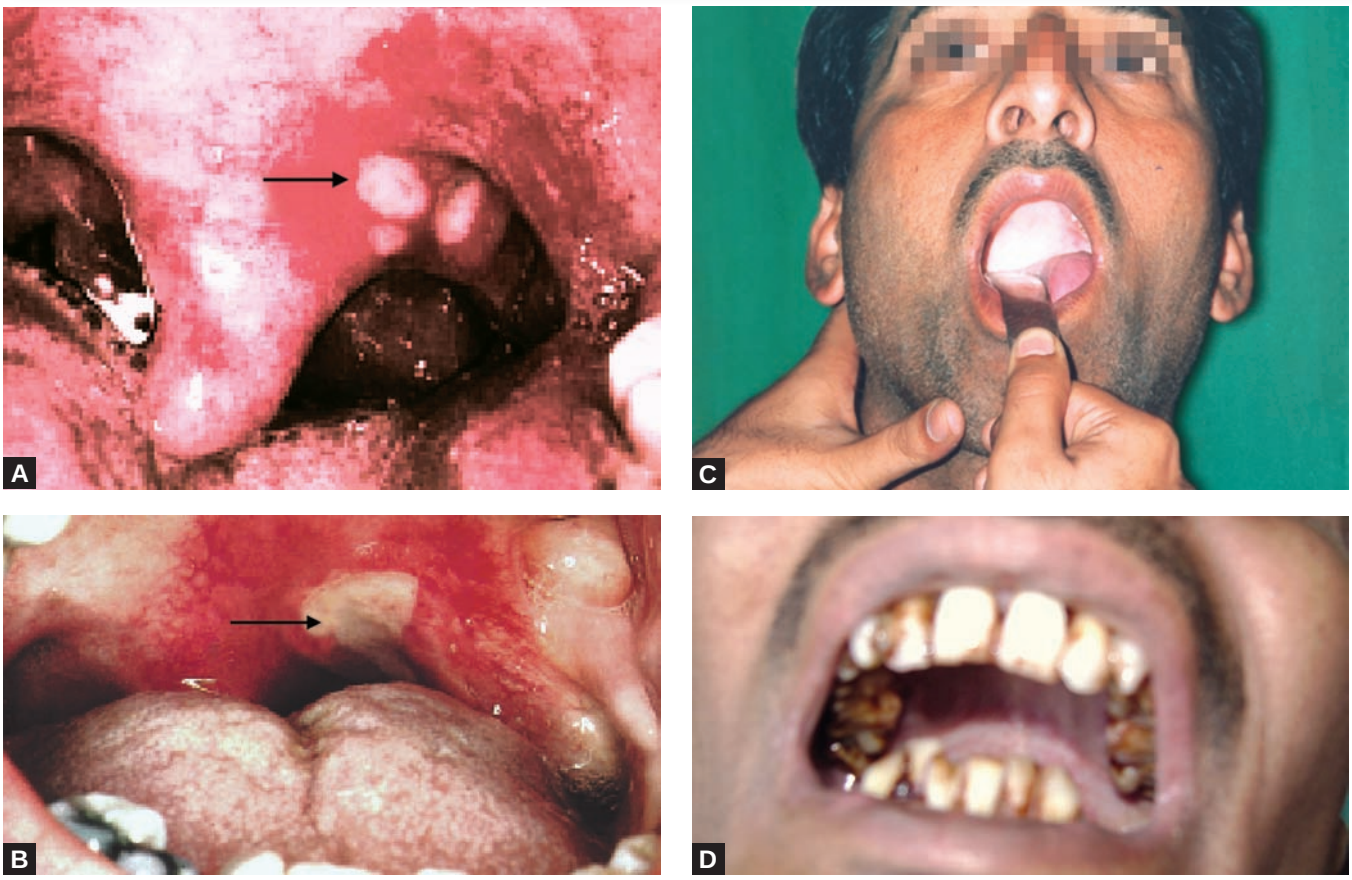
There can also be bacterial stomatitis such as Vincent angina, syphilitic or streptococcal stomatitis.

There may be traumatic stomatitis due to ill-fitting dentures, jagged teeth or bad brushing.

Behcet's syndrome

Behcet's syndrome is characterized by:

- Ulceration of buccal mucosa
- Ulcers on genitals
- Ocular lesions such as iridocyclitis and corneal ulcers
- Its cause is not known but may be due to virus infection or autoimmune causes.



Figures 30.1A to D (A and B) Aphthous ulcers in oral cavity; (C and D) Oral submucous fibrosis

Treatment

The treatment are:
- Broad-spectrum antibiotics
- Steroids
- Folic acid and vitamins.

Lichen Planus

Lichen planus is a pre-malignant condition, and its exact cause is not known.

In this condition, painful ulcers are seen on cheeks, gums and sides of tongue. The periphery of these ulcers is keratotic. Skin lesions are purple papules.

Treatment is with steroids.

Oral Submucous Fibrosis

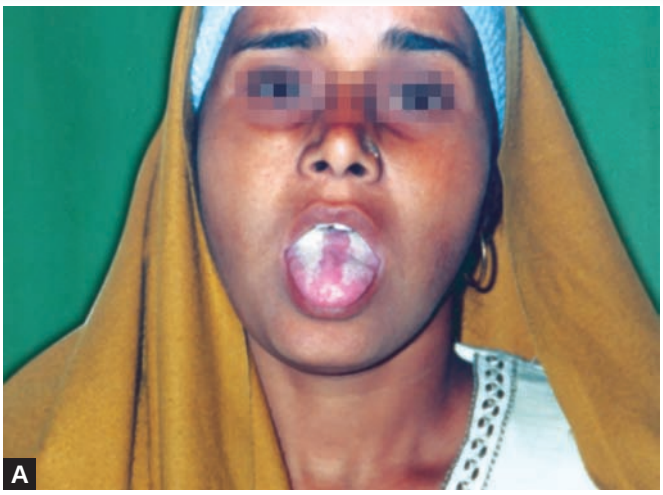
Oral submucous fibrosis is mostly seen in India, Pakistan and Bangladesh. It is seen in both sexes but more in females between 3rd to 5th decade. Incidence varies between 1 to 5 per 1000. It is characterized by dense, white, diffuse areas in the oral cavity due to extensive fibrosis in the submucosa causing progressive trismus (**Figures 30.1C and D**).

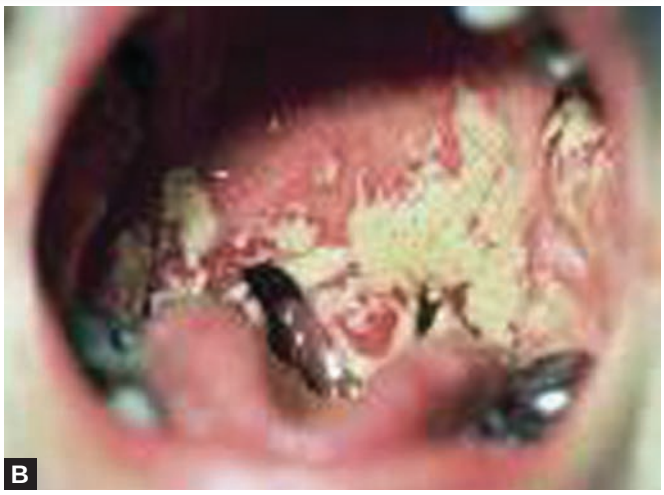
Causes

The exact etiology is not known but is thought to be due to:
- Prolonged betelnuts and arecanuts chewing leads to collection of activated T lymphocytes and macrophages causing proliferation of fibroblasts causing fibrosis
- Use of alcohol, tobacco, paan masala and spicy foods may also cause it
- It may be an autoimmune disease
- Repeated trauma, mechanical or thermal, may cause it
- Poor nutrition and vitamin A deficiency may be a factor in its etiology
- Poor orodental hygiene.

Clinical Features

The clinical features are:
- Burning sensation in the mouth
- Difficulty in swallowing





Figures 30.2A and B Oral thrush

- Difficulty in opening the mouth
- Blowing, whistling and sucking may be difficult
- Examination shows whitish blanched area over the oral mucosa, which becomes stiff and indurated.

Differential Diagnosis

1. Leukoplakia.
2. Lichen planus.
3. Thrush and trismus (**Figures 30.2A and B**).

Investigations

Investigations include hemogram, gastric analysis and biopsy to rule out malignancy.

Complications

Due to trismus, nutrition and dental hygiene may suffer. Malignancy may be seen rarely making it a premalignant condition. Conductive hearing loss may be due to eustachian tube dysfunction.

Treatment

The treatment include the following:

- Remove all irritant factors whatsoever
- Good orodental hygiene
- Good nutrition
- Local injection of hydrocortisone alone or mixed with hyaluronic acid twice or once weekly for 4 to 6 weeks in the submucosa
- Surgical measures, such as condylectomy to relieve trismus or by dividing fibrous bands in retromolar area and doing split skin grafts or mucosal flaps
- LASER surgery for dividing fibrous bands.

Leukoplakia

Leukoplakia is also called hyperkeratosis. In this condition, white patches are seen in the oral mucosa and may be associated with smoking, spirit, sepsis, spices, sharp tooth, syphilis submucus fibrosis and it is thought to be a precancerous condition (0.1–6%). Leukoplakia of tongue looks as though it has been covered with white paint (**Figure 30.3**) that has hardened, dried and cracked (Sir Henry T)

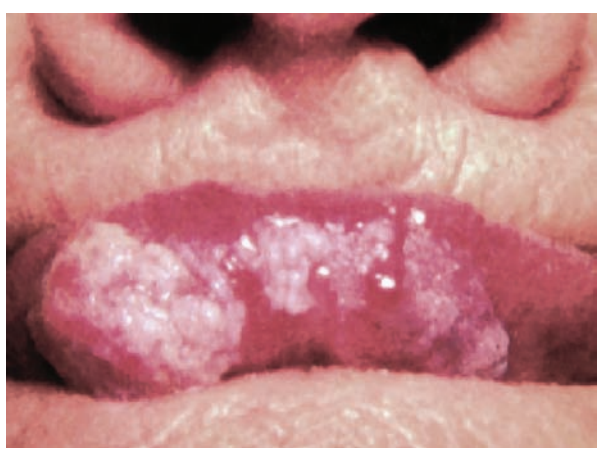


Figure 30.3 Leukoplakia tongue

Leukoplakia may be of homogenous type or nodular or speckled type.

On Examination

Patchy white areas on the cheek and dorsum of tongue are seen.

Treatment

- Remove any irritant factor
- Keep under observation
- Excision biopsy.

Erythroplakia

Erythroplakia is a red patch on mucosa and is also a pre-malignant condition. It may be homogenous or granular type.

Treatment is excision biopsy.

Allergic Stomatitis

Sometimes drug allergy may lead to stomatitis. Drugs may be systemic antibiotics, barbiturates and phenytoin. It may also be due to other causes such as lozenges and mouthwashes.

Treatment

Stop the offending agent and use of anti-allergics.

Trismus

It is inability to open the mouth and normal mouth opening is 5 to 7 cm.

- Grade I trismus is 2.5 to 4 cm mouth opening
- Grade II opening is 1 to 2.5 cm
- Grade III opening less than 1 cm
- Grade IV no opening of mouth.

It may be due to the following:

- Tetanus: It is painless
- Strychnine poisoning
- Peritonsillar abscess
- Alveolar infection of molars
- Acute otitis externa
- Temporomandibular joint arthritis
- Malignancy of oropharynx
- Oral submucous fibrosis
- Chemical burns
- Acute parotitis.

Complications

- Dental sepsis
- Poor nutrition.

Treatment

- Remove the cause.
- Surgical, i.e. condylectomy.

LUDWIG ANGINA

- Ludwig angina is a severe form of cellulitis involving submandibular space extending to floor of mouth.
- It is caused by anaerobic streptococci or pepto streptococci. Examination shows a hard woody swelling in the submental region with induration and tenderness in the floor of mouth.
- Treatment is conservative in early stage but incision and drainage has to be done, if pus formation has occurred. (for details, see deep neck infections and growths of oral cavity).

Cystic Lesions

Ranula

Cystic lesions is a mucous retention cyst in the floor of mouth arising from minor salivary glands. If it penetrates the myelohyoid muscle, it is called plunging ranula, which appears as a bluish swelling and treatment is excision or marsupialization (**Figure 30.4**).

Other Lesions

Other lesions may be mucocele or dermoid cyst, which are treated by excision.

Benign Lesions

Benign lesions are:

- Papillomas
- Hemangiomas
- Fibromas
- Lymphangiomas

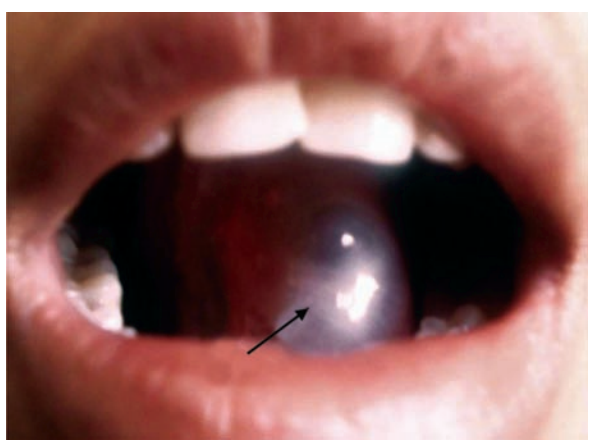


Figure 30.4 Rannula floor of mouth

- Epulis (swelling of gums)
- Myxparotid tumor (pleomorphic adenoma) (**Figures 30.5A to D**)
- Myofibroblastic tumor palate (**Figures 30.6A and B**)
- Congenital tumor tongue (Choristoma)—rarely seen (**Figure 30.7**).

These present as swelling in the oral cavity and treatment is excision by LASER surgery or cryosurgery.

Malignant Tumors

Malignant tumors may arise from lips (**Figures 30.6C and D**), oral tongue (**Figures 30.8A to C**), cheek, retromolar area and mandible and histological types may be squamous or adenocarcinoma. Predisposing factors are spirit, spices, smoking, syphilis and sharp bad teeth.

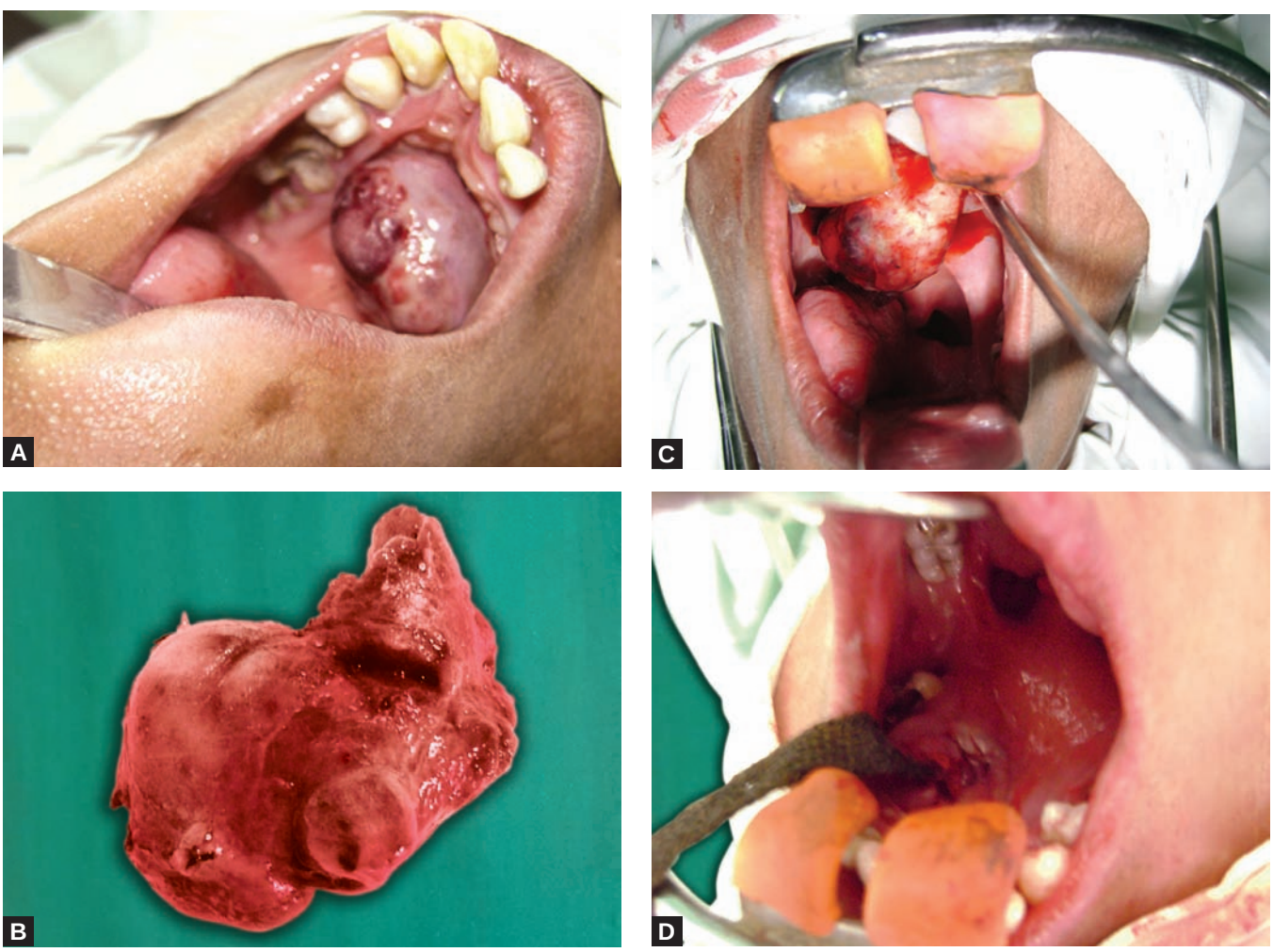
Clinical Features

Ulcerative mass, raised margins, otalgia and difficulty in opening the mouth with cervical lymphadenopathy (**Figures 30.8A to C**).

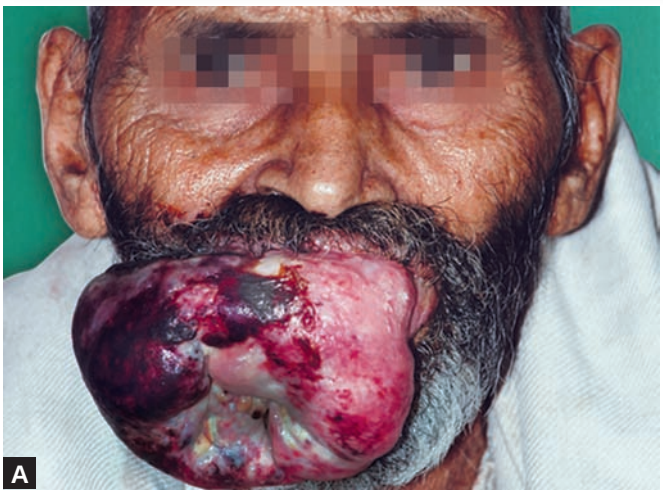
Treatment

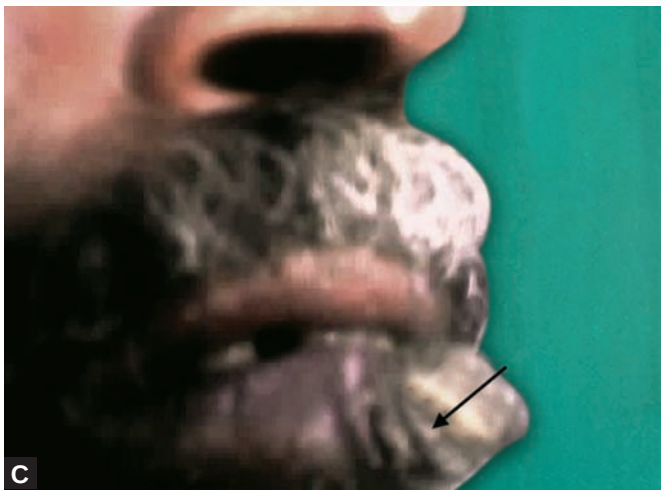
Treatment depends upon the site and stage of the tumor.

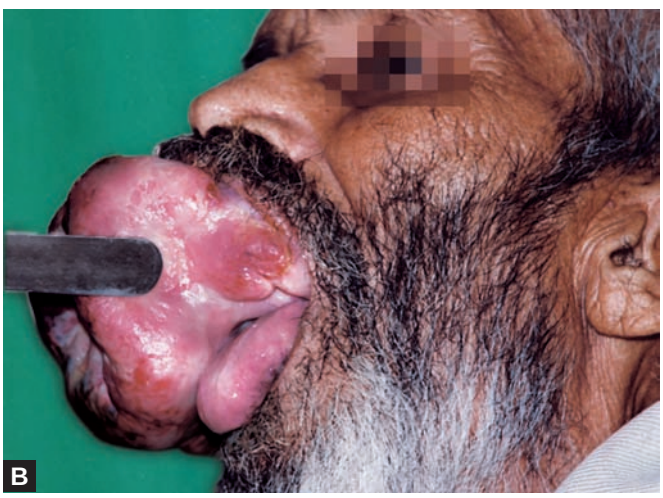
- For stage I and II, surgery is advised with or without radical neck dissection.
- Stage III requires surgery followed by radiotherapy.
- In stage IV, palliative treatment is given in the form of chemotherapy or radiotherapy with or without surgical treatment.

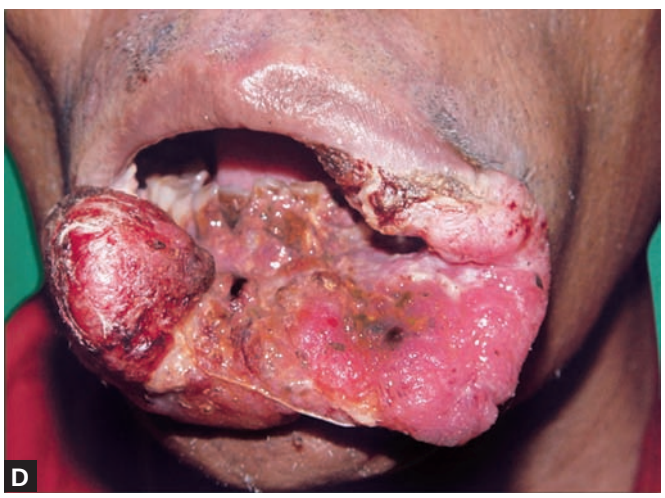


Figures 30.5A to D Myxparotid tumor (pleomorphic adenoma) of hard palate and its excision









Figures 30.6A to D (A and B) Myofibroblastic tumor of palate; (C and D) Carcinoma lip

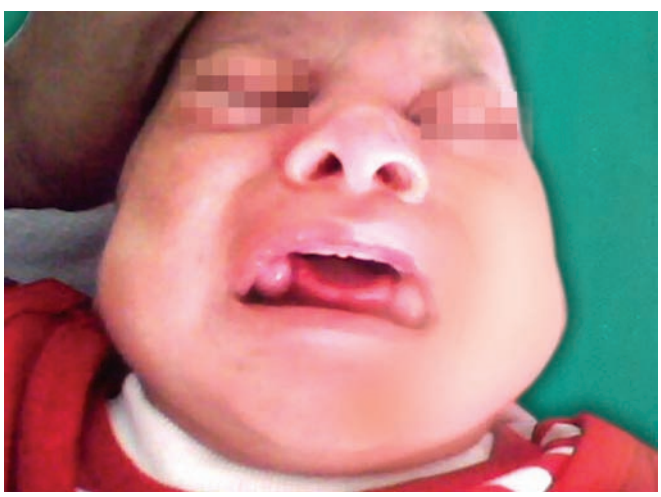
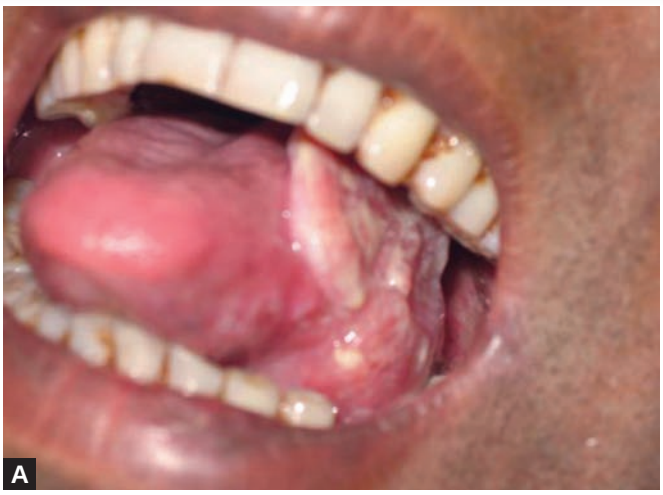
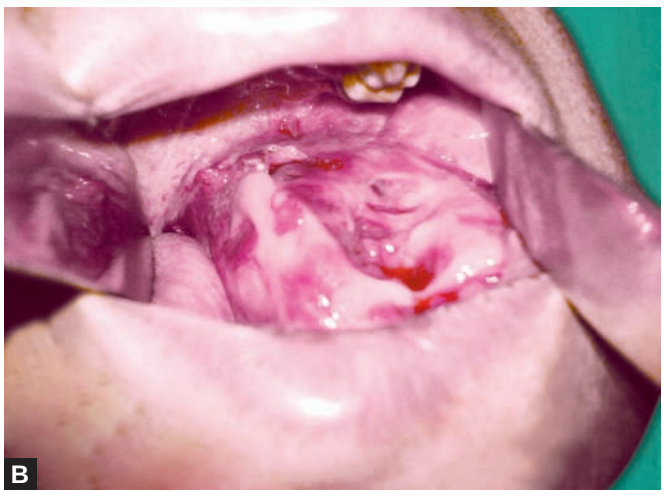
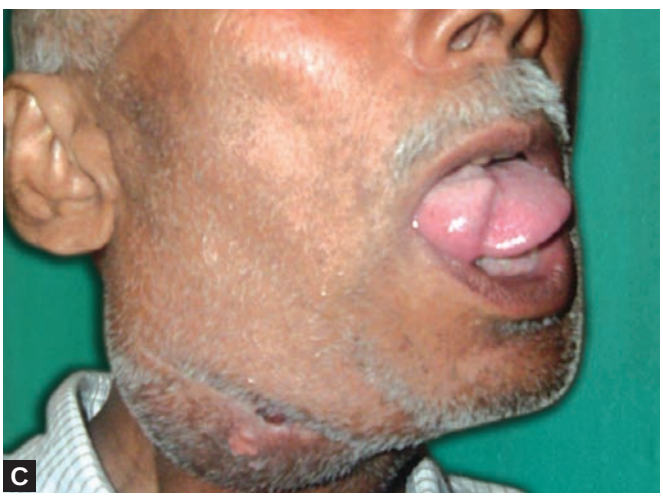


Figure 30.7 Bilateral congenital tumor of tongue (Choristoma)







Figures 30.8A to C (A and B) Carcinoma tongue; (C) Carcinoma base of tongue with secondaries neck

Key Points

1. **Aphthous ulcers** are usually multiple painful and shallow ulcers. Cauterization of base is quite effective along with treatment of the cause.
2. **Behcet syndrome** is characterized by ulcers in oral cavity, genital lesions and ocular lesions.
3. **Trismus** in oral submucous fibrosis is due to fibrosis of the area involving last molar and in front of ramus of mandible.
4. **Rannula** becomes plunging ranula, when it penetrates myelo-hyoid muscle.
5. Malignant change in **erythroplakia** is 17 times higher than in leukoplakia (0.15–6%)
6. **Stage IV** malignant lesions of oral cavity are treated by palliative measures only, i.e. by chemotherapy or radiotherapy.
7. **Fordyce's spots** are modified ectopic sebaceous glands in the oral cavity.
8. **Koplik's spots** are pathognomic of measles while Forchheimer spots on palate are seen in German's measles, scarlet fever and infectious mononucleosis.
9. **Bowen disease** is intraepidermal squamous cell carcinoma, i.e. potentially malignant.
10. Etiology of submuous fibrosis—**remember mneumonic: STAMINA: S: S**ocioeconomic status; T: **T**obacco; A: **A**reca nuts; M: **M**ultifactorial; I: **I**mmmune process; N: **N**utritional; A: **A**lcohol

Chapter 31 Diseases of Salivary Glands

What Students Must Know!

- **Non-neoplastic Lesions**
  - Acute Suppurative Sialadenitis
  - Chronic Sialadenitis
  - Submandibular Gland Excision
  - Mumps
- **Sjögren's Syndrome**
  - Frey's Syndrome
  - Sialolithiasis
- **Salivary Gland Tumors**
  - Benign Tumors
  - Malignant Tumors
  - Parotidectomy

INTRODUCTION

Diseases of salivary glands may be discussed under:
1. Non-neoplastic lesions
2. Neoplastic salivary gland tumors.

NON-NEOPLASTIC LESIONS

Suppurative disorders may be as follows.

Acute Suppurative Sialadenitis

Acute suppurative sialadenitis may involve parotid or submandibular gland. Parotid is affected more due to less bacteriostatic activity of saliva of parotid gland, than saliva of submandibular gland which has more glycoprotein contents.

Predisposing Conditions

These usually are calculi, strictures, poor orodental hygeine, dehydration and immune deficiency and postoperatively, *Staphylococcus* is the usual organism.

Clinical Features

Pain, body aches, fever, swelling of the gland and trismus. On examination, duct of the gland appears inflamed and purulent secretions can be expressed (**Figures 31.1 and 31.2**).

Treatment

- Antibiotics
- Anti-inflammatory drugs and analgesics
- Orodental hygeine.

Complications

Abscess formation.

Chronic Sialadenitis

Chronic infection of salivary glands can lead to firm, mild enlargement of the gland with repeated acute infections. It is also seen more in parotid gland followed by submandibular gland. There occurs progressive glandular destruction leading to changes in the chemistry of saliva.

Clinical Features

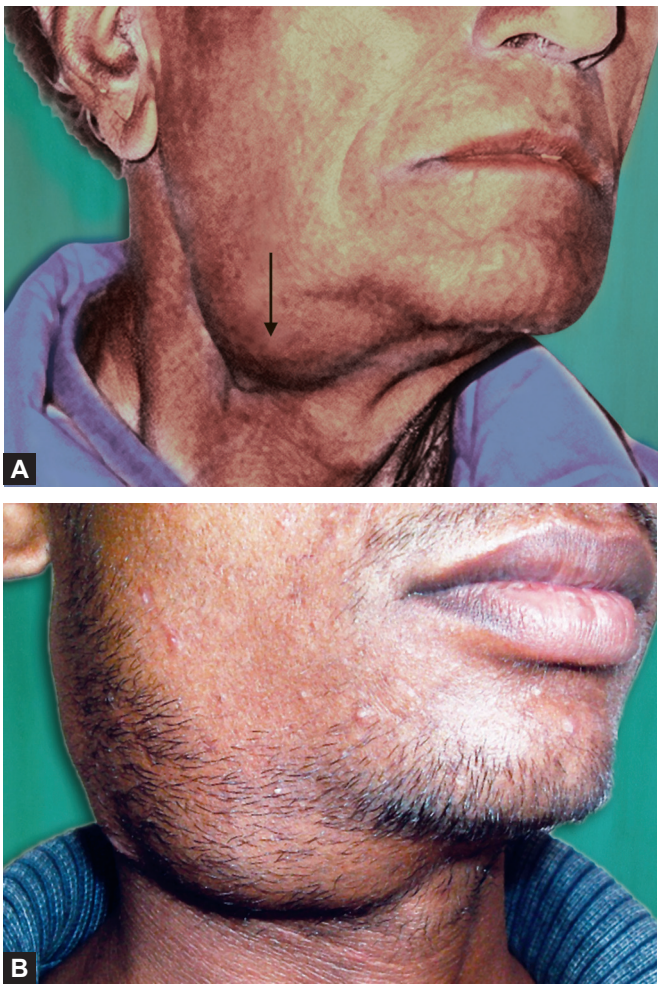
History of recurrent, mildly painful enlargement of gland.

Massage of gland produces scanty secretions at the opening of the duct.

Xerostomia may develop.

Investigations

1. Sialography—a study of ductal system of salivary glands by injecting contrast media (Meglumine diatrizoate) to show calculi, foreign bodies stricture, salivary fistulas, volume of gland, size of tumor and Sjögren's syndrome.



Figures 31.1A and B Swelling of submandibular gland

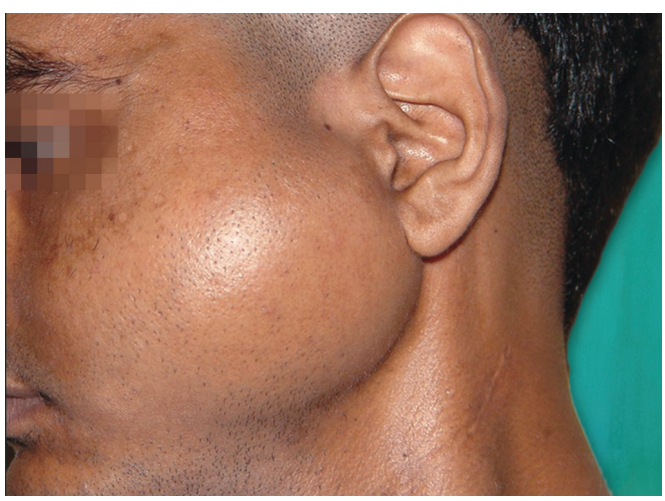


Figure 31.2 Swelling of the parotid gland

– Sialography may be conventional, secretory, interventional or hydrostatic type, computed tomography (CT) sialography, digital substraction sialography.

Various Appearances in Sialography

- In chronic Sialadenitis—Sausage or string appearance.
- In large sialolith—Pruned tree like appearance.
- In Sjögren's syndrome—Fruit laden tree like.
- Benign tumors—Ball in hand appearance
- Normal gland—Double comb appearance.

2. CT scan
3. Fine needle aspiration cytology (FNAC)
4. Color Doppler sonography—non-invasive technique to evaluate vascular anatomy.
5. Positron emission tomography—helps to differentiate benign from malignant lesions.

Treatment

- Treatment of the cause such as stone or stricture of the duct.
- If there is no cause, conservative treatment should be given in the form of antibiotics, massage of the gland and sialogogues.
- If it fails, ductal dilation, ligation of duct or total gland excision may be done. Tympanic neurectomy may also help.

Submandibular Gland Excision

Procedure

- Anesthesia—general/local anesthesia (GA/LA)
- Patient in supine position with head extended and chin to opposite side.
- Incision 6 to 7 cm long is made in the skin crease about 3 cm below the lower border of mandible to avoid injury to mandibular branch of facial nerve
- Skin, subcutaneous tissue with platysma is retracted using cat paws
- Investing layer of deep fascia is then cut protecting the mandibular branch
- Loose connective tissue is separated after clamping the anterior facial vein to expose the gland
- Anterior pole of superficial layer is mobilized upwards along with posterior belly of digastric muscle exposing facial artery here which passes upwards and forwards to enter deep lobe of gland
- Artery is clamped and tied
- Anterior pole of gland is retracted posteriorly where again many small vessels are secured
- Mylohyoid muscle is seen and retracted to see the deep lobe of the gland which can be mobilized then with a finger any vein coming in way is ligated

- Submandibular gland can be pulled downwards showing V-shaped lingual nerve which should be carefully separated
- Next submandibular duct is clamped and divided as far forward as possible. Hypoglossal nerve is also identified in the bed of the field now, drain is put and a firm dressing done.

Complications

- Injury to cranial nerves like mandibular branch of facial nerve
- Lingual
- Hypoglossal nerve.

Mumps

Mumps is also called viral parotitis and is usually seen in children up to 12 to 15 years of age. It spreads by droplet infection and its incubation period is 15 to 20 days.

Clinical Features/Diagnosis

Fever, malaise, tender and diffuse enlargement of gland.

Diagnosis is made on clinical basis serum amylase is raised in 90 percent cases. Titers of mumps S and V antibodies is raised.

Treatment

Complete bedrest, antibiotics, anti-inflammatory drugs and vitamins.

Prevention may be done by giving MMR (measles, mumps and rubella) vaccination at 15 months of age.

Complications

- Unilateral sensorineural hearing loss (SNHL) due to labyrinthitis
- Viremia causing orchitis, pancreatitis, meningitis, and encephalitis.

Sjögren's Syndrome (Sicca Syndrome)

- Sjögren's syndrome it was described by Hadden in 1883
- Sjögren was a Swedish ophthalmologist
- It is characterized by swelling of the salivary gland with xerostomia and xerophthalmia
- It is thought to be an autoimmune disorder affecting exocrine glands of the body
- In 35 percent cases, major salivary glands may be involved.
- In 90 percent cases, women are affected.

Clinical Types

Primary type: In which there is involvement of only exocrine glands causing dryness of mouth and eyes. Lymphoma may develop in primary type.

Secondary type: In which in addition to the symptoms of primary type there is rheumatoid arthritis or systemic lupus erythematosus (SLE) or primary biliary cirrhosis

Associated symptoms with primary type may be:

- Pneumonitis
- Raynaud's phenomenon
- Dryness of skin and caries teeth
- Achlorhydria
- Hepatosplenomegaly
- Myositis, pancreatitis and nephritis
- Dryness of genitals
- Lymphadenopathy.

Investigations

1. Biopsy shows periductal lymphocytic infiltration. Preferred site for biopsy is minor sublabial gland (lower lip).
2. Raised erythrocyte sedimentation rate (ESR).
3. Rheumatoid factor may be positive.
4. Antinuclear antibodies may be present.
5. Elevated antigens Sjögren's syndrome antigen A (SS-A) and Sjögren's syndrome antigen B (SS-B).

Treatment

- Symptomatic treatment in the form of artificial saliva, artificial tears and use of sialogogues to stimulate saliva formation such as eating raw apples daily and sugar-free sour candies
- Orodental hygeine should be maintained
- Use of immunosuppressant drugs such as methotrexate, helps in the prevention of development of subsequent malignancy.

Frey's syndrome (gustatory sweating)

- The condition consists of sweating and flushing of skin of face during mastication
- It occurs due to aberrent parasympathetic nerve supply of sweat glands instead of parotid gland after parotid surgery
- It is treated by tympanic neurectomy in the middle ear.

Sialolithiasis

Calculi occur in the duct of submandibular gland in 80 percent cases and 20 percent in parotid gland. They are formed when calcium phosphates are deposited around the debris and mucus.

Clinical Features

There is painful swelling of the gland due to obstruction to flow of saliva. Examination shows a calculus in the duct of the gland confirmed by plain X-ray with occlusive bite taken on dental X-rays plate. Sialography may confirm the radiolucent stone (**Figure 31.3**).

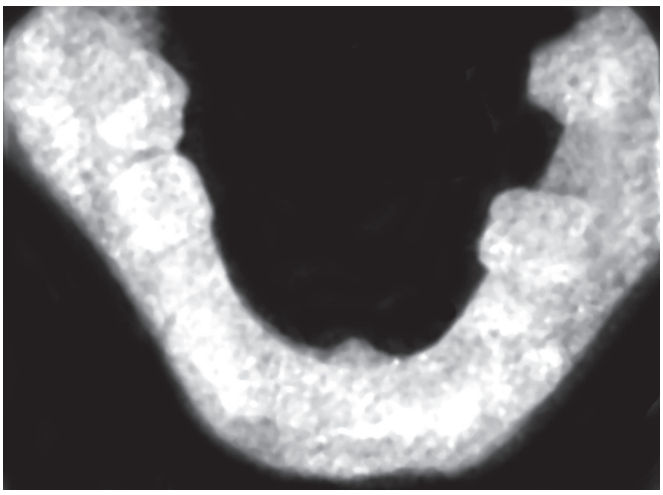


Figure 31.3 X-ray showing salivary calculus

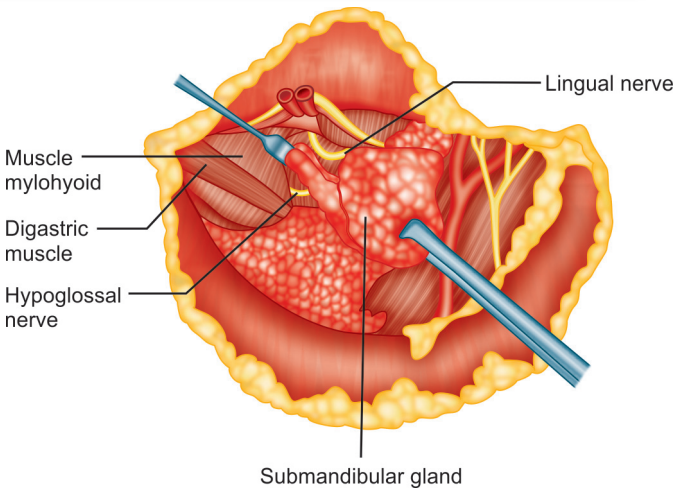


Figure 31.4 Excision of submandibular gland

Treatment

Excision of the calculus under local anesthesia if it is in the duct and if present in the gland, gland may also be sacrificed.

Sialadenosis

Sialadenosis is a nonspecific, noninflammatory, non-neoplastic enlargement of salivary gland usually the parotid. It may be seen in malnutrition, pellagra, cirrhosis, diabetes, hypovitaminosis and obesity.

Treatment is of the underlying cause.

Kussmaul's Disease

Kussmaul's disease is also called sialodochitis fibrinosa and consists of a mucus plug obstructing the duct usually seen in dehydrated patients. The patient presents with recurrent swelling and pain of the gland.

Treatment

It consists of gentle massage and sialogogues to remove the plug. Rehydration of the patient is also important.

Ptyalism

Ptyalism refers to the excessive production of saliva. It may be associated with a number of medical conditions, including inflammation, cerebral palsy and pregnancy. Medications may also produce ptyalism as a side effect.

Treatment

If medications with drying agents are not effective, surgical treatment is indicated. Other treatment options include selective neurectomy of the chorda tympani nerve, excision of the salivary gland, and either ligation or transposition of the affected duct.

SALIVARY GLAND TUMORS

Benign Tumors

Pleomorphic Adenoma

Pleomorphic adenoma is also called mixed parotid tumor. It is the most common benign tumor and may affect major and minor salivary glands. It is very slow growing, benign pathology seen more in females between 30 and 50 years. These are called mixed tumors due to presence of epithelial and mesenchymal tissues.

Clinical Features

Patients present with firm, lobulated mass of submandibular or parotid gland or of the minor salivary glands of oral cavity. Malignant change is very rare.

Treatment

Excision of the tumor (**Figure 31.4**) is done and enucleation is avoided as there may be recurrence.

Warthin's Tumor

Hilderbrand described this tumor in 1895, but Warthin of Michigan in 1929 described two cases of papillary cystadenoma. It is seen in elderly, obese males and may be soft, cystic or firm in the parotid gland. Histologically, there are epithelial cells with lymphoid tissue.

Treatment consists of wide excision.

Other Benign Tumors

They may be oncocytoma, monomorphic adenomas, hemangiomas, lymphangiomas and lipomas. These occur in parotid gland mostly and are treated by surgical excision.

Malignant Tumors

These are more commonly seen in parotid gland and can be:
- Mucoepidermoid carcinoma
- Adenoid cystic carcinoma (cylindroma)
- Squamous cell carcinoma
- Sarcomas.

Clinical Features

Sudden rapid increase in the size of growth, which becomes painful and may fungate or give secondary deposits into lymph nodes. Facial nerve may be involved.

Staging of malignancy is on the American Joint Committee on Cancer (AJCC) (1988) lines as usual.

Treatment

Total excision of parotid gland with block dissection of neck followed by radiotherapy.

In advanced cases, palliative treatment in the form of radiotherapy or chemotherapy is given.

Parotidectomy

Procedure

- Parotidectomy may be superficial parotidectomy as in benign tumors and total parotidectomy in malignant tumors
- Incision begins at preauricular region going below lobule in the skin crease on to the neck.
- Skin flap is raised upwards and downwards
- Stylomastoid region is exposed to locate the trunk of facial nerve, cartilage pointer being a reliable landmark here beside styloid process and mastoid process
- Superficial lobe of parotid is then exteriorized by blunt dissection keeping in mind branches of facial nerve
- Posterior facial vein branches will be seen deep to marginal mandibular nerve
- Parotid duct is ligated as far forward as possible
- If deep lobe has to be removed branches of facial nerve are separated and deep lobe is mobilized from its attachments by blunt dissection
- Perfect hemostasis is achieved and dressing done.

Complications

- Facial nerve palsy or weakness
- Gustatory sweating (Frey's syndrome)
- Sialocele or salivary fistulas.

Key Points

1. **Sjögren's syndrome** includes swelling of salivary glands with xerostomia and xerophthalmia.
2. Treatment of **Frey's syndrome** is by tympanic neurectomy.
3. Calculi occur in **Wharton's duct** in 80 percent cases and Stensen's duct in 20 percent cases.
4. **Sialography** is a confirmatory investigation for submandibular duct calculi.
5. Surgical treatment of choice for **pleomorphic adenoma** is superficial parotidectomy, whereas it is wide excision for Warthin's tumor.
6. **Adenoid cystic carcinoma** is the most common malignant tumor of the salivary glands.
7. Parotid gland means gland around (para) ear (otis).
8. 3/4 quantity of saliva with pH 6.5 is secreted by submandibular gland.
9. **Rule of 2 in submandibular gland surgery:**
   i. Two conditions affect it, i.e. stone and tumor.
   ii. Two superficial nerves related—cervical and mandibular branch of facial nerve.
   iii. Two deep nerves related are—lingual and hypoglossal nerve.
   iv. 2 cm below the mandible incision is given.
   v. Two parts of gland divided by myelohyoid muscle.
   vi. Two places facial artery is ligated.

Section 4 Diseases of Pharynx

Chapter 32 Surgical Anatomy and Physiology of Pharynx

What Students Must Know!

- **Development of Pharynx**
- **Pharynx-Surgical Anatomy**
  - Muscles of the Pharynx
  - Nerve Supply
  - Blood Supply of Pharynx
- **Nasopharynx**
- **Oropharynx**
  - Tonsils
  - Functions of Tonsil
- **Hypopharynx or Laryngopharynx**
  - Postcricoid Region
  - Posterior Pharyngeal Wall

PHARYNX

Pharynx develops from anterior end of primitive foregut.

1. Pharynx is a fibromuscular tube 12 to 14 cm in length, above it is 3.5 cm and below 1.5 cm.
2. It extends from base of skull above to the level of 6th cervical vertebra (lower border of cricoid cartilage) where it ends into pharyngoesophagus junction at cricopharynx, the narrowest part of digestive tract except the appendix.
3. It is lined by squamous stratified type of epithelium except in nasopharynx where the lining membrane is columnar ciliated epithelium.

Parts of Pharynx

The parts of pharynx are as follows (**Figure 32.1**):

- Nasopharynx, oropharynx and laryngopharynx or hypopharynx

1. **Nasopharynx (Epipharynx):**
   i. Nasopharynx extends from the base of skull above to the level of soft palate (C2 level).
   ii. Passavant ridge is an elevation formed by fibers of superior constrictor and palatopharyngeus on the posterior wall of pharynx, which helps in closing the nasopharynx from oropharynx with the posterior border of soft palate.
   iii. *Sinus of Morgagni:* It is an interval between upper border of superior constrictor and base of skull and many structures pass upward from the pharynx.
   iv. Rathke's pouch is seen as a dimple in the roof of nasopharynx.
2. **Oropharynx:** It extends from palatal sphincter to the level of tip of epiglottis (C4 level).

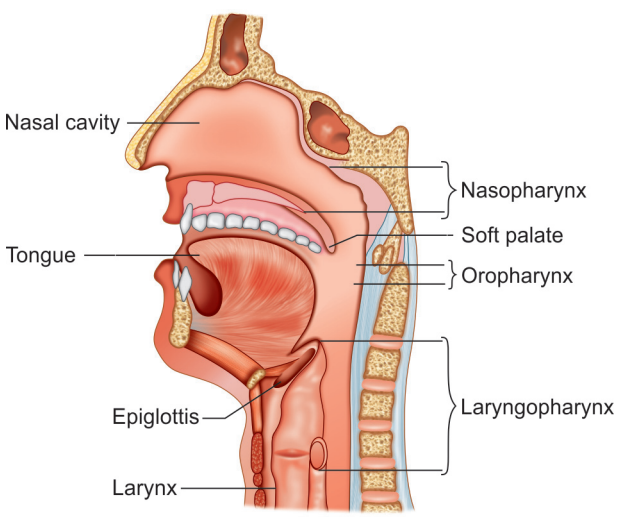


Figure 32.1 Divisions of pharynx

3. **Hypopharynx:** It extends from epiglottis up to the lower border of cricoid cartilage (lower border of C6).

Layers of Pharynx

Layers of pharynx has mucous membrane, submucous lymphoid tissue, pharyngeal aponeurosis, muscular coat and buccopharyngeal fascia.

Muscles of the Pharynx

Extrinsic Muscles

Different parts of pharyngeal wall is shown in **Figure 32.2**.

Superior constrictor
It arises from pterygoid hamulus, pterygomandibular ligament and posterior end of mylohyoid line.

Middle constrictor
It is a fan-shaped muscle, which arises from lesser and greater cornu of hyoid bone.

Inferior constrictor
- It is the thickest of all muscles of pharynx. It has two parts:
  - Upper part, i.e. thyropharyngeus with oblique fibers arising from oblique line of thyroid cartilage
  - Lower part, i.e. cricopharyngeus arises from lateral side of cricoid cartilage and its transverse fibers form cricopharyngeal sphincter.

Nerve supply
- Constrictor muscles are supplied through pharyngeal plexus
- Pharyngeal plexus is formed by pharyngeal branch of vagus and glossopharyngeal nerve and pharyngeal branch of superior cervical sympathetic ganglion
- Inferior constrictor is supplied by recurrent laryngeal nerve.
- Killian's dehiscence is a gap between oblique and transverse fibers of inferior constrictor muscle (**Figure 32.3**).

Intrinsic Muscles

- Stylopharyngeus
- Salpingopharyngeus
- Palatopharyngeus.

Blood Supply of Pharynx

- Ascending pharyngeal branch of external carotid
- Ascending palatine branch of facial (branch of external carotid)
- Greater palatine branch of maxillary.

Venous drainage through pharyngeal plexus into internal jugular vein.

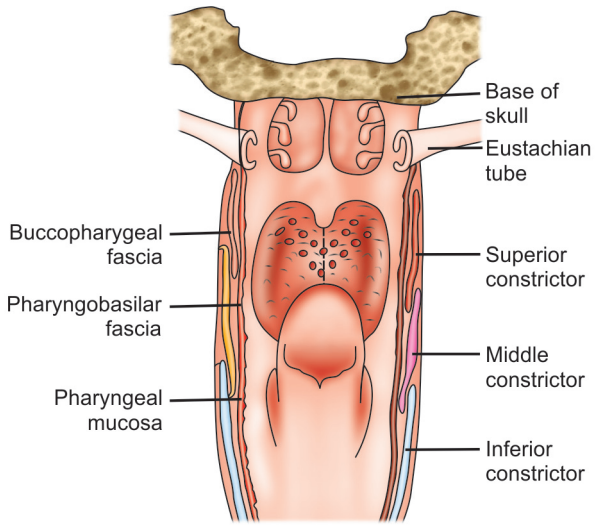


Figure 32.2 Pharyngeal wall

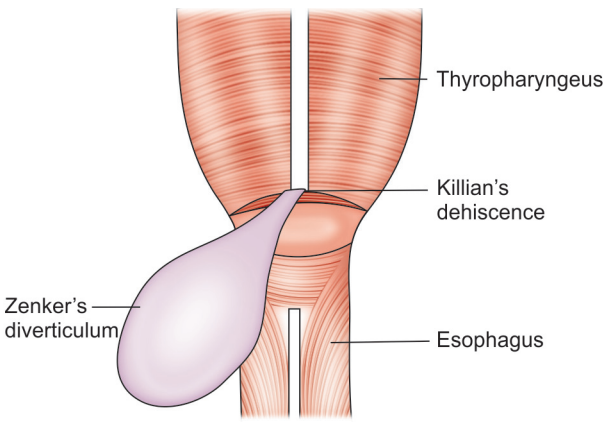


Figure 32.3 Zenker's diverticulum

Nerve Supply

Nerve supply is by pharyngeal plexus of nerves, which is formed by:
- Branch of vagus (X nerve): Motor supply
- Branches of glossopharyngeal (IX nerve): Sensory supply
- Sympathetic plexus.

Lymphatic Drainage

Lymphatic drainage is into retropharyngeal and jugulo-digastric nodes.

Subepithelial collection of lymphoid tissue in the pharynx forms Waldeyer's ring. It has no afferents and efferents drain into cervical lymph nodes. It consists of nasopharyngeal tonsil, tubal tonsil, faucial tonsil and lingual tonsil (**Figure 32.4**).

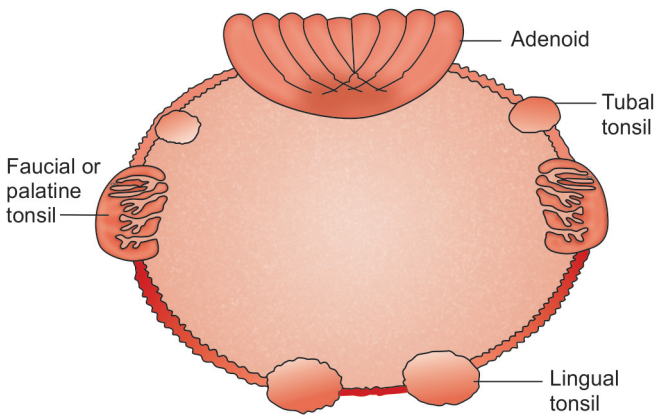


Figure 32.4 Waldeyer's ring

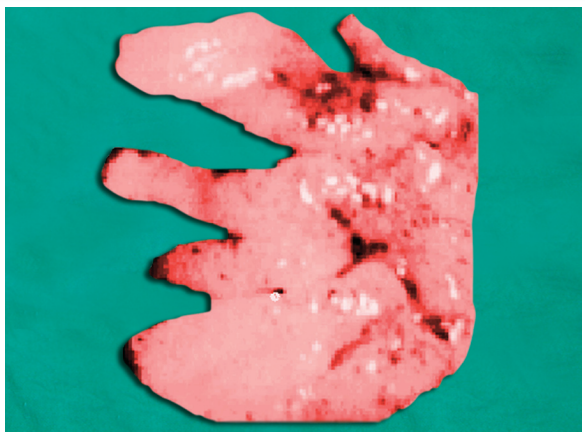


Figure 32.5 Adenoid mass

Functions

- Pharynx helps to provide immunity and formation of antibodies
- It protects the lower respiratory tract
- It forms plasma cells and lymphocytes
- Acts as a warning to the body against infectious agents in air and food.

NASOPHARYNX

1. Nasopharynx is also called third chamber of nose, which lies behind the nose and above the soft palate
2. The space communicates anteriorly with the nose through posterior choanae and with the middle ear through eustachian tube opening in the lateral wall of nasopharynx.
3. Dimensions of nasopharynx are:
   4 cm (height) × 4 cm (width) × 3 cm (length).
4. Roof and posterior wall form a continuous sloping surface, which is formed mainly by the basilar part of occipital bone and to some extent, by body of sphenoid and arch of altas vertebra.
5. Lateral wall has the eustachian tube opening, 1 to 1.25 cm (equidistant from all walls), behind and little below the posterior end of inferior turbinate.
6. The opening is triangular in shape, bounded above and behind by tubal cartilage.
7. Two folds of mucous membrane—salpingopharyngeal and salpingopalatine stretch from the opening of eustachian tube to the walls of pharynx and palate.
8. A pharyngeal recess called fossa of Rosenmuller of 1.5 cm depth lies behind the tubal elevation of eustachian tube. It contains node of Rouviere.
9. Soft palate is the anterior wall of nasopharyngeal isthmus.
10. Posterior pharyngeal wall with Passavant's ridge forms the posterior wall. This isthmus closes during swallowing and speech.
11. Nasopharyngeal tonsil or adenoid mass lies in the nasopharynx (**Figure 32.5**)
12. It consists of a number of folds, which radiate forward and laterally from a median recess called pharyngeal bursa.
13. It has no capsule and atrophies by 12 to 15 years of age.
14. No feeding blood vessel, supplied by adjacent plexus only.

OROPHARYNX

- Oropharynx is the part of pharynx, which lies behind the oral cavity
- It extends from soft palate to the upper border of epiglottis
- It opens anteriorly through nasopharyngeal isthmus into mouth
- Its lateral wall presents the palatopharyngeal arch and the faucial tonsil
- Posteriorly, it is supported by the body of second cervical and upper part of 3rd cervical vertebra
- Valleculae are situated between base of tongue and lingual surface of epiglottis bounded laterally by lateral glossoepiglottic fold (**Figure 32.6**).

Tonsils (Figures 32.7A and B)

1. These are two masses of lymphoid tissue situated in the lateral wall of oropharynx.
2. Each tonsil is placed between palatoglossal (anterior pillar) and palatopharyngeal fold (posterior pillar).
3. Its medial surface is free and projects into the pharynx.
4. Inferiorly, it extends into dorsum of tongue.
5. Superiorly, it invades the soft palate.
6. Plica triangularis is a free fold of mucous membrane extending from palatoglossal arch to the anteroinferior part of tonsil.
7. Upper part of tonsil contains a deep cleft called crypta magna or intratonsillar cleft (**Figure 32.7A**).
8. Medial surface presents 12 to 15 orifices termed tonsillar crypts or pits, which extend into the whole substance

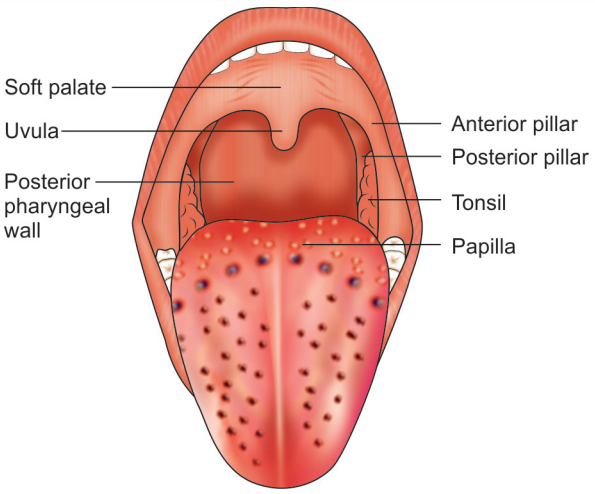


Figure 32.6 Structure of oropharynx

of tonsil, branching inside the tonsil. These help in increasing the surface area.

9. Lateral surface is covered by fibrous capsule separated from muscular wall formed by superior constrictor with styloglossus muscle on its lateral side.
10. At anteroinferior part, the capsule is firmly attached in the side of tongue.
11. Tonsillar branch of facial artery with two veins enters the tonsil at this point.
12. Paratonsillar veins descend from the soft palate onto the lateral aspect of capsule of tonsil and it is this vessel, which is responsible for massive bleeding, if injured during operation.
    - Internal carotid artery lies 2.5 cm behind and lateral to the tonsil.
    - Bed of tonsil is formed by:
      - Pharyngobasilar fascia
      - Superior constrictor and palatopharyngeus muscle
      - Buccopharyngeal fascia
      - Styloglossus and IX nerve
      - Facial artery and internal carotid artery.

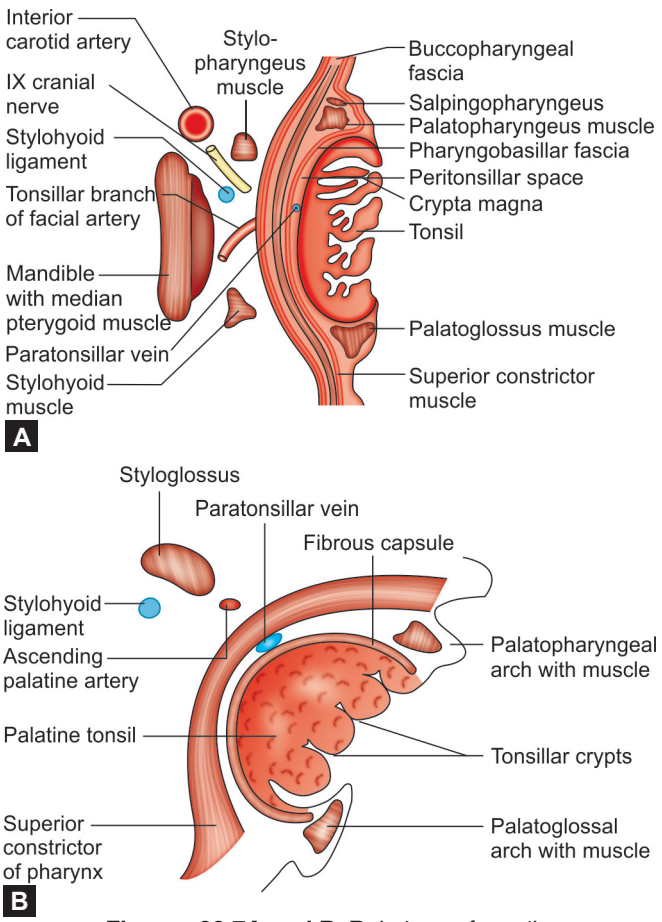
Histopathology

Tonsil consists of collection of lymphoid tissue arranged in the form of follicles.

Each follicle is surrounded by plexus of lymph vessels passing to the upper deep cervical lymph nodes, especially jugulodigastric group of lymph nodes.

It differs from lymph node:

1. It is lined by squamous epithelium
2. There is no subcapsular lymph space
3. There are no afferents to the tonsil.



Figures 32.7A and B Relations of tonsils

Blood Supply

Main blood supply comes from (**Figure 32.8**) (Remember FAAIL):

a. Tonsillar branch of **F**acial artery
b. Tonsillar branches of **A**scending palatine (branch of facial)
c. Ascending pharyngeal
d. Greater palatine branch of **I**nternal maxillary artery
e. Dorsalis linguae branch of **L**ingual artery also supply it.

Veins

One or more veins leave the lower part of deep aspect of tonsil and after piercing the superior constrictor muscle, join the paratonsillar, pharyngeal or common facial vein.

Nerve Supply

Nerve supply is derived from sphenopalatine ganglion through lesser palatine nerves and glossopharyngeal nerve.

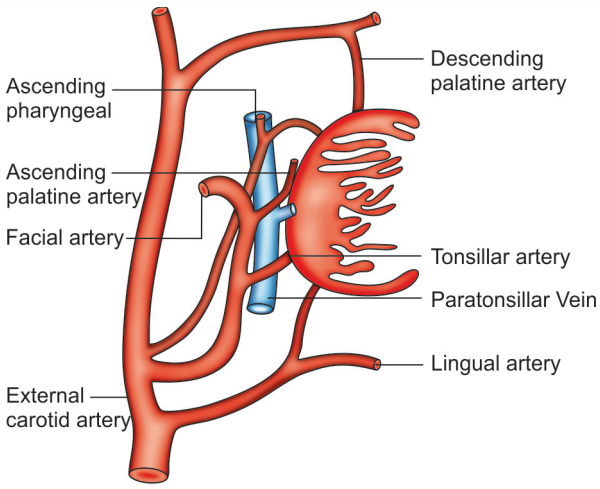


Figure 32.8 Blood supply of tonsil

Lymphatic Drainage

These drain into upper deep cervical, i.e. jugulodigastric lymph nodes 1.25 cm below and behind the angle of mandible.

Functions of Tonsil

There is a lot of controversy regarding the role of tonsil in the body's defence against disease. It is probable that organisms multiply in the crypts and other lymphoid tissue and manufacture antibodies, which explain the physiological hypertrophy of tonsil at 3 to 6 years of age when exposed to infection and thus helps in building immunity.

HYPOPHARYNX OR LARYNGOPHARYNX

1. Hypopharynx extends from the tip of epiglottis to the cricopharyngeus from 3rd to 6th cervical vertebrae.
2. It has three parts:
   i. Pyriform sinus
   ii. Posterior pharyngeal wall
   iii. Cricopharynx.
3. Anterior wall of hypopharynx presents from above downwards
4. Inlet of larynx:
   i. Posterior surface of arytenoid cartilage
   ii. Posterior aspect of cricoid cartilage.
5. Pyriform sinus lies on each side of laryngeal orifice.
6. It is bounded:
   i. Medially by aryepiglottic fold
   ii. Laterally by thyroid cartilage and thyrohyoid membrane
   iii. In the floor of sinus lies the internal branch of superior laryngeal nerve after it has pierced the thyrohyoid membrane
   iv. Any foreign body in this site may injure the nerve.
7. It is most richly supplied by lymphatics, which come out of thyrohyoid membrane to end in upper deep cervical group of lymph nodes.
8. Posteriorly, the hypopharynx is supported by bodies of 3rd, 4th, 5th and 6th cervical vertebra.

Postcricoid Region

This part of hypopharynx lies between upper and lower borders of cricoid lamina and is famous for postcricoid growth following Plummer-Vinson syndrome in females.

Lymphatics drain into parapharyngeal and paratracheal group of lymph nodes.

Posterior Pharyngeal Wall

Posterior pharyngeal wall extends from hyoid bone to the cricoarytenoid joint.

Lymphatics drain into parapharyngeal lymph nodes and finally to deep cervical lymph nodes.

Key Points

1. **Nasopharynx** extends from the base of skull to C2 level of soft palate, while oropharynx from soft palate level to tip of epiglottis (C4 level) and hypopharynx from epiglottis to lower border of cricoid cartilage (C6 level).
2. **Sinus of Morgagni** is a space between upper border of superior constrictor and base of skull and auditory tube, levator palati muscle and ascending palatine artery pass through it.
3. **Killian's dehiscence** is a gap between oblique and transverse fibers of inferior constrictor muscle.
4. **Pharyngeal plexus** is formed by branches of X nerve, IX nerve and sympathetic plexus.
5. **Node of Rouviere** lies in fossa of Rosenmuller and is a main and constant lateral group of retropharyngeal lymph node.
6. Tonsil is supplied mainly by tonsillar branch of facial, branches of ascending palatine, ascending pharyngeal, greater palatine and dorsalis linguae branch of lingual artery.
7. In **gag reflex** afferent pathway is through IX nerve and efferent pathway through X nerve.
8. In **vagal paralysis** uvula is deflected to the normal side.
9. **Galen's anastomosis** (formed by RLNv and internal laryngeal nerve) supplies pharyngoesophageal segment exploited for speech rehabilation after laryngectomy.
10. **All muscles of pharynx** (except stylopharyngeus), i.e. constrictors are supplied through pharyngeal plexus in addition to muscles of soft palate (except tensor palati), which is supplied by mandibular nerve.
11. **Primary lymphoid organs** are thymus bone marrow and intestinal epithelium while tonsils, adenoids, lymph nodes, spleen and appendix are secondary lymphoid organs.
12. **Major cells of immune system** are B-lymphocytes, T-lymphocytes, macrophages and natural killer cells.
13. **Tonsils: Blood supply—remember mneumonic: all love father mother:** Ascending pharyngeal artery; Lingual artery; Facial artery; Maxillary artery.

Chapter 33

History Taking and Method of Examination of Pharynx

What Students Must Know!

- **Clinical Features**
  - Dysphagia
  - Halitosis
  - Hyponasality
- **Mallampatti's Classification**
  - Examination of Naso and Hypopharynx
  - Investigations
  - Posterior Rhinoscopy

SYMPTOMS AND SIGNS

The patient usually presents with following symptoms and signs.

Symptoms

Pain during Swallowing (Odynophagia)

- Which may be continuous or intermittent.
- Unilateral or bilateral.
- Localized or referred to the ear.

Usual causes are:
Acute tonsillitis, pharyngitis, abscesses of the pharynx, quinsy, stomatitis, ulceration of oropharynx and foreign bodies.

Dysphagia or Feeling of a Lump in the Throat

Enquire if the dysphagia is for solids or liquids, its duration, progression, any vomiting, weight loss and hematemesis. It may be seen because of varied reasons, especially pathology of hypopharynx, esophagus, pharyngeal pouch or globus hystericus.

Hyponasality

Rhinolalia aperta occurs due to incompetence of nasopharyngeal sphincter such as in cleft palate, palatal palsy, palatal perforation, growths of soft palate or surgery on the soft palate, as for the sleep apnea syndrome.

Hawking Sensations or Foreign Body Sensation

It occurs in diseases of nose and paranasal sinus (PNS) due to dripping of postnasal discharge, foreign body or allergic conditions.

Fever

It is usually of moderate to high degree seen in acute infective conditions of tonsils and throat.

Other Symptoms

They may be:
1. Cranial nerve palsies.
2. Halitosis or foul smell which are seen in caries, ulcers and growth of pharynx.
3. Decreased hearing due to eustachian tube dysfunction may be seen in lesions of nasopharynx.

Signs

1. Examination of oral cavity is done by pressing the anterior two-thirds of tongue.
2. Lips, buccal mucosa, gums, hard and soft palate, teeth, tongue such as fissured tongue and floor of mouth are examined first followed by anterior and posterior pillars, faucial tonsils, uvula, tonsillolingual sulcus, retromolar trigone and posterior pharyngeal wall.

3. Movements of soft palate are observed and gag reflex is tested by touching the posterior pharyngeal wall with a tongue depressor.
4. **Tonsillolingual sulcus is commonly referred to as surgeon's graveyard, because growth of this region may be missed unless examined carefully by inspection and palpation of the area for any induration.**
5. Other areas, which fall into surgeon's graveyard are nasopharynx, base of tongue, floor of mouth, vallecula and pyriform fossa.
6. Tonsils are examined for size, congestion, membrane, bulge, mass or dirty white spotson the surface of tonsil, besides palpation of tonsil and Jugulodigastric lymph nodes at the angle of mandible.

Mallampatti Classification

It is related to the size of tongue and size of pharynx and test is done by asking the patient to sit and to open his mouth widely with tongue protruding forward

1. Class I soft palate, uvula and both pillars are visible
2. Class II soft palate and part of posterior pharyngeal wall are seen.
3. Class III only soft palate visible
4. Class IV soft palate is not visible.

Importance: Higher the classification more difficult for the anesthetist to intubate the patient.

EXAMINATION OF NASOPHARYNX AND HYPOPHARYNX

Nasopharynx is examined by posterior rhinoscopy mirror also known as post nasal mirror and tongue depressor and asking the patient to breathe through the nose. Fogging of mirror can be prevented:

1. By dipping the mirror in warm water
2. Heating the glass surface against some heat such as bulb or spirit lamp
3. Using a demisting solution on the mirror
4. Dipping in savlon solution
5. Rubbing the mirror on buccal mucosa for a thin film of saliva.

Besides posterior rhinoscopy, other methods for examination of nasopharynx are:

1. Palpation of nasopharynx.
2. Yankauer nasopharyngeal speculum.
3. Fibreoptic flexible nasopharyngoscope (**Figure 33.1**).
4. Nasal endoscope of 120°.
5. By passing rubber catheter and lifting the soft palate under anesthesia.
6. X-ray nasopharynx and computed tomography (CT) scan study.

Hypopharynx is examined using indirect laryngoscopy (IDL or IL) mirror after inspection and palpation of neck has been done.

Figure 33.1 Flexible nasopharyngoscope

Procedure

A warmed IDL mirror (to avoid fogging) is tested on the dorsum of hand, tongue is wrapped around a gauze piece and mirror is taken inside to lift the uvula and the patient is asked to breathe through the mouth (**Figures 33.2A and B**). If excessive gagging occurs, spray with 4 percent xylocaine solution. Various structures seen are as shown in **Figure 33.3**.

Why IDL examination is not an ideal procedure?

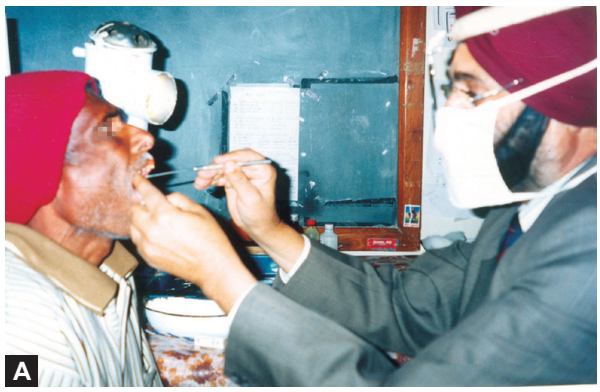
- Sometimes, it is difficult to do IDL in young patients with sensitive throat or overhanging epiglottis or with short and obese neck.
- So, in such cases, direct laryngoscopy procedure gives true image because of direct visualization.
- It gives 3-dimensional true image, as compared to 2-dimensional image on IDL
- All hidden areas of larynx can be properly visualized.
- Diagnostic and therapeutic procedure can also be under-taken.

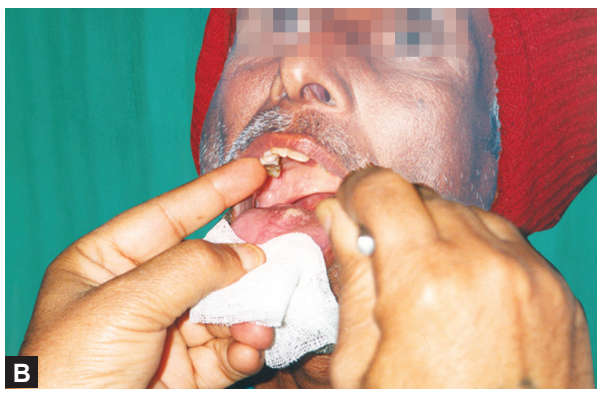
Investigations

1. Erythrocyte sedimentation rate (ESR), hemoglobin (Hb), total leukocyte count (TLC) and differential leukocyte count (DLC).
2. Total serum proteins.
3. Monospot test
4. Serum iron and iron-binding capacity
5. Serum electrolytes
6. Venereal disease research laboratory (VDRL)
7. Endoscopy including microlaryngoscopy and fiberoptic laryngoscopy.
8. Biopsy is most important.
9. Radiological examination:

Plain Films

1. Chest X-ray
2. Lateral view and base of skull view to see erosion of skull base.





Figures 33.2A and B (A) Method of indirect laryngoscopy; (B) Front view

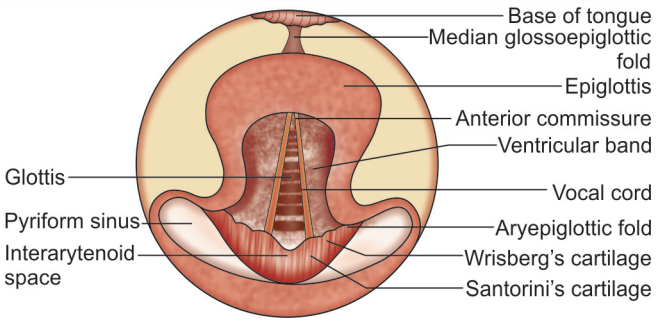


Figure 33.3 Structures seen on indirect laryngoscopy

Contrast Films

- Barium swallow study
- Carotid angiography
- Contrast laryngography.

Computed Tomography Scan

To see the extent and spread of growth to adjacent structures.

PET Scan

Positron emission tomography (PET) helps to identify recurrence or residual tumor cells following treatment of cancer by the principle of glucose metabolism in tumor cells.

Key Points

1. **Rhinolalia clausa** (hyponasality) occurs due to obstruction, while rhinolalia aperta (hypernasality) is due to incompetent nasopharyngeal sphincter.
2. **Tonsillolingual sulcus** is also called surgeon's graveyard, because growths in this region may be overlooked or missed.
3. While doing **posterior rhinoscopy** or indirect laryngoscopy, **mirror surface** is to be warmed to prevent fogging and not the metallic surface.
4. Direct laryngoscopy differs from IDL by giving **3-D, true image** and all hidden areas can be examined.
5. Endoscopy is very important not only to see the growth but also to find the extent of growth for staging purposes
6. **IDL examination is an OPD procedure and is not an ideal procedure** because:
   a. Gag reflex may not allow the examination
   b. It is only a diagnostic procedure
   c. Image in the mirror is reversed anteroposteriorly
   d. Hidden areas are not visible.

Chapter 34 Inflammatory Diseases of Pharynx

What Students Must Know!

- **Acute Inflammatory Diseases**
  - Acute Pharyngitis
  - Acute Nasopharyngitis
- **Differential Diagnosis of Membranous Lesions of Pharynx**
  - Acute Diphtheritic Pharyngitis
  - Vincent's Angina
  - Infectious Mononucleosis
  - Agranulocytosis
  - Fungal Pharyngitis
- **Chronic Inflammatory Diseases of Pharynx**
  - Keratosis Pharyngis
- **Specific Infections of Pharynx**
  - Syphilis of Pharynx
  - Tuberculosis of Pharynx
  - Lupus of Pharynx
  - Scleroma

ACUTE INFLAMMATORY DISEASES

Acute Pharyngitis

Acute pharyngitis is the most common type of sore throat seen in viral conditions such as in common cold, measles, influenza and typhoid. It may be seen after certain drugs such as arsenic, mercury or dental sepsis. Although usually viral, bacteria such as *Streptococcus*, *Pneumococcus* or *Haemophilus influenzae* may also be the causative agents.

Clinical Features

1. Feeling of rawness of throat
2. Fever, body aches, pain on swallowing
3. Dry cough
4. Examination shows congested mucosa of pharynx, uvula, tonsils and pillars. Edema with some discharge over these areas may be seen. Later on, ulcers may also appear in oropharynx. Lymph nodes may be enlarged and tender.

Treatment

- Antibiotics such as doxycycline 100 mg twice daily or benzenesulphonic acid (BSA) for 5 to 7 days
- Anti-inflammatory agents such as brufen or nimesulide
- Potassium permanganate gargles
- Soft bland diet.

Acute Nasopharyngitis

It may be caused by bacteria or viruses. It may follow rhinosinusitis.

The patient complains of discomfort and feeling of burning sensation behind the nose. Nasopharynx is congested and edematous with some mucopurulent discharge.

Treatment is similar as in acute pharyngitis.

Acute Diphtheritic Pharyngitis

It is acute diphtheritic infection of pharynx by *Corynebacterium diphtheriae* seen between 2 to 5 years of age. Its spread occurs by droplet infection.

Clinical Features

Symptoms:

- Fever mild to moderate in degree
- Sore throat
- Tachycardia out of proportion to fever.

Signs

Toxic look, greyish white membrane covering the tonsil, pharynx and adjacent areas. Membrane when separated leaves a raw bleeding surface.

Massively enlarged cervical lymph nodes (Bull neck).

Neurological and cardiac complications may occur.

Differential Diagnosis

- Thrush
- Vincent's angina
- Ulcerative condition of throat.

Investigation

Bacteriological examination of the throat swab is confirmatory.

Treatment

1. Complete bedrest and isolation
2. Antibiotics in the form of high doses of penicillin
3. Anti-diphtheric serum (ADS): When suspected, without waiting for the throat swab report, start 20,000 to 1,00,000 units of ADS depending upon the duration and extent of the disease
4. Tracheostomy, if respiratory distress develops.

Vincent's Angina

It is an ulcerative lesion of the pharynx and was commonly seen during the First World War and was called trench mouth. It was thought to be due to lack of hygiene, malnutrition and diabetes. It is caused by gram-negative fusiform bacilli and a spirochete (Borrelia vincenti).

Clinical Features

High-grade fever with chills, malaise, sore throat, halitosis and examination shows toxic patient with ulcerative and membranous lesions of oropharynx and oral cavity with cervical lymphadenitis.

Diagnosis

A swab from ulcer shows the bacteria.

Treatment

1. Systemic antibiotics such as penicillin or erythromycin
2. Isolation of patient
3. Oral hygiene
4. Antiseptic gargles.

Infectious Mononucleosis

It is also called glandular fever and is a systemic infection caused by Epstein-Barr (EB) virus. It spreads by direct contact such as kissing. In this disease, there is increase of mononuclear cells in the blood.

Clinical Features

Sore throat, pyrexia, odynophagia, malaise, lymphadenopathy of cervical, axillary group and splenomegaly.

Diagnosis

1. It is confirmed by finding atypical large mononuclear cells in blood
2. Positive monospot test is conclusive
3. Liver enzymes value may be elevated
4. Electrocardiography (ECG) may show evidence of myocarditis.

Treatment

Antibiotics have no role. Especially ampicillin should never be given as it may cause severe skin reaction. Aspirin and corticoids in severe cases.

Complications

- Peripheral neuropathy
- Hepatitis
- Myocarditis.

Agranulocytosis

In this condition, there is polymorphonuclear leukopenia along with ulceration of oropharyngeal mucosa.

Etiology

Drugs such as sulphas, amidopyrine, chloramphenicol and anticancer drugs.

Clinical Features

Pyrexia, headache, malaise, sore throat, and ulceration of the pharynx. White blood cell (WBC) count falls below 3000 per cubic mm and neutrophils are rare.

Treatment

- Stop the offending drug
- To stimulate bone marrow, pentonucleotide is the drug of choice
- Blood transfusion
- Penicillin, to control secondary infection.

Differential diagnosis of membranous lesions of pharynx

- Acute follicular tonsillitis
- Diphtheritic pharyngitis
- Infectious mononucleosis
- Agranulocytosis
- Fungal infections
- Vincent's angina
- Keratosis pharyngis
- Streptococcal pharyngitis.

Fungal Pharyngitis

It is characterized by small, whitish dots of patchy areas in the oropharyngeal area. *Candida* infection is usually an extension of oral thrush. It is usually seen in infants and children or old debilitated patients after prolonged illness and antibiotics.

Causative Organism and Types

- *Candida albicans*
- Moniliasis (thrush)
- Blastomycosis

Clinical Features

Burning sensation, difficult and painful swallowing with halitosis.

Examination shows creamy white plaques in the pharynx, which can be easily removed with no bleeding or raw areas (**Figures 34.1 and 34.2**).

Treatment

Local

- One percent Gentian violet application
- Clotrimazole solution locally
- Antibiotics to prevent secondary infection
- Antifungal drugs, such as systemic nystatin or amphotericin, 10 mg 4 times daily slowly to avoid renal damage.

CHRONIC INFLAMMATORY DISEASES OF PHARYNX

Keratosis Pharyngis

In this condition, multiple, white, elongated, keratinized epithelial outgrowths project from the surface of tonsil, base of tongue or posterior pharyngeal wall.

The exact cause is not known, but excessive smoking, drinking, chewing and local sepsis may be the factor.

Clinical Features

- May be no symptoms
- Foreign body sensation
- Examination shows white keratin outgrowths in the oropharynx.

Treatment

- No treatment, if asymptomatic
- Remove the cause
- Alkaline gargles locally
- If only tonsil shows outgrowth tonsillectomy will be helpful.

SPECIFIC INFECTIONS OF PHARYNX

Syphilis of Pharynx

It may be primary (uncommon), secondary or tertiary syphilis of pharynx.

Ulcer on palpation is cartilaginous hard. Snail track ulcer of secondary syphilis is common and punched out ulcer of gumma is characteristic.

Diagnosis and treatment is as usual.

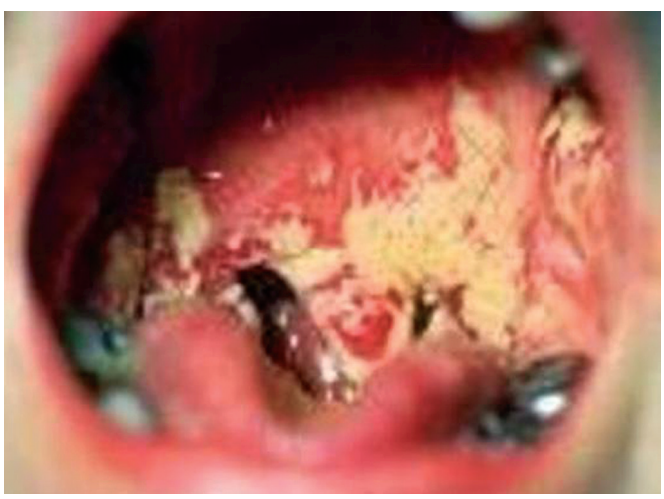


Figure 34.1 Candidiasis of oropharynx

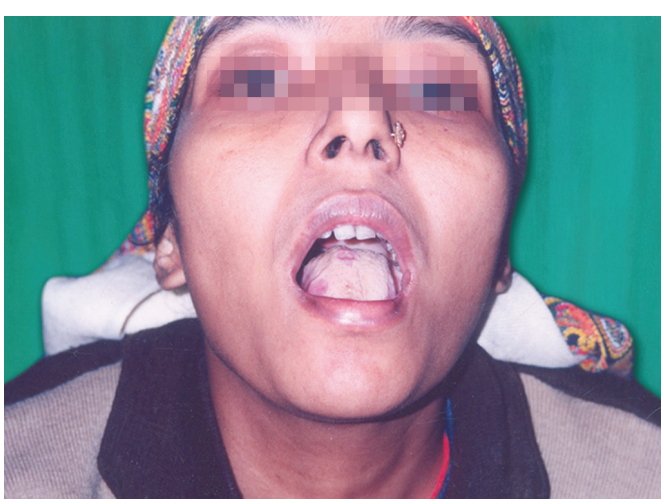


Figure 34.2 Oral thrush

Tuberculosis of Pharynx

Acute miliary tuberculosis is the most common type seen. Ulcers are painful and edges are punched out.

Treatment is by antitubercular drugs.

Lupus of Pharynx

In this condition, pinkish yellow nodules like apple jelly nodules of skin appear on the mucosa of oropharynx. These nodules may break and healing takes place by scarring. It is treated by antitubercular drugs.

Scleroma

It is rarely seen in pharynx. It forms painless, hard infiltrates, which on section show hyaline bodies and Mikulicz cells. Diplobacillus may be obtained from the lesion.

There is no specific treatment, but tetracyclines may be helpful.

Key Points

1. **Dose of ADS in diphtheria** depends upon the duration and extent of disease varying from 20,000 units to 1 lac units.
2. **Vincent's angina** also called trench mouth is due to gram-negative fusiform bacilli and a spirochaete (*Borrelia vincenti*).
3. Important causes of **ulcers in oral cavity** are infective (viral—HIV, bacterial, fungal), traumatic, neoplastic, allergic, blood disorders, skin disorders, nutritional disorders and hormonal imbalance
4. **Infectious mononucleosis** is caused by EB virus and positive monospot test is diagnostic
5. **Behcet's syndrome** is characterized by aphthous ulcers in mouth, genital ulcers and uveitis.
6. **Premalignant lesions** in oral cavity may be leukoplakia, lichen planus, erythroplakia.
7. **Referred otalgia** due to pharyngeal lesions is due to IXth and Xth cranial nerves.
8. **White patch on the tonsil** may be:
   - Infectious mononucleosis
   - Diphtheria
   - Vincent's angina
   - Membranous tonsillitis
   - Thrush
   - Agranulocytosis
   - Acute leukemia.

Chapter 35

Diseases of Tonsils and Adenoids

What Students Must Know!

- **Acute Tonsillitis**
  - Clinical Features
  - Treatment
- **Differential Diagnosis of Tonsillitis and Diphtheria**
- **Peritonsillar Abscess or Quinsy**
  - Etiology
  - Clinical Features
  - Treatment
- **Chronic Recurrent Tonsillitis**
  - Clinical Features
  - Diagnosis
  - Management
- **Faucial Diphtheria**
  - Clinical Features
  - Treatment
- **Diseases of Adenoids**
  - Clinical Features
  - Management

INTRODUCTION

1. Palatine or faucial tonsils are a pair of lymphoid tissue in the lateral wall of oropharynx.
2. It is a part of Waldeyer's ring.

Diseases of tonsils can be studied under the following headings:

I. *Inflammatory diseases of tonsil*

A. Acute conditions
   - Acute tonsillitis
   - Peritonsillar abscess
   - Intratonsillar abscess
   - Lingual tonsillitis and abscess.

B. Chronic conditions
   - Chronic or recurrent tonsillitis
   - Chronic specific tonsillitis, i.e. diphtheria, syphilitic, tubercular.

II. Tumors of tonsil

- Benign and malignant growths.

ACUTE TONSILLITIS

Acute tonsillitis is an acute inflammation of faucial tonsil, which is most commonly seen in children or adolescents. Tonsils may be involved alone or along with inflammation of pharynx.

Types

1. **Acute catarrhal**—in which mucosa over the tonsils is congested
2. **Acute follicular**—a severe form in which pus points are seen at the mouth of crypts.
3. **Parenchymatous**—the tonsils are congested and enlarged
4. **Membranous type**—exudates on the medial surface coalesce to form a membrane.

Causative Organism

- *Streptococcus pneumoniae* (β-hemolytic streptococci) [90%]
- *Staphylococcus*
- *Pneumococcus*
- *Haemophilus influenzae*
- Diphtheroids
- Viral infections.

Predisposing Factors

- Upper respiratory tract infections
- Chronic sinusitis, chronic tonsillitis
- Lower body resistance
- Blood dyscrasias
- Exposure to contagious infection
- Excessive use of cold drinks

- Excessive pollution
- Foreign body impaction.

Clinical Features

Symptoms

- Sudden onset with fever of more than 40°C;
- Bodyaches
- Throat pain or raw feeling in throat
- Painful swallowing
- Thick and muffled voice
- Trismus and pain referred to ear
- Foul breath.

Signs

- Markedly congested pillars
- Enlarged and red tonsils (**Figure 35.1**)
- Crypts filled with purulent material resembling yellow beads of pus (**Figure 35.2**)
- Jugulodigastric nodes are enlarged and tender
- Tongue may be coated.

Diagnosis

- Blood for hemoglobin (Hb), total leukocyte count (TLC), and differential leukocyte count (DLC) shows increased polymorph count
- Throat swab for culture and sensitivity (**Table 35.1**).

Differential Diagnosis of Membranous Tonsillitis (Table 35.1)

- Diphtheria
- Glandular fever
- Aphthous ulcers
- Thrush
- Vincent's angina
- Leukemia
- Agranulocytosis.

Treatment

- Complete bed rest
- Soft, warm and simple diet
- Antibiotics such as amoxicillin, cefadroxil in appropriate doses for 5 to 7 days
- Anti-inflammatory drugs
- $KMnO_4$ gargles (1: 4000)
- Vitamins such as vitamins C, D, B complex
- Lozenges with local, anesthetic action.

Complications

- Peritonsillitis and quinsy
- Parapharyngeal and retropharyngeal abscesses in the throat
- Laryngeal edema
- Otitis media
- Septicemia
- Septic foci leading to subacute bacterial endocarditis (SABE), nephritis or rheumatic fever, brain abscess, mediastinitis aspiration pneumonia.

PERITONSILLAR ABSCESS OR QUINSY

1. Peritonsillar abscess is a collection of pus in the peritonsillar space which lies between the superior constrictor laterally and capsule of the tonsil medially.

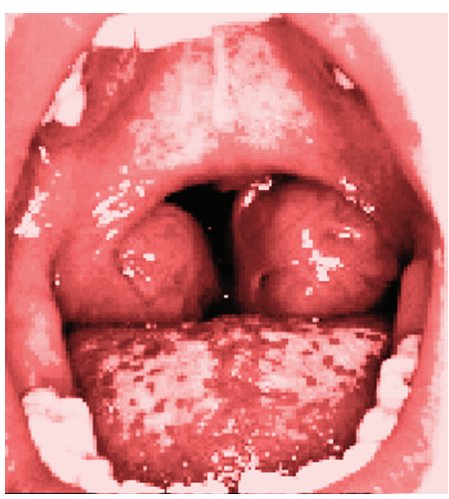


Figure 35.1 Hypertrophic tonsillitis

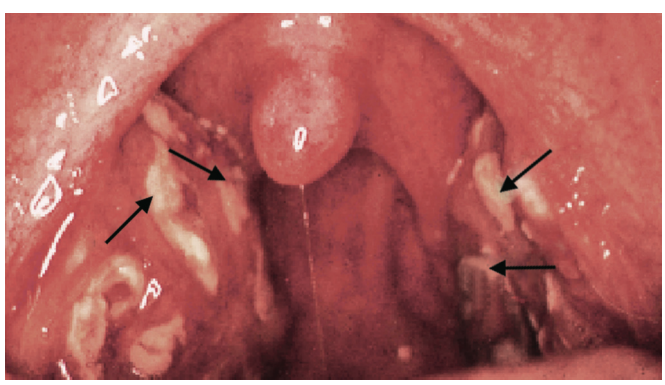


Figure 35.2 Acute follicular tonsillitis

Table 35.1: Differential diagnosis

Acute follicular tonsillitis	*Acute diphtheria*
• Children between 6 and 20 years or more	• Children under 10 year usually 2 to 5 years
• History of attacks of recurrent tonsillitis – Acute onset	• History of exposure to a diphtheria case – Slow onset
• Temperature varies 102°—105°F	• Temperature up to 102°F or less
• Pain is severe	• Pain mild only
• Toxemia not seen	• Toxemia present
• Pulse rate is proportionate to rise of temperature	• Pulse rate out of proportion to fever
• Dirty white pseudomembrane limited to tonsil only, can be easily removed with pillars, palate, uvula separated with no raw areas	• Membrane formation extensive on tonsil, difficulty and leaves a raw bleeding surface and it reforms after removal
• Throat swab shows bacteria such as *Streptococcus, Staphylococcus or Haemophilus influenzae Corynebacterium diphtheriae*	• Throat swab shows *Corynebacterium*
• Jugulodigastric glands are enlarged and tender	• Massive lymphadenopathy (Bull's neck)
• Schick test negative	• Schick's test positive
• Albuminuria absent	• Albuminuria present
• Treatment with antibiotics	• Treatment with antidiphtheritic serum (ADS) and antibiotics

2. It is usually unilateral and affects adult males mostly.
3. Infection usually starts in intratonsillar cleft due to blockage of mouth of crypts following an attack of acute tonsillitis, from where it spreads beyond the capsule causing peritonsillitis, which may then lead to peritonsillar abscess.

Etiology

1. Recurrent attacks of acute tonsillitis cause obstruction and obliteration of intratonsillar clefts and the infection spreads to peritonsillar area causing suppuration.
2. Foreign bodies in tonsil may also lead to quinsy.
   Causative organisms are the same as in acute tonsillitis.

Clinical Features

- The patient looks ill and febrile (40°C)
- Odynophagia
- Dribbling saliva
- Inability to open mouth (trismus is less marked as compared to parapharyngeal infection)
- Muffled voice.

On Examination

- The affected side is congested and bulging (**Figure 35.3A**)
- Tonsil is pushed downwards and medially
- Edema of uvula and it is pushed to the opposite side
- Pillars are congested
- Halitosis
- Trismus
- Jugulodigastric glands tender and enlarged.

Complications

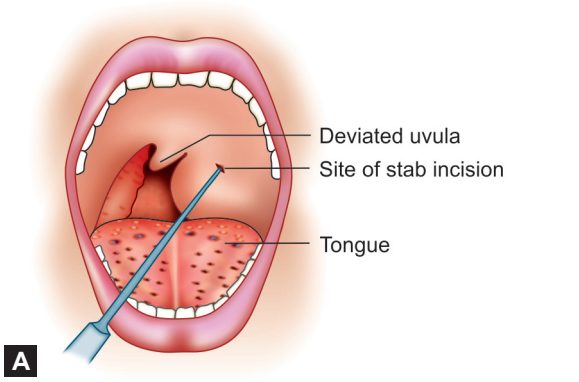
- Parapharyngeal abscess
- Retropharyngeal abscess
- Thrombophlebitis of internal jugular vein
- Septicemia
- Laryngeal edema
- Aspiration pneumonia
- Cavernous sinus thrombosis.

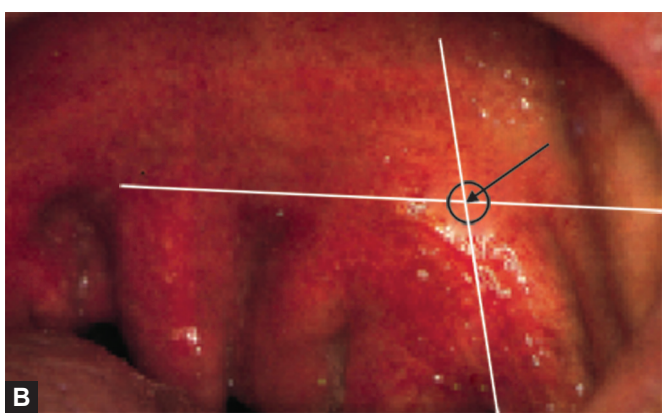
Differential Diagnosis

- Acute tonsillitis
- Malignancy of tonsils
- Parapharyngeal abscess.

Treatment of Quinsy

1. *Medical management*
   i. Broadspectrum antibiotics, such as ampicillin/amoxicillin or 3rd generation cephalosporins, in sufficient doses.
   ii. Anti-inflammatory drugs and analgesics such as brufen or nimesulide.





Figures 35.3A and B Peritonsillar abscess (Quinsy) left side with technique of drain

iii. Condy's gargles.
iv. Soft, bland and warm diet.

2. *Surgical management:* Incision and drainage of abscess must be done as early as possible which will relieve the symptoms immediately.

Technique

1. The patient is in sitting position; throat is sprayed with 4 percent xylocaine.
2. General anesthesia is avoided for fear of aspiration.
3. A quinsy forceps or a guarded number 11 stab knife is used.
4. Site of incision is the site of maximum pointing of abscess or at the junction of a horizontal line at the base of uvula and a vertical imaginary line along the anterior pillar or it may be done through intratonsillar cleft.
5. After incision, sinus forceps is used to drain the abscess (**Figure 35.3B**).
6. Some surgeons prefer to do aspiration of the abscess instead.
7. **Interval tonsillectomy** is performed after 4 to 6 weeks to prevent recurrence.
8. **Rarely, hot tonsillectomy** is performed at the same time after draining the abscess. It is called abscess or quinsy tonsillectomy. It is usually avoided as there is excessive bleeding or may lead to thromboembolism.

INTRATONSILLAR AND LINGUAL ABSCESS

Intratonsillar and lingual abscess, conditions are not seen very commonly. Intratonsillar abscess means an abscess which follows due to retention of pus in the follicle. Swelling is confined to the tonsil and it is inflamed also. Lingual tonsillar abscess follows lingual tonsillitis causing severe difficulty in swallowing and laryngeal edema.

Treatment

Treatment is with antibiotics, anti-inflammatory drugs and incision and drainage of abscess.

CHRONIC RECURRENT TONSILLITIS

Chronic recurrent tonsillitis is a chronic recurrent infection of the faucial tonsils with at least 4 to 6 attacks of acute tonsillitis in a year.

Types

Types of chronic recurrent tonsillitis may be of:
- Chronic parenchymatous type as seen in children
- Chronic fibrotic
- Septic type of tonsillitis seen in adults following recurrent attacks.

Etiology

Etiology of chronic recurrent tonsillitis usually follows recurrent attacks of acute tonsillitis; hence, causative agents and predisposing factors remain the same.

Clinical Features

- History of recurrent sore throat and difficulty in swallowing
- History of rise of temperature and bodyaches
- Halitosis
- Hawking sensation and unpleasant taste
- Dry cough and failure to grow.

On Examination

Tonsils may be enlarged as in parenchymatous type or may be embedded due to fibrosis, may show important cardinal signs such as:

1. Pus coming out from crypts on pressing through anterior pillar
2. Anterior pillars are flushed
3. Jugulodigastric glands are enlarged, but not tender.
4. Tonsillar cyst may be seen on the surface in case the mouth of crypt is blocked (**Figure 35.4**).

Diagnosis

Diagnosis of chronic tonsillitis is made by typical history of the case and presence of three cardinal signs of chronic septic tonsillitis.

Management

1. Improve the nutrition and dietary habits of the patient.
2. Remove any predisposing factors.
3. If in spite of all precautions, the patient continues to have frequent attacks, treatment is tonsillectomy operation (see operative surgery).
4. If the operation is contraindicated due to some reasons, long-acting penicillin, gargles with an astringent solution and Mandle's throat paint may be advised.

Complications

- Pharyngitis, laryngitis, quinsy
- Ear infections or effusion in middle ear
- Sleep apne syndrome
- Rheumatic fever
- Cardiac complications endocarditis
- Glomerulonephritis.

Causes of unilateral enlargement of tonsil

- Peritonsillar abscess
- Tonsillolith
- Tumors of tonsil (lymphoma/carcinoma)
- Tuberculosis
- Aneurysm of carotid
- Foreign bodies
- Tonsillar cyst
- Gumma of tonsil
- Vincent's angina
- Parapharyngeal abscess.

FAUCIAL DIPHTHERIA

Faucial diphtheria is characterized by membranous exudates at the site of infection followed by distant toxic effects. It is caused by Klebs-Loeffler bacillus, i.e. *Corynebacterium diphtheriae* which grows on Loeffler's and tellurite medium and ferments glucose. It has three main strains, i.e. gravis, intermedius and mitis and all these produce endotoxins, which cause serious complications.

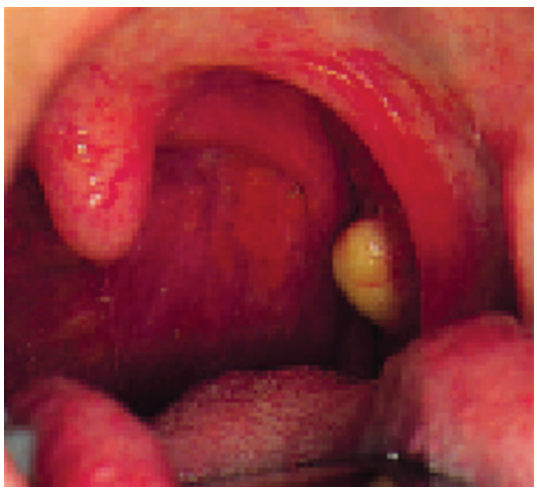


Figure 35.4 Tonsillar cyst

Incidence

Incidence of faucial diphtheria is decreasing these days because of active immunization. It is commonly seen between 2 and 10 years of age; because below 2 years, there is immunity provided by mother and up to 10 years there is usually immunity gained either by active immunization or by passive exposure to infection giving immunity.

Pathogenesis

Multiplication of organism leads to production of toxin and epithelial necrosis with collection of polymorphs and fibrin leading to false membrane formation, because it consists of necrotic layers of mucosa (**whereas true membrane is superimposed on the intact mucosa**).

Incubation period varies between 2 and 5 days.

Clinical Features

- Child becomes quiet and refuses to eat
- Lassitude
- Malaise and headache
- Moderate fever (less than 102°F)
- Characteristic fetor.

On Examination

1. Grayish or yellowish, thick membrane on one or both tonsils extending to soft palate and the membrane can be removed with difficulty and leaves a raw surface.
2. There is massive cervical lymphadenitis. **Bull's neck** is seen in severe form of diphtheria.

3. Laryngeal diphtheria causes laryngeal obstruction, hoarseness, stridor, cyanosis and asphyxia. Remember, drowsiness, vomiting, pallor and tachycardia are signs of early toxicity.

Diagnosis

Diagnosis is made by:
1. Symptoms and signs
2. Throat swab for *Corynebacterium diphtheriae*, a negative swab does not exclude diphtheria.
   - TLC is raised.
   - Albuminuria is present.
   - Schick test is positive (means 10 mm diameter erythema indicating susceptibility).
   - Moloney test determines the sensitivity to products of diphtheria. In this test, we give 0.1 ml of diluted toxoid.

Differential Diagnosis

- Acute streptococcal tonsillitis
- Thrush
- Infectious mononucleosis
- Quinsy.

Treatment

1. Complete isolation and rest for 2 weeks. If myocarditis has set in, rest will continue till electrocardiography (ECG) becomes normal.
2. If paralysis has started, tracheostomy with or without positive pressure respiration will be indicated.
3. Before discharge, three negative swabs are must.
4. Specific treatment is with antidiphtheritic serum (ADS)
   i. Dose depending upon duration and extent of the disease and not the age of the patient
   ii. Mild case 20,000 units
   iii. Moderately severe case 40,000 to 80,000 units.
   Half the dose is given IM and the remainder half IV, after testing with 0.2 ml of serum. If the patient is sensitive to serum, small dose in dilution can be given subcutaneously.
5. Antibiotics—Penicillin 5 to 10 lac units after sensitivity.
6. Steam tent.
7. Tracheostomy, if indicated.

Complications

Cardiovascular System

Acute circulatory failure may be due to myocarditis or peripheral circulatory failure. It starts within 3 to 20 days and the earliest signs are tachycardia, pallor, vomiting, changed heart sounds, blood pressure (BP) falls, jugular venous pressure (JVP) is raised, ECG shows low-voltage graph with depressed ST segment and inverted T wave.

Central Nervous System

Peripheral neuritis with palatal palsy, eye palsies, respiratory failure at 6 weeks. Peripheral neuritis of limbs starts at 4 weeks.

Prognosis

Malignant diphtheria has 50 percent mortality. Death may take place as late as 10 weeks from onset. Survival is always followed by complete recovery.

TUBERCULOSIS OF TONSILS

Tuberculosis of the tonsils is suspected when cervical lymph nodes are found to have tubercular pathology. It is because of tonsil being the most common mode of entry of bacilli. It is confirmed by histopathological examination.

Treatment is antitubercular therapy.

DISEASES OF ADENOIDS

1. Adenoids are also called nasopharyngeal tonsil, or Luschka's tonsil which are of maximum size at 5 years of age.
2. Main blood supply of adenoids is by ascending palatine and ascending pharyngeal artery and lymphatic drainage occurs into retropharyngeal lymph nodes.
3. Adenoids form a part of Waldeyer's ring of lymphoid tissue. Its involution starts at puberty, but sometimes may persist for a longer period.
4. Infection of the adenoids may be called adenoiditis which is usually because of acute or chronic rhinitis, sinusitis or tonsillitis.
5. Adenoids hypertrophy may be physiological or inflammatory. Predisposing factors are same as for tonsillitis.

Clinical Features

Symptoms of hypertrophy are not due to increased size of adenoid mass, but due to disproportion in the size of nasopharynx and adenoids.
1. Child is unable to suck for a long time due to nasal obstruction and snores at times.
2. Nasal voice (rhinolalia clausa).
3. Nasal discharge.
4. Mouth breathing and drooling of saliva.
5. Conductive hearing loss due to secretory or purulent otitis media.

Adenoid facies

- Open mouth
- Vacant expression
- High-arched palate
- Overcrowded upper teeth
- Drooling of saliva
- Loss of nasolabial groove
- Pinched and narrow nose
- Nasal and lifeless voice
- Underslung mandible.

6. General symptoms may be:
   - Malnourished child
   - Pigeon chest
   - Protruding abdomen
   - Flat voice
   - Failure to grow
   - Halitosis.

Examination of Child

1. Adenoids may be seen hanging behind the soft palate.
2. Posterior rhinoscopy may help.
3. Digital palpation, especially under anesthesia.
4. Soft tissue X-ray nasopharynx (lateral view) (**Figure 35.5**).

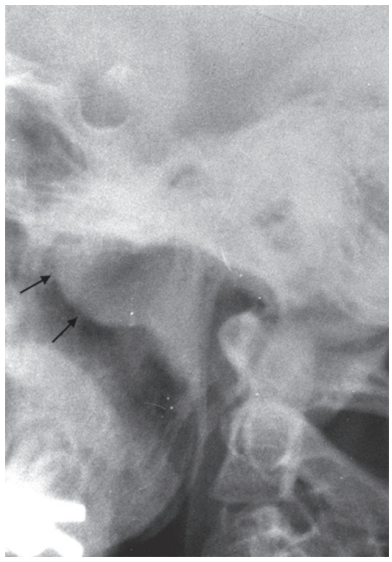


Figure 35.5 X-ray soft-tissue nasopharynx lateral view showing adenoids

Treatment

1. Improve nutrition.
2. Infection, if present, is to be treated by antibiotics along with decongestants.
3. Adenoidectomy operation (see operative surgery).
4. If secretory otitis media occurs, myringotomy should be done after removal; of adenoids in the same sitting.

Complications of Adenoids

If not removed or treated, may lead to nasal problems, aural problems and general manifestations as stated above.

Key Points

1. **In Quinsy** pus collects between superior constrictor muscle and tonsillar capsule.
2. Besides I and D for peritonsillar abscess, **interval tonsillectomy** is advised to prevent recurrence.
3. **Cardinal signs** of chronic septic tonsillitis are: flushing of anterior pillar, pus coming out from mouth of crypts and enlarged and non-tender jugulodigastric lymph nodes.
4. **Diphtheria of tonsil** is seen in children less than 10 years of age with characteristic pseudomembrane formation and Bull's neck.
5. **Adenoid facies** are produced due to disproportion in the size of nasopharynx and adenoid mass.
6. **Adenoids** are clinically seen by 4th month and radiologically after 6 months of age.
7. **Hypertrophy of lingual tonsil** is seen after tonsillectomy; in chronic smokers and in menopausal women, but not secondary to peritonsillar abscess.
8. **Differential diagnosis of membranous tonsillitis—remember mneumonic:** MALA-D VICTIM: M: **M**embranous Tonsillitis; A: **A**phthous ulcers; L: **L**eukaemia; A: **A**granulocytosis; D: **D**iphtheria, V: **V**incent's angina; I: **I**nfectious nucleosis; C: **C**andida infection; T: **T**raumatic ulcers; I: **I**diopathic/Idiosyncrasy; M: **M**alignancy
9. **Acute tonsillitis** in children is caused by β-hemolytic streptococci.
10. **Rhinolalia clausa** (hyponasality) may be seen in nasal polyps, growths, allergy adenoids, common cold, nasopharyngeal mass.
11. **Rhinolalia aperta** (hypernasality) is seen in paralysis of soft palate, after adenoidectomy; cleft palate; short palate; large nasopharynx and submucus cleft palate.
12. **Indications for tonsillectomy—remember mneumonic:** HARMS: **H**ypertrophy; **A**bscess (Quinsy); **R**ecurrent sore throat; **M**alignancy is suspected; **S**eizures (Febrile seizures due to tonsillitis).

Chapter 36 Diseases of Nasopharynx

What Students Must Know!

- **Introduction**
  - Surgical Anatomy of Nasopharynx
  - Fossa of Rosenmüller
- **Diseases of Nasopharynx**
  - Congenital
  - Traumatic
  - Inflammatory
- **Nasopharyngeal Fibroma**
  - Etiology
  - Clinical Features
  - Treatment
  - Diagnosis
- **Nasopharyngeal Carcinoma**
  - Clinical Features
  - Staging of NPC
  - Diagnosis
  - Treatment
- **Difference between Nasopharyngeal Carcinoma and Fibroma**

INTRODUCTION

1. It is imperative to know about the surgical anatomy of nasopharynx, so that the various diseases affecting it, their course, their complications and different operations in this area are well understood and patients are managed properly.
2. Juvenile nasopharyngeal fibroma is the most common benign tumor in adolescents while nasopharyngeal carcinoma occurs in 60 to 70 years of age.

SURGICAL ANATOMY OF NASOPHARYNX

Nasopharynx is a connecting link between oropharynx and nasal cavity and is lined by pseudostratified squamous epithelium and has rigid walls. It communicates with:

- **Anteriorly:** Posterior choanae and posterior part of nasal septum.
- **Floor:** It is formed by soft palate and a part of hard palate.
- **Roof:** It is sloping and is formed by basisphenoid, basiocciput and outer aspects of C1 and C2 vertebrae and these contributes to form the posterior wall also.
- **Posteriorly:** It communicates with oropharynx and is guarded by a ridge, known as Passavant's ridge or cushion, which has a sphincteric action and is a fibromuscular band, which prevents the regurgitation of fluids from oropharynx to nasopharynx.
- **Laterally:** It communicates with the middle ear cavity via eustachian tube. The nasopharyngeal orifice of eustachian tube has a pad of fat known as Ostmann's pad of fat, which in malnourished children atrophies and leads to patulous eustachian tube predisposing to recurrent middle ear infections.

  The **dimensions of an adult nasopharynx** are:
  1. Height—4 cm
  2. Width—4 cm
  3. Anterioposterior diameter —3 cm.

Venous Drainage and Blood Supply

Venous drainage and blood supply is from a plexus of vessels derived from various vessels supplying and draining this region. However, the main blood supply is from branches of external carotid artery and it is as given below:

1. Ascending palatine artery
2. Tonsillar artery (branch of facial artery)
3. Ascending pharyngeal artery (branch of external carotid artery)
4. Dorsal lingual branches of the lingual artery.

The venous plexus drains into pterygoid plexus of veins and into internal jugular vein. Nasopharynx houses a pad of lymphoid tissue at the roof, known as nasopharyngeal tonsil, which in the later years of life atrophies and may persist in some cases for a long time. Pathologically, enlarged nasopharyngeal tonsil is known as adenoid. The lymphatic

drainage is to retropharyngeal and upper deep cervical lymph nodes.

Sinus of Morgagni

1. Sinus of Morgagni is a large gap between the upper concave border of the superior constrictor muscle and the base of skull.
2. It is the sinus present in lateral wall of nasopharynx near the torus tubarius through which eustachian tube, levator palati muscle and ascending palatine artery gain access to the nasopharynx.

Fossa of Rosenmüller

1. Fossa of Rosenmüller is a 1.5 cm deep cleft behind and above the torus tubarius.
2. It is the commonest site of nasopharyngeal carcinoma
3. Its apex is in close approximation to anterior margin of carotid canal and its base is in close approximity with the base of skull and medially with the foramen lacerum.
4. Buccopharyngeal (visceral) fascia surrounds the nasopharyngeal mucosa and the superior and middle constrictor muscles, separating it from deep cervical fascial spaces.

METHODS OF EXAMINATION OF NASOPHARYNX

1. Digital palpation
2. Posterior rhinoscopy
3. Radiological studies:
   - X-ray studies
   - Computed tomography (CT) scan and magnetic resonance imaging (MRI).
4. Fiberoptic nasopharyngoscopy.
5. Endoscopic examination—functional endoscopic sinus surgery (FESS).

Posterior Rhinoscopy

Posterior rhinoscopy can be used as an outpatient department (OPD) procedure without anesthesia, if the patient is cooperative. The instruments used are:

- Head mirror
- Light source
- Tongue depressor
- Posterior rhinoscopy mirror.

Method

- Patient is explained about the procedure and is taken into confidence.
- The tongue is depressed with the tongue depressor gently.
- The posterior rhinoscopy mirror is intro-duced into the oral cavity and taken at the base of uvula, without touching it, after heating its back on the spirit lamp or rubbing its mirror surface with the cheek mucosa or heating its mirror surface with hot air or water, to avoid mist formation and the examination of nasopharynx is done on all sides.
- If the patient gags, this reflex can be suppressed by spraying the oral cavity with 10 percent topical xylocaine spray and by giving sedation. However, this cannot be done in children.

Posterior Rhinoscopy Under General Anesthesia

Posterior rhinoscopy under general anesthesia is usually done to take biopsy and have the general examination in detail.

Procedure

After intubation, mouth is opened by using a Boyle-Davis mouth gag and the tongue is depressed. Two catheters are passed through the nostrils and got out from the oropharynx and the soft palate is retracted. A posterior rhinoscopy mirror is passed behind the soft palate and nasopharyngeal examination is carried out in detail and one can also take the biopsy during the same sitting.

Palpation of Nasopharynx

Palpation of nasopharynx is not usually done nowadays. However, at times one may like to do it. It should, however, not be performed if one thinks of a nasopharyngeal angiofibroma for fear of bleeding; and if to be done, should be done in operation theater and under general anesthesia.

Procedure

Doctor should stand by the side of patient. After wearing the gloves, open the mouth of the patient, insert the middle finger and thumb between the two jaws, so that the mouth remains open and the patient does not bite. The index finger of the other hand which is passed just behind the soft palate into the nasopharynx to palpate it.

Radiological Studies

X-ray Study of the Nasopharynx

True lateral view of nasopharynx can be seen on routine soft-tissue neck lateral view, which will show any obstruction of air column between the nose and oropharynx. If mass is present, it can be delineated by doing a contrast study.

The other plain X-ray for nasopharynx is by sub-mentovertical view. However, in the present era with the availability of CT scan and MRI both contrast and noncontrast, one can easily see the extent of nasopharyngeal diseases and their extension, if any, to other surrounding areas.

Fiberoptic Nasopharyngoscopy

It is most convenient procedure for the examination of nasopharynx, as an OPD procedure and one can document it and a biopsy can be taken at the same time.

Endoscopic Examination

Endoscopic examination is done, using rigid endoscope 0° and 30°.

DISEASES OF NASOPHARYNX

Diseases of nasopharynx are as given below:
1. Congenital
2. Traumatic
3. Inflammatory
4. Neoplastic.

Congenital

Congenital diseases of nasopharynx as such are very rare. However, there can be some masses present at the time of birth in the nasopharynx, because of developmental abnormalities, which are:
- Meningioma
- Craniopharyngioma
- Dermoid cyst
- Thornwaldt's bursa
- Teratoma
- Hemangioma
- Lymphangioma
- Chondroma
- Chordoma.

Traumatic

Traumatic lesions may be because of gunshot injuries or accidental injuries and are primarily treated symptomatically needing:
- General management of shock and bleeding
- Control of infection
- At times airway management.

Inflammatory

(a) Acute
(b) Chronic.

Acute

- Allergic
- Nonallergic
- Bacterial
- Viral
- Fungal.

Primary infection of the nasopharynx is not so common. It gets secondarily affected by the infections of nose and paranasal sinuses, which may be acute or chronic. The patient presents with general constitutional symptoms like:
- Malaise
- Fever
- Rhinitis (postnasal discharge)
- Stuffy nose
- Epistaxis
- Blocking sensation in the ears, because of eustachian tube involvement
- Deafness
- At times tinnitus.

On examination, the patient has fever; nasopharyngeal mucosa is red and congested. Postnasal discharge may at times be blood stained and at times the patient may get frank bleeding from the nose (epistaxis) and/or with the sputum.

Chronic

Chronic involvement of the nasopharynx is rare and is involved secondarily to involvement of nose and paranasal sinuses.

Treatment

- Antibiotics
- Nasal and systemic decongestants
- Mucolytic and mucokinetic agents
- Antipyretics
- Antiallergics and analgesics
- Antiviral and antifungal agents depending on the nature of the disease.

  At time, for epistaxis other surgical treatments may be needed thereafter like:
  - Cauterization
  - Anterior nasal packing
  - Posterior nasal packing
  - A proper care of the patient.

Neoplastic

Neoplastic conditions may be divided into:
a. Benign lesions of nasopharynx
b. Malignant conditions
c. Cysts of nasopharynx, e.g. Thornwaldt cyst (also called nasopharyngeal bursa). It is due to embryonic communication between caudal end of notochord and the nasopharyngeal epithelium. It is located in the midline of posterior wall of nasopharynx and is treated by excision.

Benign Lesions of Nasopharynx

Benign lesions are:

1. Common lesions
   - Angiofibroma
2. Less common and rare lesions
   - Chondroma
   - Pleomorphic adenoma
   - Warthin's tumor
   - Teratoma (congenital tumors arise from all the three germinal layers and are seen in female children).
   - Hamartoma and choristoma (not true neoplasms but are malformations).

These rare tumors cause eustachian tube dysfunction and upper airway obstruction and their treatment is transpalatal removal.

Nasopharyngeal fibroma

Introduction

1. Nasopharyngeal fibroma (NPF) is also called juvenile angiofibroma and is the most common benign lesion of nasopharynx.
2. Incidence varies from 0.05 to 0.1% of head and neck tumors.
3. Most common site of origin of nasopharyngeal angiofibroma is close to the **superior margin of sphenopalatine foramen** in the posterior part of nasal cavity.
4. It grows towards the nasopharynx, nose, paranasal sinus (PNS), pterygopalatine fossa and infratemporal fossa.
5. It may also go into orbit and middle cranial fossa by the process of erosion of floor anterior to foramen lacerum.

Etiology

- Since, the tumor is mostly seen in adolescent males near puberty, it is thought that it may be **testosterone hormone dependent tumor** although exact cause is not known.
- This hormone may act as a trigger factor for hamartomatous nidus of vascular tissue in the nasopharynx.

Blood supply

- Internal maxillary artery
- Ascending pharyngeal artery
- Vidian artery
- Branches of internal carotid artery (ICA)
- Sphenopalatine artery.

Pathology

1. Exact nature of tumor is not known, but has been thought to arise from periosteum of nasopharynx.
2. Others considered it to be chemodectoma arising from non-chromaffin paraganglionic cells while others thought it as hamartoma.
3. Tumor consists of vascular and fibrous tissue components.
4. Vessels have deficient muscular coat; hence, inability to contract.
5. Histopathologically, endothelial layer lined vascular spaces and fibrous tissue stroma in plenty or vice versa are visible under the microscope.

Clinical features

> A fifteen-year-old boy presenting with unilateral nasal obstruction, recurrent massive nosebleed and swelling over cheek is pathognomonic of nasopharyngeal angiofibroma

- Ten to twenty years males are affected mostly
- Usual presentation is recurrent massive nose bleed
- Nasal obstruction
- Change of voice due to mass in nasopharynx
- Conductive hearing loss
- Proptosis and frog face deformity if orbital extension
- Involvement of IInd, IIIrd, IVth and VIth cranial nerves.

Physical examination

Reveals a pale to reddish, firm, sessile and smooth mass in the nasopharynx, which may be visible below the soft palate and it may also be pressed downwards (**Figure 36.1A**). Remember; never do finger palpation of the suspected angiofibroma for fear of massive bleeding.

Diagnosis

1. History and physical examination is important.
2. **Biopsy—no and should never be done** in suspected cases, because it may cause extensive bleed.
3. X-ray of soft-tissue nasopharynx (lateral view).
4. CT scan with contrast is must to see the extent of mass (the investigation of choice), any bony erosion and even the antral sign (**also called Holman Miller's sign**), which means anterior bowing of posterior wall of maxillary sinus (**Figures 36.1B to D**).
5. MRI may be done, if extension into orbit or intracranial spread has taken place.
6. Arteriography may help to know the source and degree of blood supply of tumor for planning surgery. Usually, it is not done because of the risks such as blindness, death, hemiplegia and transverse myelitis.

Differential diagnosis

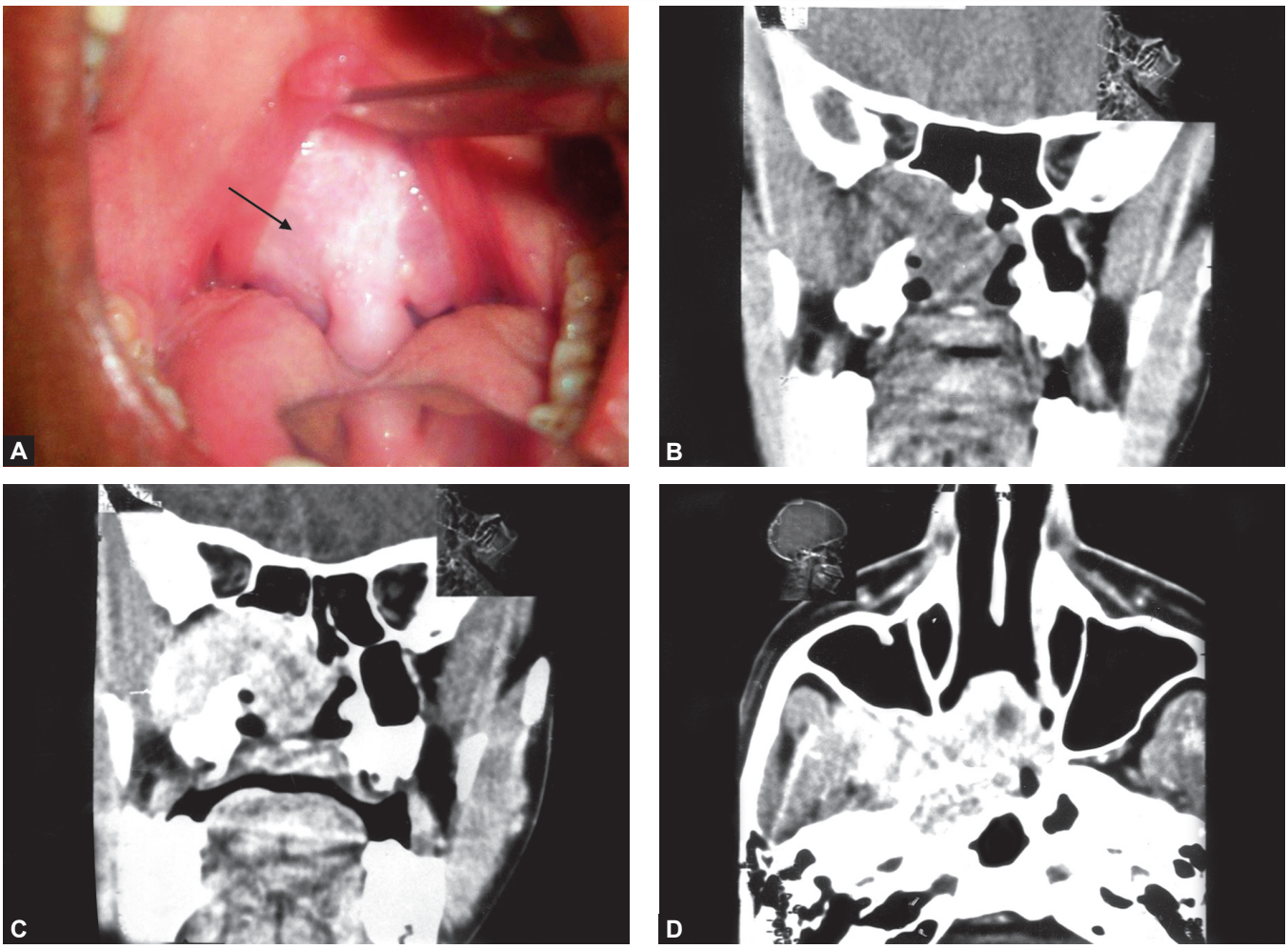
- Antrochoanal polyp
- Nasopharyngeal carcinoma
- Inverted papilloma
- Adenoids hypertrophy
- Fungal mass

Staging of angiofibroma

Staging is important to decide the line of management depending upon the stage of tumor.

Chandler et al gave the following staging:

- Stage I—Tumor limited to nasopharynx.
- Stage IIa—Pterygopalatine fossa is involved.



Figures 36.1A to D (A) A mass in the nasopharynx; (B) A case of nasopharyngeal fibroma in a 13-year-old male child involving nose, maxillary antra and infratemporal fossa on right side; (C) Another CT section of the same patient; (D) Another case of extensive nasopharyngeal fibroma in a 13-year-old male child

- Stage IIb—Pterygomaxillary fossa, orbits and posterior wall of maxillary antrum is involved.
- Stage IIc—Cheek and infratemporal fossa is affected.
- Stage III—Intracranial extension.

Ugo Fisch also described staging of NPF, which varies slightly from that described by Chandler.

Treatment

Surgery: Primary surgical removal of the tumor is the best treatment available. Various surgical approaches for removal of tumor may be as follows:

a. **Lateral rhinotomy** approach nowadays is the best approach for removal of tumor from nose, nasopharynx, PNS and orbit.
b. **Wilson's transpalatine approach,** where soft palate is dissected free of hard palate.
c. **Sardana's approach** (transpalatine and sublabial combined).
d. Transhyoid and transmandibular approach.
e. Transzygomatic.
f. Facial degloving approach.
g. Craniotomy/rhinotomy approach.
h. Maxillary swing method.

Before surgery, at least 2 to 3 units of blood should be ready to compensate the extensive blood loss.

Some prefer to reduce the vascularity of tumor by giving preoperatively stilboestrol 2.5 mg thrice daily for 3 to 4 weeks

Embolization:

1. Intra-arterial embolization has also been tried for the same reason to decrease the vascularity of tumor
2. Using transfemoral route feeding vessel is identified,

which are then embolized 48 to 72 hours prior to surgery using materials like gelfoam or GTC coils, silicon spheres, Teflon or tantalum powder
3. Estrogen 5 mg twice daily for 10 to 15 days before surgery and preoperative radiation therapy 3,000 rads can also be tried besides ligation of external carotid.

Other methods of treatment:
1. **Wait and watch** for spontaneous regression is not favored these days.
2. **Role of radiotherapy:** Although has been tried in many centers but is not preferred because of the fear of osteomyelitis, radiation-induced malignancy, arrest of facial growth centers and atrophic rhinitis.
3. **Sclerotherapy and electrocoagulation:** Cryosurgery does not have any role in treatment because there is too little time for ice ball formation due to extensive vascularity of the tumor.
4. **Role of hormones:** Testosterone and estrogen or the combinations have been tried, but with limited success only. It helps to mature the collagen in the fibrous stroma and also decreases the vascularity of tumor.

Malignant Lesions of Nasopharynx

Malignant lesions may be:
- Nasopharyngeal carcinoma
- Adenocystic carcinoma
- Rhabdomyosarcoma
- Lymphomas
- Plasmacytoma
- Chordoma.

Nasopharyngeal Carcinoma
1. Nasopharyngeal carcinoma (NPC) is most commonly seen tumor in Chinese, especially in southern states and Taiwan.
2. Many factors have been thought to cause NPC such as genetic, environmental, dietary and personal habits.
3. In Chinese, its incidence is about 18 percent of all malignant tumors. In India, the incidence is 0.5 percent of all malignant tumors.
   i. Besides above **Epstein-Barr virus (EBV)** has also been blamed to cause NPC.
   ii. Exposure to polycyclic hydrocarbons.
   iii. Dietary ingestion of **nitrosamines** such as salted fish, preserved and canned vegetables.
   iv. Chronic **rhinosinusitis** and poor hygiene.
   v. **Occupational**—industrial fumes, metals, wood dust and Agarbatti smoke.

Pathogenesis

More than 80 percent of the carcinomas are squamous cell carcinomas and grossly, the tumor may be of exophytic type, ulcerative or infiltrative variety.

The World Health Organization (WHO) has classified NPC into:
- Type I (squamous cell carcinoma),
- Type II (Non-keratinizing carcinoma) and
- Type III (undifferentiated carcinoma), (**Figure 36.2**).
- Histopathologically, tumors are well to moderately differentiated with large cells, eosinophilic cytoplasm with abundance of keratin in type I and almost no keratin in type II. Type III tumors have typical anti-EBV serological profile.

Staging

Tumor, nodes and metastasis (TNM) classification (American Joint Committee System [AJC System]).

Primary Tumor (T):
- T1S—carcinoma *in situ*
- T1—confined to one site only
- T2—involving 2 sites say from nasopharynx to oropharynx or nasal cavity
- T3—when tumor involves bone or extends to PNS
- T4—tumor involving base of skull or cranial nerves.

Nodes (N):
- NX—nodes not assessible
- N0—no lymph node metastasis
- N1—unilateral lymph nodes up to 3 cm
- N2—lymph nodes of up to 6 cm
- N3a—lymph nodes of more than 6 cm
- N3b—lymph nodes in Ho's triangle.

Distant Metastasis (M):
- MX—metastasis cannot be assessed.
- M0—no distant metastasis.
- M1—distant metastasis present.

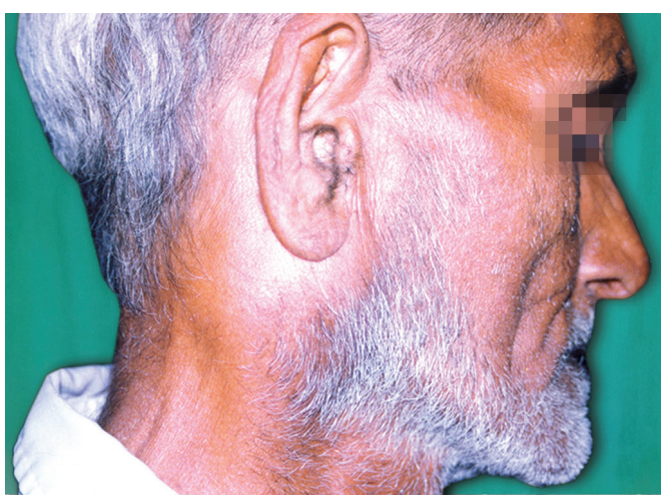


Figure 36.2 A 60-year-old patient of nasopharyngeal carcinoma presenting with secondaries neck

Clinical features

1. **Males** between **50 and 70 years** are mostly involved although many younger patients with NPC have been seen.
2. Usual presentation is bleeding from nose.
3. Nasal obstruction and nasal discharge (blood stained).
4. **Denasal speech** due to mass in nasopharynx (**Figures 36.3A to C**).
5. **Ear symptoms**, such as diminished hearing and serous otitis media, may be the presenting symptom.
6. **Craniopathies** usually the III, IV, V and VI are involved first causing squint, diplopia, facial pains and diminished corneal reflex (VI nerve being the most common).
7. **Jugular foramen syndrome** when IX, X and XI are involved and may be due to the pressure of lymph nodes on the nerves.
8. **Trotter's triad** occurs when there is conductive deafness, ipsilateral temporoparietal neuralgia and palatal paralysis due to involvement of eustachian tube, Vth and Xth nerve.
9. **Lymph nodes**, unilateral or bilateral, especially in the posterior triangle of neck (**Figure 36.3D**) may be the presenting symptom (Most common presenting feature in more than 60 to 90% cases).
10. **Distant metastasis** may involve bones, lung and liver (**Figure 36.3E**).
11. Other symptoms such as headache, neck pain or weight loss may be present.

Diagnosis

- Clinical features are suggestive.
- Examination of nasopharynx.
- X-ray nasopharynx.
- CT scan.
- MRI to see intracranial extension.
- Biopsy to see the nature of growth. Sometimes when lymph nodes are present in the neck and primarily is not seen in the nasopharynx (occult primary), a blind biopsy may show evidence of growth in nasopharynx.
- Serological screening by using immunoglobulin antigen (IgA) or viral capsid antigen (VCA). VCA is a diagnostic marker and helps in screening and follow up. Antigen dependant cellular cytotoxicity (ADCC) is of prognostic value, high level has good prognosis.

Differential diagnosis

- Nasopharyngeal fibroma
- Thornwaldt's cyst or bursitis
- Rhinosporidiosis
- Inverted papilloma
- Other malignant tumors like lymphomas, rhabdomyosarcomas, plasmacytomas, adenoid cystic carcinoma.

Treatment

Radiotherapy: Radiotherapy is the mainstay of treatment for NPC. Total dose of 6,500 rads is given to the primary tumor and the nodes in daily dose of 150 to 200 rads, 5 days a week. Transnasal brachytherapy with Iridium-192, delivers high dose to the tumor.

Role of surgery: Surgery is very limited. Radical neck dissection is reserved for cases, in which lymph nodes persist in spite of radiation treatment. Aggressive surgery, such as infratemporal fossa approach of Fisch, has been described.

Chemotherapy: Adjuvant chemotherapy is being used as a palliative therapy for alleviation of pain and prolonging life in some cases.

Role of vaccine: Vaccine against EBV has been used in those areas, where there is high prevalence of NPC to prevent its occurrence.

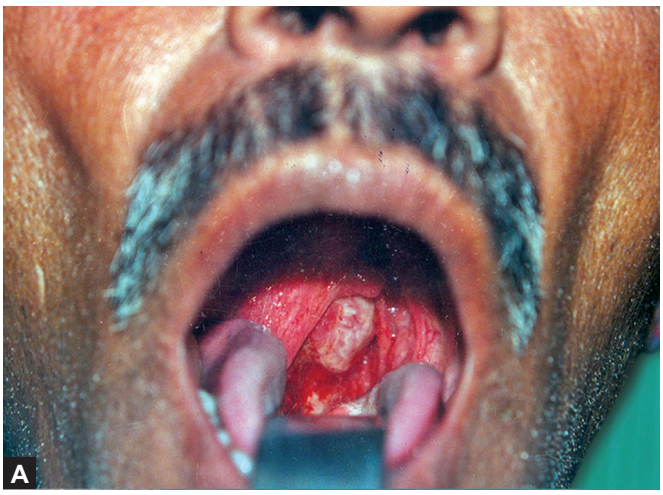
Prognosis

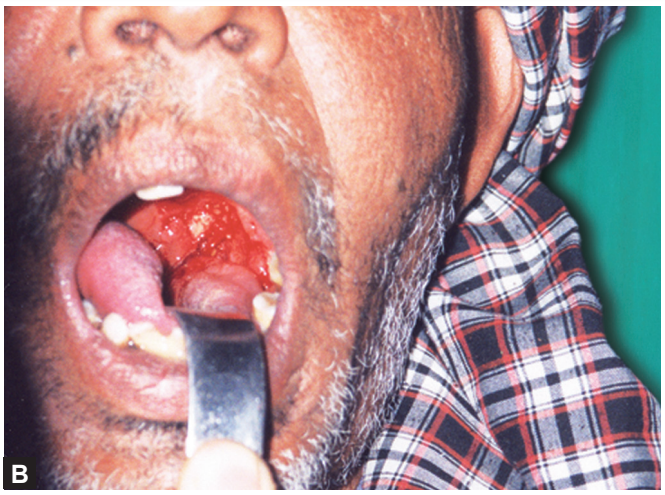
Five-year survival rate varies with stage of NPC. The WHO type I tumors have poor prognosis, i.e. 20 percent 5 years survival only while it may be nearly 50 percent in types II and III.

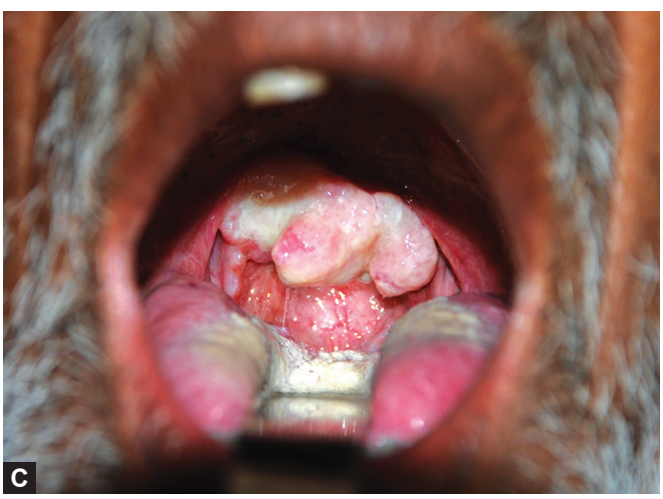
Table 36.1 shows differences between NPF and NPC.

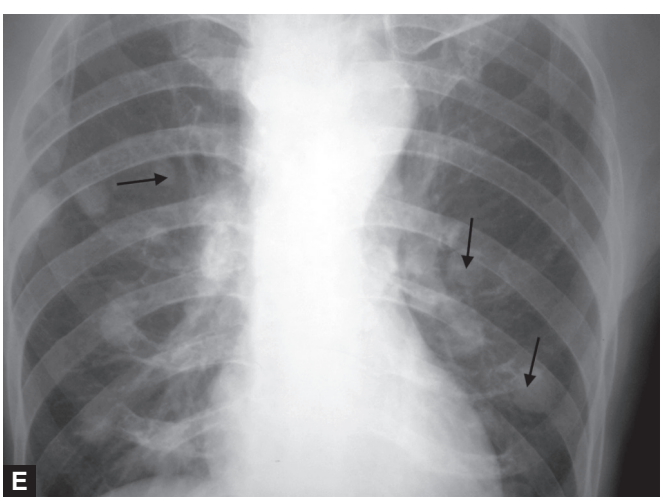
Table 36.1: Difference between nasopharyngeal fibroma and carcinoma

Difference in	*Nasopharyngeal fibroma*	*Nasopharyngeal carcinoma*
Incidence	0.05–0.1% of head and neck tumors	0.5 percent of all malignant tumors
Age group	Adolescent (14-16 years)	50–60 years
Etiology	Testosterone hormone dependant	Epstein Barr virus/nitrosamines/chronic sinusitis
Spread	By direct extension to adjacent areas such as nose, infratemporal fossa	By process of erosion involves cranial nerves III, IV, V, VI, IX, X, XI
Lymph nodes	Benign lesion—no lymphatic spread	Most common presentation in posterior triangle of neck
Presenting features	Massive nosebleed with nasal obstruction	Lymph adenopathy, cranial nerves palsy, Trotter's triad
Investigations	Computed tomography (CT) scan; no biopsy.	CT scan and biopsy
Treatment	Preoperative stilbestrol and surgery	Radiotherapy/chemotherapy no surgery









Figures 36.3A to E (A to C) Carcinoma nasopharynx; (D) Carcinoma nasopharynx with burst secondaries neck; (E) Same patient with secondaries lung–Cannon Ball appearance

Key Points

1. **Fossa of Rosenmüller** may be the common site of origin of nasopharyngeal carcinoma (NPC).
2. **Thornwaldt cyst** also called nasopharyngeal bursa is located in the midline of posterior pharyngeal wall.
3. Juvenile angiofibroma seen in adolescent males arises from superior margin of sphenopalatine foramen, it spreads through the pathway of least resistance, while NPC spreads by a process of erosion of bone.
4. **Trotter's triad**—typical of NPC consists of conductive hearing loss, neuralgia and palatal paralysis.
5. **Ho's triangle** in supraclavicular region is bounded by lateral and medial ends of clavicle with a point, where head joins the neck. Glands in this triangle may be because of NPC
6. Structures passing thru **Sinus of Morgagni** include eustachtian tube, tensor palate, levator palate and palatine branch of ascending pharyngeal artery.
7. **Juvenile nasopharyngeal fibroma** (JNF) is usually supplied by sphenopalatine branch of internal maxillary artery.
8. **NPC usually presents** with painless cervical lymph adenopathy in more than 60 to 90% cases
9. **Secondaries neck** are more commonly due to nasopharyngeal carcinoma (NPC) than from tonsil or pyriform sinus
10. NPC may extend through **foramen lacerum** causing 6th nerve palsy at the tip of petrous bone.
11. **Millar–Hollman's sign** is seen in JNF, fibrous **dysplasia, schwannoma** and nasopharyngeal carcinoma.
12. Nasopharyngeal carcinoma causing Trotter's triad—**remember mneumonic: NPC**: N: **N**euralgia (CN-5); P: **P**alatal paralysis(CN-x); C: **C**onductive deafness
13. Nasopharyngeal carcinoma symptoms—**remember mneumonic: NOSE:** N: **N**eck nodes; O: **O**bstruction nose; S: **S**erous otitis media; E: **E**pistaxis.

Chapter 37 Deep Neck Infections

What Students Must Know!

- **Importance of Neck Spaces**
  - Fascia of Head and Neck
- **Potential Spaces of the Neck**
  - Parapharyngeal Space
  - Submandibular Space
  - Retropharyngeal Space
- **Specific Deep Neck Infections**
  - Parapharyngeal Abscess
  - Retropharyngeal Space Abscess
  - Ludwig's Angina

INTRODUCTION

Importance of Neck Spaces

1. The neck spaces have by far the most complex anatomy as compared to other parts, as they encompass many vital structures, e.g. aerodigestive tract and great vessels.
2. The entire neck is compartmentalized in order to separate all the vital areas to prevent spread of infection.
3. Pharynx is provided with cushion effect of various parapharyngeal, retropharyngeal and other spaces.
4. These spaces also prevent the spread of infection from one compartment to the other.
5. To deal with these complex infections, it is mandatory to know the anatomical boundaries of all these spaces.

FASCIAE OF HEAD AND NECK

1. Superficial cervical fascia.
2. Deep cervical fascia:
   i. Superficial layer of deep cervical fascia.
   ii. Visceral layer of the deep cervical fascia.
   iii. Prevertebral fascia.

Cervical Fascia

The cervical fascia is a fibrous connective tissue enveloping neck muscles and neurovascular bundles creating potential neck spaces.

Superficial Cervical Fascia

The superficial fascia is located deep to the skin extending from the skull down to the thorax and axilla.

Deep Cervical Fascia

Superficial layer of deep cervical fascia
Superficial layer of deep cervical fascia completely surrounds the neck extending from the skull to the chest. The deep cervical fascia are the septate extensions from superficial layer.

Attachments

- Superiorly attached to the external occipital protuberance, the mastoid and the zygoma
- Inferiorly to the scapula, clavicle and manubrium of sternum
- Posteriorly to the ligamentum nuchae and spines of cervical vertebrae
- Anteriorly attached to the mandible and the hyoid bone.

Visceral layer of the deep cervical fascia

- Visceral layer of the deep cervical fascia encircles the viscera of neck namely the pharynx, larynx, esophagus, trachea, thyroid cartilage and the neurovascular structures associated with the carotid artery
- The large space enclosed by the visceral fascia is important due to the potential communication of infections from the mouth, pharynx, esophagus, larynx or trachea with the mediastinum.

Prevertebral fascia

Prevertebral fascia lies anterior to the cervical vertebral bodies medially and covers the prevertebral muscles laterally.

- Extends laterally to the tip of the transverse processes of the cervical vertebrae on both sides
- The space between the prevertebral fascia and buccopharyngeal fascia is the retropharyngeal space or space of Gillette
- It extends from base of skull to the mediastinum
- There is dense attachment of the fascia at the level of C2 and C3, thus preventing the spread of infection into the mediastinum.

POTENTIAL SPACES OF THE NECK

There are potential spaces in the neck enclosing important structures to prevent spread of infections beyond the compartment.

1. The lateral pharyngeal or parapharyngeal space.
2. The retropharyngeal space.
3. Submandibular space.
    - Submaxillary space
    - Sublingual space

Parapharyngeal Space or Lateral Pharyngeal Space

- Pharyngeal space is cone shaped with its base at the base of skull and apex at the hyoid bone
- It is divided by styloid process into prestyloid and retrostyloid compartments
- This space communicates with retropharyngeal, submandibular, parotid and visceral spaces
- Lateral pharyngeal space is a cone-shaped space, which is pierced at its apex by carotid sheath providing a dangerous conduit for spread of infection to the mediastinum
- It was named by Mosher as Lincoln highway of the neck after the famous Lincoln Highway of USA.

Boundaries or Relations

- Superior—base of skull
- Inferior—hyoid bone
- Anterior—pterygomandibular raphe
- Posterior—prevertebral fascia covering prevertebral muscles
- Medial—superior constrictor and buccopharyngeal fascia
- Lateral—parotid gland,mandible and lateral pterygoid and sternomastoid muscle (lower part).

Prestyloid Compartment (Anterior Compartment)

Prestyloid compartment is related to tonsillar fossa medially and medial pterygoid muscle laterally.

It contains:

- Internal maxillary artery
- Lymph nodes
- Lingual nerve and auriculotemporal nerve
- Loose areolar tissue.

Retrostyloid Compartment (Posterior Compartment)

Retrostyoid compartment is related to lateral pharyngeal wall medially and parotid gland laterally.

It contains:

- Internal carotid artery
- Internal jugular vein
- IX, X, XI and XII cranial nerves
- Upper deep cervical lymph nodes.

Communications

- Anteriorly and inferiorly communicates with the space associated with floor of mouth
- Medial wall is formed by the buccopharyngeal fascia lying on the constrictor muscles
- Posteromedially communicates with the retropharyngeal space
- Posterolateral wall contains medial portion of the carotid sheath.

Submandibular Space

- Submandibular space is a space between the floor of mouth and fascia along the hyoid bone and mandible
- The submandibular space is further divided by the mylohyoid muscle
- The space below the mylohyoid muscle is termed the submaxillary space
- The space located above is referred to as sublingual space
- The submaxillary space communicates with submental space and from there to the opposite side
- The infection from submandibular space spreads to other spaces of neck, e.g. parapharyngeal space and retropharyngeal space
- The infection of submandibular and submental space is termed as 'Ludwig angina.'

Retropharyngeal Space (Space of Gillete)

Relations

- The retropharyngeal space lies between the prevertebral fascia and the buccopharyngeal fascia
- Extending from base of skull to superior mediastinum (up to bifurcation of trachea T4 level)
- The attachment of fascia at C2 and C3 limits the spread of infection to mediastinum
- Posterior boundary is alar fascia and laterally is carotid sheath

- Retropharyngeal space is subdivided into two lateral compartments (spaces of Gillette) by a fibrous raphe
- Each lateral space contains retropharyngeal nodes (nodes of Rouviere), which usually disappear at 3 to 4 years of age
- These lymph nodes drain the nasopharynx, part of oropharynx, paranasal sinuses, petrous and the middle ear
- The lateral communication of the retropharyngeal space is the parapharyngeal space
- The infection from both the spaces, if not controlled, can lead to spread of infection into the lateral compartments of neck (**Figures 37.1A and B**).
- Retropharyngeal abscess due to suppuration of lymph nodes remains unilateral because of median raphae
- If the cause is caries of vertebrae it spreads across the midline behind prevertebral fascia as there is no partition behind it
- Prevertebral space is also called 'danger space' (Grodinsky) because of spread of infection from neck to mediastinum, abdomen and pelvis.

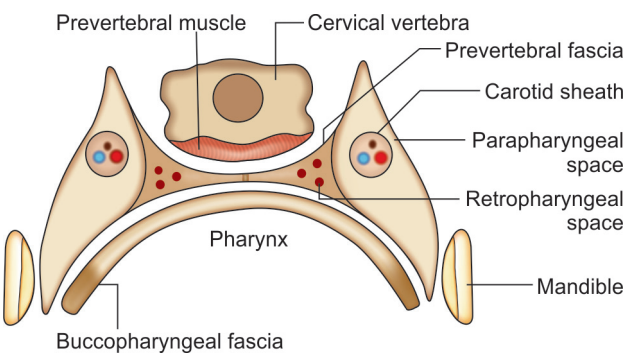


Figure 37.1A Parapharyngeal and retropharyngeal space

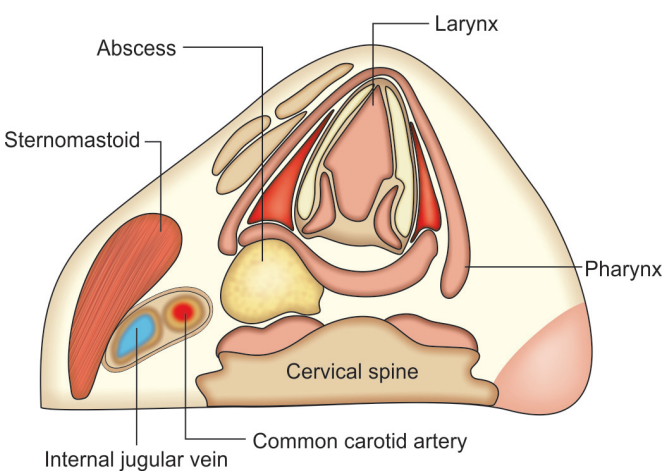


Figure 37.1B Retropharyngeal abscess

SPECIFIC DEEP NECK INFECTIONS

Parapharyngeal Abscess

Etiology

- Peritonsillar abscess by direct extension, lymphatics or septic thrombosis of peritonsillar veins
- Dental infections (third mandibular molar)
- Upper aerodigestive tract infection/trauma
- Acute suppurative otitis media
- Congenital cysts and infected fistula
- Penetrating injury to neck
- Iatrogenic injuries
- Sialadenitis/parotitis
- Petrositis.

Microbiology

Common organisms are:

- *Staphylococcus*
- Alpha and beta streptococci
- *Escherichia coli*
- Others are *Peptostreptococcus, Bacteroides, Fusobacterium, Actinomyces* and *spirochaetes*, etc.

Signs and Symptoms

- Fever, pain, trismus and dysphagia
- Swelling behind the angle of jaw
- Limited neck movements or torticollis (due to spasm of prevertebral muscles)
- Intraoral examination reveals swelling of the lateral pharyngeal wall, especially behind the posterior tonsillar pillar and displacement of tonsils medially
- Lateral inclination of neck to the affected side
- Further extension of disease may lead to involvement of cranial nerves IX, X and XI.

Management

- Conservative management
- Surgical management.

Conservative management

- Fluid replacement
- Analgesics
- Aggressive antibiotic therapy.

Antibiotic therapy is usually aimed at gram-positive organisms, with appropriate modification based on the clinical situation and culture results. Often, an aminoglycoside is added for broader coverage (for aerobic and anaerobic organisms).

Surgical management

Procedure

- It is done under general anesthesia/local anesthesia
- Surgical approach to the lateral pharyngeal space is through external route and never by intraoral route
- If trismus is marked, then preoperative tracheostomy is mandatory
- A horizontal incision 2 to 3 cm below the angle of mandible is made inferior to mandibular margin extending from anterior limit of submandibular gland to just posterior to angle of mandible and vertical limb along anterior border of sternocleidomastoid muscle
- Access to lateral pharyngeal space is achieved by blunt dissection between tail of submandibular gland and anterior border of sternocleidomastoid
- Find the carotid sheath and follow it to all areas of pus in the neck
- A drain is inserted and left for 48 to 72 hours for complete drainage of parapharyngeal space and antibiotics are continued for 10 days.

Complications

- Airway compromise secondary to encroachment by pharyngeal edema
- Internal jugular vein (IJV) thrombosis resulting in septic thrombi with pulmonary emboli
- Carotid artery hemorrhage resulting from necrosis of the artery wall secondary to surrounding abscess cavity
- Pneumonia, emphysema, bacterial endocarditis or uncontrolled septicemia
- Mediastinitis may occur along the carotid sheath.

Retropharyngeal Space Abscess

- Acute
- Chronic.

Acute Retropharyngeal Abscess

Etiology

- It is more commonly seen in children as a result of suppurative infection of the retropharyngeal lymph nodes draining ear, nose and throat
- Sometimes acute infection may present in adults due to trauma or iatrogenic causes, e.g. endoscopic procedures or oral surgeries.

Signs and symptoms

- Initial features of fever, malaise, poor appetite, irritability and difficulty in swallowing
- As infection progresses, it leads to neck rigidity, tenderness and torticollis
- Dyspnea due to swelling in posterior pharyngeal wall just lateral to the midline
- Dysphagia
- Lateral inclination of neck to the same side
- On examination, a unilateral bulge is seen in the posterior pharyngeal wall.

Management

- Antibiotics depending on culture and sensitivity (C and S) report
- Anti-inflammatory drugs
- Incision and drainage of abscess.

Chronic Retropharyngeal Abscess

Etiology

- Commonly seen secondary to cervical caries (Koch's)
- Tuberculous infection of the retropharyngeal lymph nodes secondary to tuberculosis of deep cervical nodes causes a true retropharyngeal abscess.

Signs and symptoms

- Symptoms are less prominent as abscess is slow in onset and may behave as cold abscess
- However, dyspnea is seen if abscess is compromising the upper airway
- Dysphagia
- On examination, a midline bulge is seen in the posterior pharyngeal wall with non-tender jugulodigastric lymph nodes.

Management

- X-ray soft tissue neck lateral view reveals widening of space between prevertebral fascia and the buccopharyngeal fascia (**Figure 37.2**)
- X-ray chest to rule out possible mediastinal involvement and to see any tubercular focus in the chest

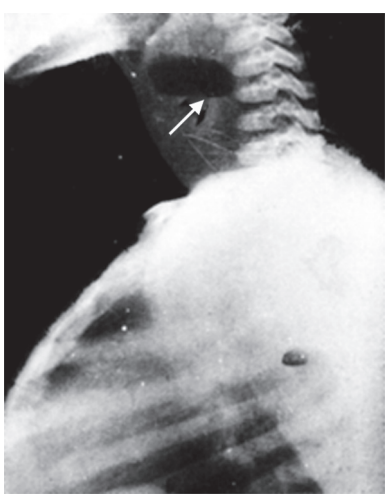


Figure 37.2 Retropharyngeal abscess with fluid level

- Computed tomography (CT) scan or magnetic resonance imaging (MRI) scan is useful to know the extent of disease.

Conservative management
- Fluid replacement
- Antibiotic coverage for aerobic and anaerobic organisms
- Antitubercular therapy in chronic retropharyngeal abscess.

Surgical management
Tracheostomy may be required in case of mechanical obstruction to the airway due to large abscess or laryngeal edema.

Incision and drainage are the treatment of choice in all retropharyngeal abscesses.
1. *Acute retropharyngeal abscess:*
   i. No anesthesia is required and the patient is held in supine position with head end lowered to prevent aspiration
   ii. An intraoral vertical incision is given in the most prominent/fluctuant area of the abscess and pus is evacuated by suction, keeping the airway clear to prevent any aspiration.
2. *Chronic retropharyngeal abscess:*
   i. Under anesthesia, a vertical incision is given along the anterior border of sternocleidomastoid from hyoid bone to cricoid cartilage
   ii. Dissection is continued medial to carotid sheath and lateral to trachea
   iii. Retropharyngeal space can be approached by retracting the larynx and sternocleidomastoid in opposite direction (**Figure 37.3**).

Complications
1. Undrained retropharyngeal abscess may rupture spontaneously into the pharynx and result in pneumonia or lung abscess secondary to aspiration. If ruptures during sleep, it may cause sudden asphyxial death
2. Parapharyngeal abscess
3. Laryngeal edema and airway obstruction
4. Mediastinitis
5. Septicemia
6. Later disseminated tuberculosis.

Ludwig Angina

- It is defined as spreading severe form of cellulitis involving submandibular space (both submaxillary and sublingual spaces)
- Wilhelm Friedrich von Ludwig (1836) described this condition
- It is an acute inflammatory condition or cellulitis of floor of mouth usually caused by sepsis in the mouth
- Submaxillary and sublingual spaces are separated and also continuous around the posterior border of mylohyoid muscle (**Figure 37.4**).

Etiology
- Common in young adults with periodontal disease, i.e. molar infection (80% of cases)
- Soft tissue or tonsillar infection (20% cases)
- Penetrating injury to floor of mouth
- Fracture of mandible
- Submandibular sialadenitis

Microbiology
- Results from infection with both aerobic and anaerobic flora
- Commonly reported aerobes are alpha hemolytic streptococci followed by *Staphylococcus* and *Bacteroids*.
- Anaerobic streptococci or peptostreptococci usually are the causative organisms.

Clinical Features
1. Young patients with poor dentition presenting with unilateral, oral or neck pain and swelling with high-grade fever, trismus, excessive salivation and odynophagia

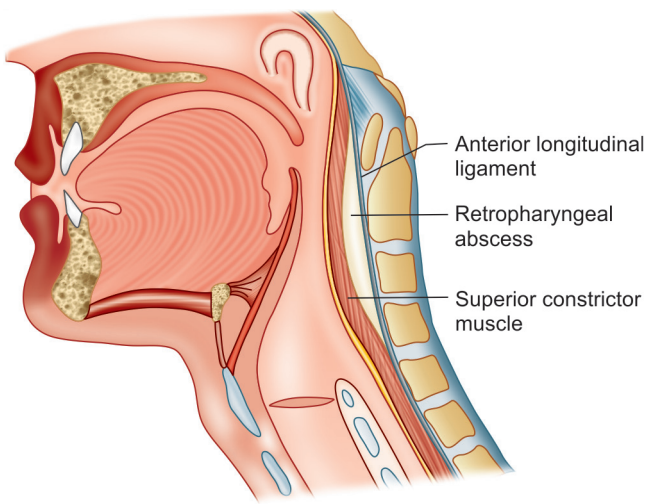


Figure 37.3 Retropharyngeal abscess

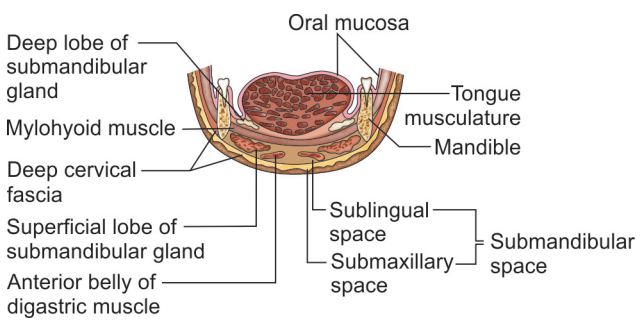


Figure 37.4 Submandibular space—its boundaries and contents

2. Swelling, tenderness and induration at the floor of mouth massive mucosal bilateral swelling above the hyoid bone and pointing of soft tissue over the edges of the lower teeth and tongue is pushed superiorly
3. Woody and hard submental swelling (cellulitis and not an abscess)
4. Dyspnea and stridor due to glottic edema
5. Submandibular glands or lymph nodes not involved.

Management

Investigations

1. *White blood count* (*WBC):* Markedly elevated range 15,000 to 20,000.
2. *X-ray studies show:*
   - Soft tissue edema
   - Occasionally gas
   - Posterior displacement of tongue with airway encroachment.
3. *Panoramic tomography:* To determine the site of origin of tooth infections.
4. *CT scan and MRI scan:* To determine the extent of spread of infection.

Conservative management

- IV fluids
- Systemic antibiotics.

Surgical management

- Extraction of inciting teeth (if identifiable)
- Tracheostomy : if airway is compromised
- Incision and drainage.

Incision and Drainage

- A median longitudinal incision is given three to four fingers breadth below mandibular margin
- Pus may not be found at time of decompression, but will often drain from wound after several days of decompression.

Complications

- Acute airway obstruction
- Extension of infection to the carotid sheath or retropharyngeal space with inferior extension into the mediastinum
- Septic shock/septicemia
- Aspiration pneumonia.

1. **Parapharyngeal space,** also called lateral pharyngeal space, extends from base of skull to the hyoid bone.
2. **Retropharyngeal space** (space of Gillette) extends from base of skull to the mediastinum and contains nodes of Rouviere.
3. **Common causes of parapharyngeal abscess** are—by spread of infection from tonsils, teeth injuries and trauma such as penetrating injuries or iatrogenic injuries.
4. **Access to lateral pharyngeal space** is gained by blunt dissection between the tail of submandibular gland and anterior border of sternocleidomastoid.
5. Most common **complications of parapharyngeal abscess** are IJV thrombosis, pneumonitis, septicemia and mediastinitis.
6. **Acute retropharyngeal abscess** is seen in children due to suppuration of the nodes of Rouviere, while chronic retropharyngeal abscess is seen because of caries spine or tubercular infection of the retropharyngeal lymph nodes.
7. Acute retropharyngeal **abscess in children** is comparatively more dangerous as the infants have shorter spine and the larynx is situated higher.
8. **Ludwig angina** is cellulitis of submandibular and sublingual spaces usually caused by periodontal disease.
9. Lateral pharyngeal space is a cone-shaped space, which is pierced at its apex by carotid sheath providing a dangerous conduit for spread of infection to the mediastinum. It was **named by Mosher as Lincoln highway of the neck.**
10. **Ultrasound (USG) of neck** is a useful examination to distinguish simple lymph node swelling from an abscess in the neck.
11. **Retropharyngeal abscess** is best evaluated with lateral radiograph of neck in flexion.
12. **Danger space** extends from base of skull superiorly to diaphragm inferiorly and contents are loose areolar tissue and infection here may spread to posterior mediastinum.

Chapter 38 Tumors of Oropharynx

What Students Must Know!

- **Classification**
- **Benign Tumors**
  - Hemangioma
  - Papilloma
  - Pleomorphic Adenoma
- **Malignant Tumors**
  - Adenocarcinoma
  - Adenocystic Carcinoma
  - Lymphoepithelioma
  - Lymphomas
- **Carcinoma Tonsil**
  - Etiology
  - Clinical Features
  - Diagnosis
  - Management
- **Carcinoma Base of Tongue**

INTRODUCTION

- Oropharynx extends from the level of hard palate above to the floor of vallecula opposite the hyoid bone below.
- It includes palatine tonsils with anterior and posterior faucial pillars, soft palate, posterior wall of pharynx, base of tongue and lingual part of epiglottis.
- Important factors contributing to cancer oropharynx are spices, spirit, smoking, sepsis, sharp tooth and previous irradiation.
- Lymphatic drainage of oropharynx occurs to jugulo-digastric group of lymph nodes, which is a part of upper deep cervical group of lymph nodes.

CLASSIFICATION

Tumors of oropharynx may be as follows:

1. *Benign tumors:* Such as papilloma, adenoma or pleomorphic adenoma of epithelial origin. These also may be fibroma, lipoma, hemangioma, neurinoma or chondroma of connective tissue origin.
2. *Malignant tumors:* Most commonly seen are malignancy of the tonsil, base of tongue or wall of pharynx. Most of these tumors are squamous cell carcinoma (80%), while the rest may be adenocarcinoma and adenocystic carcinoma or lymphomas (20%).

BENIGN TUMORS

Hemangioma

Hemangioma is usually congenital and in 90 percent cases affects girls. It may occur on tongue, cheek, palate, tonsil and posterior and lateral pharyngeal walls. It may be of capillary or cavernous type. Capillary hemangioma or even asymptomatic cavernous type hemangioma, if small, may not require any treatment. It may become large enough to threaten life due to recurrent bleeding, airway obstruction or obstruction to feeding.

Treatment

Hemangioma usually regresses spontaneously within 2 years of life, so surgical removal is always delayed if possible, until the age of 3 years.

Other Forms of Treatment

- Injection of sclerosing agents like boiling water, etc.
- Diathermy or cryotherapy coagulation
- Laser excision
- Cryosurgical excision of hemangioma has a role in hemophilia patients.

Papilloma

Papilloma is usually pedunculated and occurs in oral cavity, tonsil, soft palate and faucial pillars; but sometimes, they may extend to the pharynx and larynx. It usually does not cause any symptoms. When large, it causes local irritation in the throat.

Treatment

- Surgical excision
- Laser surgery.

Pleomorphic Adenoma

Pleomorphic adenoma mostly occurs submucosally on the hard or soft palate (**Figure 38.1A**), arising from the minor salivary glands or may arise from the deep lobe of parotid and extend into the pharynx, pushing the soft palate and tonsils.

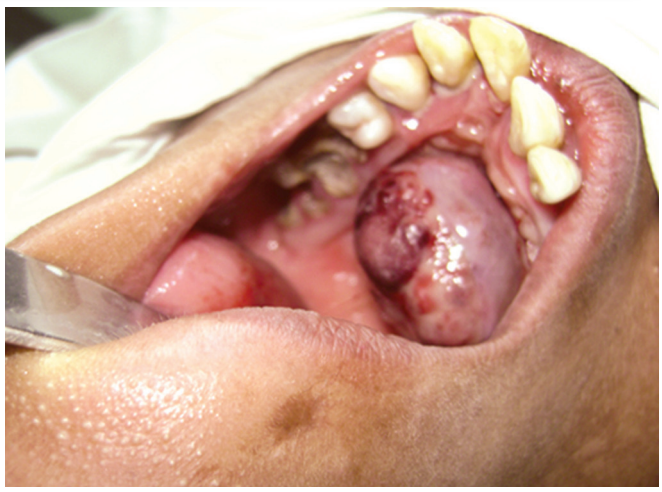


Figure 38.1A Pleomorphic adenoma palate

Treatment

It is a potentially malignant benign neoplasia and requires total surgical excision.

Mucous Cyst

Mucous cyst usually occurs in the valleculae. It is yellow in appearance and may be pedunculated or sessile. When it becomes large, it may cause foreign body sensation in the throat.

Treatment

- If mucous cyst is pedunculated, it requires surgical excision
- If it is in a cyst form, then incision and drainage with removal of its cyst wall is performed.

MALIGNANT TUMORS

The potential sites of malignancy may be:

- Roof—soft palate
- Lateral wall—tonsils, tonsillar fossa, anterior and posterior faucial pillars
- Posterior wall—posterior wall of pharynx
- Floor—posterior one-third of tongue and lingual part of epiglottis.

Types

Squamous Cell Carcinoma

Squamous cell carcinoma is the most common neoplasm. It may be well-differentiated, moderately differentiated or poorly differentiated.

Adenocarcinoma and Adenocystic Carcinoma

Adenocarcinoma and adenocystic carcinoma tumors arise from minor salivary glands. They mostly occur on the hard and soft palate and tonsillar pillars.

Lymphoepithelioma

Lymphoepithelioma consists of nonkeratinizing squamous epithelium cells and occasionally, it shows transitional cell preponderance exhibiting features of transitional cell carcinoma. This tumor is a variant of squamous cell carcinoma with lymphocytic elements. The tumor is very radiosensitive.

Lymphomas

- Lymphomas tumors are non Hodgkin's lymphomas, especially B-cell type of high-grade malignancy
- Hodgkin's disease is rare in oropharynx (8%)
- Male to female ratio is 2:1 and occurs mostly in young adults and sometimes in children
- Epstein-Barr virus (EBV) is found in almost all cases of non Hodgkin's lymphomas
- The common sites of involvement are tonsils and base of tongue.

Carcinoma Tonsil

- Squamous cell carcinoma of tonsil is fairly common in our country
- The tumor presents as an ulcerated lesion with necrotic base or as an unilateral tonsillar swelling without ulceration resembling peritonsillar abscess
- Squamous cell cancer occurs between the age of 50 and 80 years. Men are affected five times more than females (**Figure 38.1B**).

Etiology

- The important etiological factors are history of tobacco smoking, alcohol abuse and poor orodental hygiene
- Spread of tumor to adjacent structures, such as soft palate, tonsillar pillars, base of tongue, pharyngeal wall and even hypopharynx, may take place by direct involvement
- Lymphatic spread occurs in majority of the cases to the regional lymph nodes level II, III, IV, involving jugulo digastric group of lymph nodes initially
- Distant metastasis occurs to lungs, liver and bones in late cases through hematogenous spread.

Clinical Features

- The disease presents with sore throat, difficulty in swallowing, pain in the ear or mass in the neck. The lesion may remain asymptomatic for a long time
- Later on, bleeding from the mouth, halitosis and trismus may be present
- The patient may present with unilateral or bilateral neck swelling due to lymph node (LN) metastasis.

On Examination

- There may be exophytic or ulcerative growth present on the tonsil, which may bleed to touch (**Figures 38.1C and D**).
- Neck lymph nodes may be palpable, they may be mobile or fixed, unilateral or bilateral. Their size must be noted for staging the disease.

Diagnosis

Diagnosis becomes apparent when there is unilateral enlargement of tonsil along with neck node metastasis and difficulty in swallowing food with referred otalgia.

Differential Diagnosis

- Peritonsillar abscess
- Ulcerative lesions, e.g. tuberculosis (TB), syphilis
- Vincent angina.

Investigations

- X-ray examination is not helpful but an axial computerized tomography (CT) scan helps to assess the extent of the tumor.
- Biopsy is essential to know the type and fine needle aspiration cytology (FNAC) of involved lymph nodes is diagnostic.
- According to Union Internationale Contre Le Cancer (UICC) and American Joint Committee (AJC), the tumor nodes and metastasis (TNM) classification is as follows.

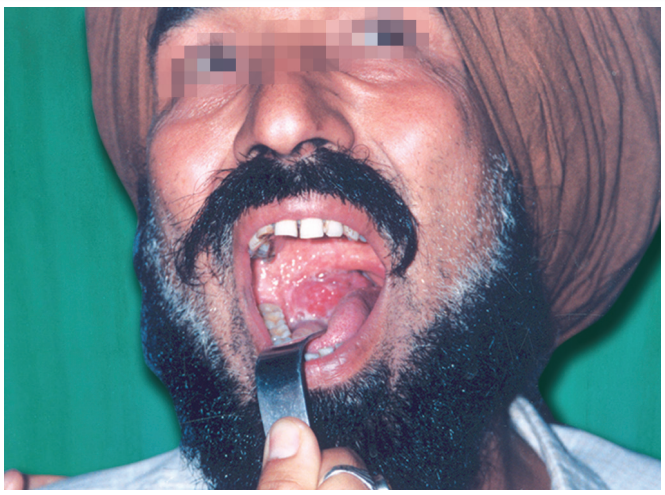
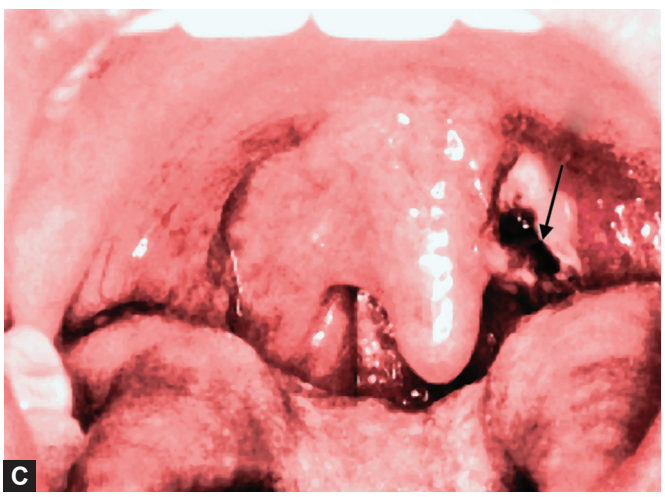
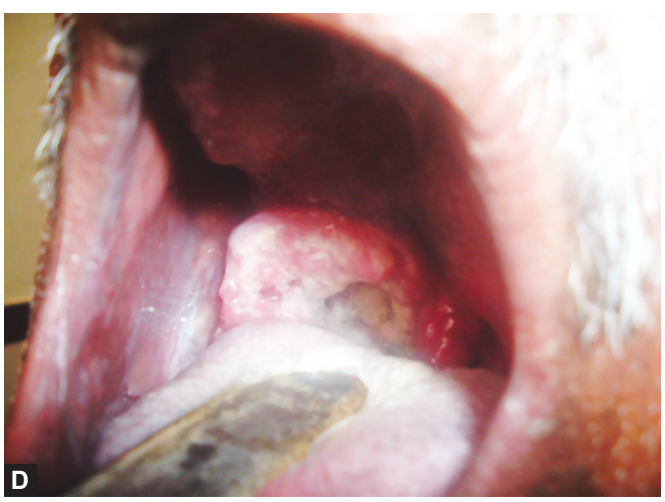


Figure 38.1B Carcinoma right tonsil





Figures 38.1C and D Malignant growth tonsil

Tumor Classification

- T_x Primary tumor cannot be assessed
- T_0 No evidence of primary tumor
- T_{1s} Carcinoma *in situ*
- T_1 Tumor 2 cm or less in diameter
- T_2 Tumor greater than 2 cm but less than 4 cm
- T_3 Tumor greater than 4 cm spreading to anterior or posterior pillar, base of tongue or soft palate
- T_4 Tumor with extension to mandible, pterygoid muscles, parapharyngeal space, neck and skin.

Lymph Node Classification

- N_0 No regional LN involvement
- N_1 Homolateral, movable regional lymph nodes
- N_2 Movable contralateral or bilateral regional (lymph nodes)
- N_3 Fixed regional lymph nodes.

Nodal (AJC Classification)

- N_0 No clinically positive lymph node
- N_1 Single clinically positive homolateral node 3 cm or less in diameter
- N_{2a} Single clinically positive homolateral node 3 cm to 6 cm
- N_{2b} Multiple clinically positive lymph nodes
- N_{3a} Massive homolateral node (nodes) with one greater than 6 cm
- N_{3b} Bilateral nodes
- N_{3c} Contralateral node or nodes.

Treatment

1. *Radiotherapy:* Radiotherapy is given to the sensitive and early tumors of tonsil with a full curative dose of 6,500 rads (radiation-absorbed dose) in fractions of 150 to 200 rads per day for 5 days a week along with irradiation of involved cervical lymph nodes.

   Radiotherapy is the treatment of choice for non-Hodgkin's lymphoma.
2. *Surgery:* Surgical excision of the tonsil (tonsillectomy operation) is done for early superficial lesions.
   - Larger lesions (T3 and T4), which involve mandible (base) require
   - Combined mandibulectomy and neck dissection of oropharynx (COMMANDO) operation, i.e. hemimandibulectomy with block neck dissection along with resection of lateral pharyngeal wall with part of tongue base and part of soft palate.
3. *Combination therapy:* Surgery may be combined with pre- or postoperative curative radiotherapy.

Surgery followed by combination chemotherapy is another choice of treatment in whom recurrence has occurred following radiotherapy and chemotherapy may be given as an adjunct to surgery or radiotherapy.

Palliative treatment is given for very advanced lesions. 5 year around survival rate in calcium tonsil is 25 percent.

Carcinoma of Posterior One-third of Tongue or Base of Tongue

Carcinoma of base of tongue like tonsil is fairly common. The tumor remains asymptomatic for a long time, until when the patient presents with neck node swellings.

Symptomatology

- The patient may present with sore throat and feeling of lump in the throat along with discomfort on swallowing food
- There may be pain in the ear and change in the quality of speech (plummy voice)
- The characteristic feature is anchoring of tongue or fixation of tongue on the involved side. The tongue deviates towards the involved side when the patient is asked to protrude his tongue. It is due to an infilterative type lesion, which spreads to involve the musculature of tongue
- It may spread to epiglottis, pre-epiglottic space and hypopharynx below; superiorly, it spreads to involve the tonsil and tonsillar pillars
- There is early and massive spread to the cervical lymph nodes through lymphatics involving homo or bilateral lymph nodes. Upper deep cervical group (jugulodigastric group) of lymph nodes are affected first
- Distant metastasis occurs to lung, liver and bones.

Diagnosis

- Depends upon a careful history and proper clinical examination of the patient along with investigations
- Indirect laryngoscopic exam. Lesion on the side of tongue can be seen by indirect laryngoscopic mirror
- Finger palpation of the base of tongue under anesthesia gives an idea of degree of infiltration of tissues
- Biopsy is taken with the help of punch biopsy forceps under local anesthesia for histopathological examination to know the type and variety of tumor.
- FNAC of involved upper deep cervical lymph node is done.

Treatment

- *Radiotherapy:* Early tumors of base of tongue, such as non Hodgkin's lymphomas, lymphoepithelioma or carcinoma, are radiosensitive and can be cured by curative radiotherapy dose along with irradiation to the involved upper deep cervical group of lymph nodes.

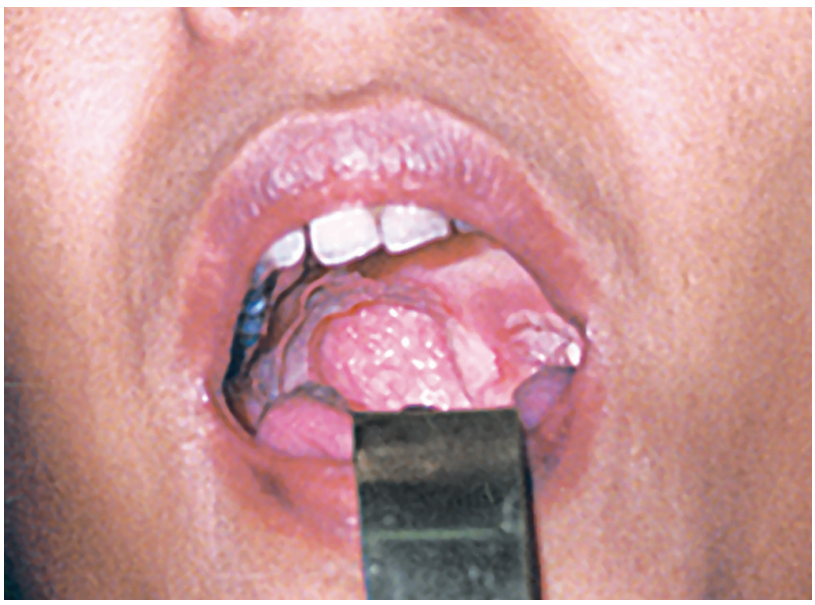


Figure 38.2 Growth palatine arch and tonsil

- *Surgery:* Larger lesions require COMMANDO operation in the form of hemiglossectomy, hemimandibulectomy and block neck dissection of lymph nodes. It may be combined with laryngectomy, if the tumor has encroached upon the larynx.
- *Chemotherapy:* May be given alone or may be combined with radiotherapy and surgery.

  Advanced cancers of base of tongue may require tracheostomy or gastrostomy at times to restore the airway and food passage. In Ca tongue (of lesion less than 4 cm) surgery carries a survival rate of 50 percent.

Carcinoma of Palatine Arch

The palatine arch consists of soft palate and anterior tonsillar pillars. Majority of the cancers are squamous cell type. Tumors are of well-differentiated variety. There is delayed metastasis to regional lymph nodes (**Figure 38.2**).

Symptoms

These patients present with sore throat, pain on swallowing or referred otalgia.

Growth is visible in the mirror on opening the mouth to the patient himself.

Treatment

Surgical excision with pre or postoperative radiation.

Carcinoma of Posterior and Lateral Pharyngeal Wall

Tumors of posterior and lateral pharyngeal wall spread silently for a long time in the submucosa to involve tonsil, soft palate, tongue, nasopharynx or hypopharynx later on. They may spread to the deeper tissues involving parapharyngeal space. Majority of the patients present with lymph node metastasis, especially bilateral lymph node spread is common.

Treatment

- Radiotherapy
- Surgical excision of the growth by lateral pharyngotomy with block neck dissection of lymph nodes.

Lymphoma of the Oropharynx

- Incidence of Hodgkin's disease in the oropharynx is very low
- Only non Hodgkin's lymphomas occur in the oropharynx constituting 8 to 15 percent of all the tumors occurring in the region

- Lymphomas involve the rich network of lymphoid tissue of the oropharynx
- These tumors are highly aggressive in nature or low-grade lymphomas, which are less aggressive
- All lymphomas contain EBV and attack the sites of epithelial proliferation in the oropharynx
- The high-grade lymphomas are completely cured by the treatment in early stages, whereas low-grade lymphomas are less curable even though they progress slowly.

Investigations

Excisional biopsy of the lymph nodes involved and a piece of tonsillar tissue is necessary to confirm the diagnosis and histopathological picture of the disease. Thick sections are cut to confirm the T-cell lymphomas.

Treatment

Radiotherapy is the treatment of choice for non Hodgkin's lymphomas. About 6,500 to 7,000 rads are given over 1.5 to 2 months time period in divided fractions.

1. **Oropharynx** extends from the level of hard palate to hyoid bone and drains to upper deep cervical group of lymph nodes.
2. **LASER**—evaporation of benign lesions is the latest method of treatment.
3. Curative dose of radiotherapy is 6,500 rads given 150 to 200 rads/day for 5 days a week.
4. **COMMANDO operation** includes hemimandibulectomy, hemiglossectomy, excision of tumor along with block dissection of neck nodes.
5. **Diagnosis of malignancy** is made by careful examination, FNAC of swelling followed by biopsy of the lesion.
6. Remember the important **modalities of treatment of malignancy** are:
   i. Radiotherapy
   ii. Surgery or a combination of radiotherapy and surgery
   iii. Chemotherapy.
7. In **occult primary** coffin corner area (also called **surgeon's graveyard**) must be thoroughly looked for any evidence of growth.
8. **Oropharyngeal cancers etiology**—**remember mneumonic**: 6 S's: Smoking; Spicy food; Syphilis; Spirits; Sore tooth; Sepsis

Chapter 39 Tumors of Hypopharynx

What Students Must Know!

- **Surgical Anatomy Hypopharynx**
  - Pyriform Sinus
  - Postcricoid Region
  - Posterior Pharyngeal Wall
- **Tumors of Hypopharynx**
  - Benign Tumors
  - Malignant Tumors
- **Carcinoma of Pyriform Sinus**
  - Clinical Features
  - Treatment
- **Carcinoma of the Postcricoid Region**
  - Clinical Features
  - Treatment
- **Carcinoma of Posterior Pharyngeal Wall**

SURGICAL ANATOMY

Hypopharynx lies below the oropharynx beginning at the level of hyoid bone superiorly (C_3) to the opening of esophagus at 6th cervical vertebrae.

It has three parts:

1. Pyriform sinus.
2. Postcricoid region.
3. Posterior pharyngeal wall.

Pyriform Sinus

Pyriform sinus is bounded laterally by thyrohyoid membrane and medially by aryepiglottic fold. Lymphatics from the area drain into upper deep cervical lymph nodes. Internal laryngeal nerve lies under the mucosa of pyriform sinus.

Postcricoid Region

It extends from posterior surface of arytenoid cartilage to the inferior border of cricoid cartilage. It drains into paratracheal group of lymph nodes.

Posterior Pharyngeal Wall

Posterior pharyngeal wall area extends from hyoid bone above to the cricoarytenoid joint inferiorly. Lymphatic drainage of this area goes to deep cervical group of lymph nodes via parapharyngeal lymph nodes (**Figure 39.1**).

TUMORS OF HYPOPHARYNX

Classification

Benign

Such as papilloma, adenoma, fibroma or leiomyoma. These may be polypoidal causing dysphagia and are confirmed on barium swallow study and hypopharyngoscopy.

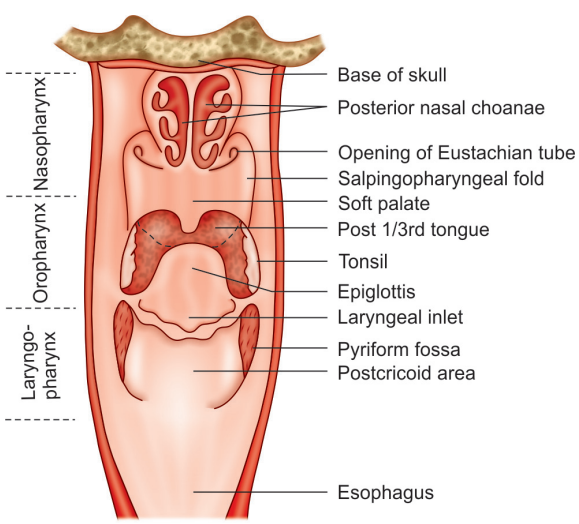


Figure 39.1 Parts of pharynx as seen from behind

Treatment is by surgical excision through lateral pharyngotomy approach.

Malignant Tumors

- Carcinoma of the hypopharynx is very common in India.
- As the hypopharynx is lined by the squamous epithelium, majority of the tumors are squamous cell carcinomas with varying degree of differentiation.
- Usually, these tumors are well-differentiated carcinomas (85%).
- Tumors of hypopharynx usually present late due to delay in diagnosis and aggressive nature of disease.

MALIGNANT TUMORS OF HYPOPHARYNX

The types of malignant tumors involving the hypopharynx are as follows:

Epithelial Malignant Tumors

- Squamous cell carcinoma
- Adenocarcinoma
- Adenocystic carcinoma
- Transitional cell carcinoma
- Carcinosarcoma or pseudosarcoma
- Undifferentiated carcinoma.

Malignant Mesodermal Tumors

- Leiomyosarcoma
- Non-Hodgkin lymphoma.

CARCINOMA OF PYRIFORM SINUS

- Squamous cell carcinoma of hypopharynx constitutes 60 percent or more of all the tumors in this region
- It affects more of the males than females and the age incidence is above 40 years of age. Squamous cell carcinoma may be exophytic or ulcerative in nature
- Neck lymph node metastasis is very common in this disease because of rich lymphatic network in this region. An enlarged neck lymph node may be the only symptom of the disease in its early stages as there is adequate space in the pyriform fossa to accommodate enlarging tumor before the other symptoms of the disease develop
- The increased incidence of the disease in our country is associated with tobacco smoking, tobacco chewing and alcohol abuse coupled with malnutrition and unhygienic conditions.

Spread of the Tumor

- Tumors of the pyriform fossa spread locally to involve vallecula, epiglottis and the base of tongue superiorly. It may involve the postcricoid region when spreading downwards. It may involve the lateral wall of the pyriform sinus and extend through the thyrohyoid membrane to enter the carotid sheath and thyroid gland
- Regional metastasis to neck nodes occurs through the lymphatic spread, since pyriform sinus is richly supplied by the lymphatic network involving upper and middle deep cervical lymph nodes in 75 percent of cases
- Distant metastasis may occur to liver, lungs and bones usually after 1 to 2 years. Since the lymphatic network freely crosses the midline, bilateral lymph node involvement is common
- Tumors of the pyriform fossa involving the medial wall invade the aryepiglottic fold rapidly by virtue of rich lymphatics to enter the paraglottic space. From here, the neoplasm spreads submucosally downwards to involve the vocal cords causing hoarseness of voice, because of fixation of the vocal cord
- Paralysis of a vocal cord may occur due to involvement of the recurrent laryngeal nerve or due to fixation of the cricoarytenoid joint causing immobility of the vocal cord
- Tumor, nodes and metastasis (TNM) classification of tumors of hypopharynx is difficult, because it may not be possible to detect extension and fixation to surrounding structures.

Staging of Tumors of Hypopharynx

- T_x Minimum requirement to assess the primary tumor cannot be met
- T_{1S} Carcinoma *in situ*
- T_O No evidence of primary
- T_1 Tumor confined to one site
- T_2 Tumor extending to adjacent site without fixation of hemilarynx
- T_3 Tumor extending to adjacent area with fixation of hemilarynx
- T_4 Tumor extending to bone, cartilage or soft tissues.

N and M—classification is like other classifications already given.

Clinical Features

In the early stages, the patient may complain of pricking sensation or sticking of food in throat.

- About two-thirds of the patients come with a neck node swelling. There may be pain on swallowing, pain in the ear, difficulty in swallowing solid food or enlarged neck nodes.

- Dysphagia is progressive from solids to liquids as the disease advances.
- There may occur hoarseness of voice and difficulty in breathing because of involvement of larynx.
- Foetid smell from mouth and blood-tinged sputum may be present.

Clinical Examination

Indirect Laryngoscopic Examination

Indirect laryngoscopic examination may reveal exophytic, ulcerative or ulceroproliferative growth. There may be pooling of secretions or saliva in the pyriform fossa above the growth. There may occur fixation of the vocal cords or cricoarytenoid joint, so its mobility is also assessed.

The neck is examined and palpated for lymph node metastasis between the mastoid and angle of mandible.

Investigations

Radiology

1. X-rays lateral view for soft tissue neck.
2. Barium swallow examination.
3. Computerized axial tomography (CAT) to assess the spread of the neoplasm.
4. Magnetic resonance imaging (MRI) of the area involved, where the facility is available.
5. Direct laryngoscopic examination is a must for biopsy and accurate assessment of the extent of disease.

Laboratory Investigations

As these patients are prone to develop blood and electrolyte imbalance, complete bio-chemical assay of the blood of the patient must be done.

Treatment

Radiotherapy

Radiotherapy is done in patients, where tumor size is small and lymph nodes are mobile. It gives better chances of survival, where recurrence does not occur.

Surgery

- Surgical treatment of tumor along with lymph node excision in the form of block neck dissection must be done to ensure 5 years survival rate
- Surgery in the form of total or partial laryngopharyngectomy with block neck dissection is done.
- Reconstruction of the pharynx along with the surgery or after the surgery can be planned out.

Combined Surgery and Radiotherapy

Radiotherapy can be given preoperatively, where the tumor size has increased and lymph nodes have become fixed to reduce local recurrence by implantation and spread of tumor cells by veins and lymphatics. It also relieves the lymph node fixation, so that lymph nodes become mobile and can be easily dissected during surgery.

Postoperative radiotherapy is given to sterilise the operative field area from the tumor cells, if it has been left over.

CARCINOMA OF THE POSTCRICOID REGION

- Squamous cell carcinoma of the postcricoid region constitutes 30 percent of laryngopharyngeal malignancies

- The association of **Plummer-Vinson (Paterson and Brown-Kelly, 1919)** syndrome is in about one-fourth to one-half cases of carcinoma of postcricoid area, characterized by:
  - Anemia, glossitis, pharyngeal web
  - koilonychia and splenomegaly
  - The hypochromic microcytic anemia is an important etiological factor in the development of carcinoma.
- It is more common in females in as early as 20 to 30 years of age group.

Spread

In tumors of the postcricoid area, the tumor is not easily seen unless it extends into the pyriform fossae. It causes pooling of secretions in the pyriform fossa. It may be an ulcerative lesion arising from the postcricoid region and spreading in a circular fashion causing obstruction of mouth of esophagus due to downward spread. It may spread to involve arytenoids superiorly and recurrent laryngeal nerve when spreading laterally or by the involvement of the cricoarytenoid joint causing hoarseness of voice or loss of speech.

Through lymphatics, it may spread to paratracheal lymph nodes, later on to regional lymph nodes. Bilateral or contralateral cervical lymph nodes may be involved.

Clinical Features

1. There is progressive dysphagia to solids and then to liquids leading to malnutrition and weight loss in females. Progressive dysphagia is the predominant feature of the disease.
2. There may be hoarseness of voice or aphonia when larynx is involved due to involvement of recurrent laryngeal nerve or cricoarytenoid joint fixation.
3. Referred otalgia.
4. Absence of laryngeal crepitus.

Diagnosis

Indirect Laryngoscopic Examination

Indirect laryngoscopic examination may not be helpful in showing postcricoid growth, unless the growth has extended superiorly to involve pyriform sinus, but pooling of secretions in the hypopharynx is suggestive of growth.

Radiography

1. X-rays soft tissue neck lateral view shows an increased prevertebral shadow (**Figure 39.2**) or increased post-laryngeal space.
2. Barium swallow examination. It is diagnostic of tumor presence showing filling defect in the lumen.

Direct Laryngoscopic Examination

Direct laryngoscopic examination is done to see the extent of the disease and to take the biopsy material from the tumor site.

Laboratory Investigations

Blood tests reveal markedly reduced hemoglobin with reduction in total red blood cells (RBCs). Peripheral blood smear examination shows hypochromic microcytic anemia.

Treatment

- It has a bad prognosis, because of the site of involvement and late diagnosis.
- Early lesions can be treated by **curative dose radiotherapy**. This preserves the voice. Surgery also gives good results in early lesions. It is performed through lateral pharyngotomy approach with primary repair of the site
- Failed cases and advanced tumors may require total laryngopharyngectomy or **total laryngopharyngo-esophagectomy with gastric pull up** for reconstruction of food passage
- **Contraindications to surgery are:**
  1. Poor general health, old age.
  2. Distant metastasis.
  3. Extensive growth.
  4. Fixed and bilateral nodes.

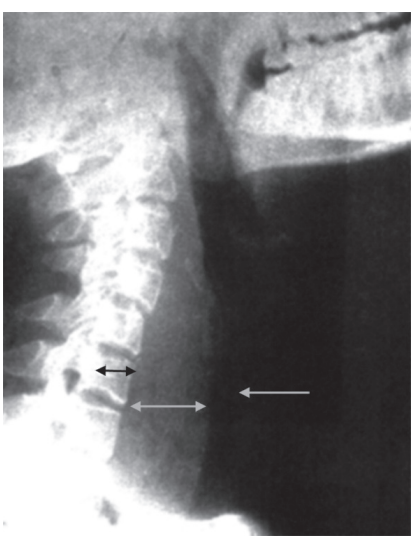


Figure 39.2 Increased prevertebral shadow

CARCINOMA OF POSTERIOR PHARYNGEAL WALL

- Carcinoma of the posterior pharyngeal wall is very uncommon constituting only 10 percent of all the tumors of the hypopharynx
- The tumor may be exophytic or ulcerative and remains localized for a long period of time. It may then spread to involve prevertebral muscles and vertebral bodies
- Lymph node metastasis may occur to both sides of the neck due to bilateral lymphatic spread. Initially, the carcinoma spreads to retropharyngeal group of lymph nodes and then to cervical lymph nodes.

Clinical Features

The patient may present with dysphagia or spitting of blood.

Mostly occurs in males above the age of 50 years. History of smoking, alcohol consumption along with malnutrition may be present.

The patient may present with neck node enlargement.

Diagnosis

Indirect Laryngoscopy Examination

Indirect laryngoscopy examination may show tumor on posterior pharyngeal wall as an exophytic growth or ulcerative lesion.

X-ray Soft Tissue Neck

Anteroposterior (AP) view and lateral view may show vertical extent and thickness of the disease along with erosion or swelling of the vertebral body.

Direct Laryngoscopy

Direct laryngoscopy is done to confirm the diagnosis and to take biopsy for histopathological examination.

Treatment

Radiotherapy

Early exophytic lesions can be treated with radiotherapy with preservation of vocal function.

Surgery

Surgery can be done through lateral pharyngotomy approach with primary repair of the site involved.

Advanced tumors may require laryngopharyngectomy along with total block neck dissection of the lymph nodes of both sides with repair of the food passage with gastric pull up or colon transposition.

Key Points

1. **Hypopharynx** extends from C3 level to C6 level.
2. In hypopharynx, **pyriform sinus is the most richly supplied by lymphatics**, draining into upper deep cervical lymph nodes.
3. **Paralysis of vocal cords** in tumors of pyriform sinus may be due to involvement of recurrent laryngeal nerve (RLN) or fixation of cricoarytenoid joint.
4. Surgical treatment of tumors of pyriform sinus is **partial or total laryngopharyngectomy with block dissection** of neck.
5. **Plummer-Vinson syndrome** may be associated with postcricoid carcinoma.
6. Examination of neck for **laryngeal crepitus** due to movements of larynx over the bodies of vertebra is important and it is absent in postcricoid growth or in retropharyngeal abscess.
7. **Postcricoid carcinoma** is treated surgically by total laryngopharyngectomy.

Section 5

Diseases of Larynx and Trachea

Chapter 40

Anatomy and Physiology of Larynx

What Students Must Know!

- **Framework of Larynx**
  - Cartilages
  - Spaces of Larynx
- **Ligaments and Membranes of Larynx**
- **Muscles of Larynx**
  - Nerve Supply of Muscles
- **Cavity of Larynx**
  - Saccule of Larynx
  - Vestibular Folds
  - Vocal Folds
- **Laryngeal Compartments**
  - Physiology of Larynx

LARYNX

1. Larynx is an organ of voice and also serves as an air passage.
2. It extends from root of tongue to the trachea.
3. It lies against 3rd to 6th cervical vertebrae posteriorly.
4. It develops from tracheo-bronchial groove, which is a midline diverticula of foregut.
5. Epiglottis and thyroid cartilage develop from 4th branchial arch, while cricoid and arytenoid develop from 6th arch derivatives.
6. Anteriorly, it is covered by skin, fascia and depressor muscles of hyoid bone.
7. The infant's larynx differs from the adult by following points (**Table 40.1**).
   - Shape—it is funnel-shaped
   - Size—it is smaller in infants
   - Subglottis—with narrow subglottis
   - Softness—its cartilages are softer
   - Submucosal space—epiglottis is narrow and folded with more of submucosal space.
   - Sensitivity—laryngeal reflexes are very active
   - Superiorly placed and is situated high.

Table 40.1 Average measurement

Size	*Adult male*	*Adult female*
Length	44 mm	36 mm
Transverse	43 mm	41 mm
Anteroposterior	36 mm	26 mm

Framework of Larynx

The framework of larynx consists of cartilages, connected by ligaments, mucous membrane and moved by many muscles.

Cartilages

They are nine in number and are derived from 4th, 5th and 6th arches (**Figure 40.1**).

Unpaired Cartilages

Thyroid cartilage

- It is the largest cartilage of all laryngeal cartilages and is of hyaline nature, which ossifies at 25 year-of-age
- Two alae meet in midline at 90° in males and 120° in females
- Thyroid cartilage projects to form the Adam's apple
- Oblique line gives attachments to sternothyroid, sterno-hyoid and inferior constrictor muscles.

Cricoid cartilage

- It is also a hyaline cartilage
- It is signet ring like in shape
- It consists of a narrow anterior arch and broad posterior quadrate lamina for articulation with arytenoids.

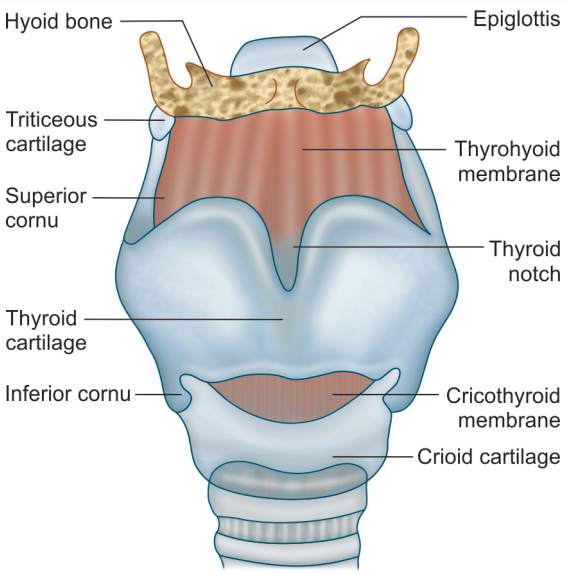


Figure 40.1 Various cartilages of larynx

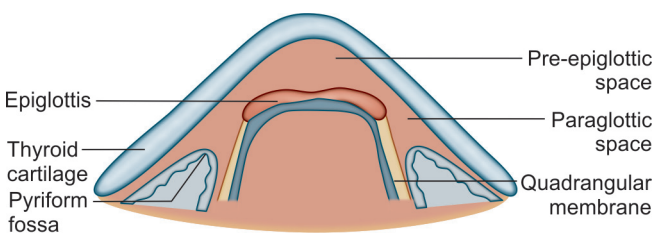


Figure 40.2 Pre-epiglottic and paraglottic space

Epiglottic cartilage

- It is fibroelastic cartilage, which never ossifies
- It is leaf-like consisting of two ends, two surfaces (anterior and posterior) and two sides
- It plays a role during deglutition
- It is omega shaped in children.

Paired cartilages

Arytenoid cartilages

- It is pyramidal in shape and articulates with cricoid lamina
- It has a base, apex and three surfaces
- Base has a vocal process for vocal ligament and muscular process laterally for attachment of posterior and lateral cricoarytenoid muscles of larynx.

Cuneiform cartilage of Santorini and corniculate cartilage of Wrisberg

They are small paired cartilages in the margin of aryepiglottic folds.

Spaces of Larynx

Pre-epiglottic Space

It is also called **space of Boyer**. Its contents include:

- Lymphatics
- Fat
- Areolar tissue

It is bounded by:

- Upper part of thyroid cartilage and thyrohyoid membrane in front
- Infrahyoid epiglottis and quadrangular membrane behind
- Hyoepiglottic ligament above (**Figure 40.2**)
- Continuous with paraglottic space laterally.

Importance

Malignancy can spread to this space in carcinoma larynx and has to be cleared in laryngectomy.

Paraglottic Space

Boundaries are:

- Laterally—thyroid cartilage
- Medially—ventricle and quadrangular membrane
- Posteriorly—pyriform sinus
- Anteriorly—continuous with space of Boyer.

Importance

Growths when invade this space can present in the neck through cricothyroid membrane.

Reinke's Space

Reinke's space is a subepithelial space on the vocal cord.

It is bounded:

- Superiorly by mucous membrane of vocal cord
- Inferiorly by vocal cords
- Anteriorly by anterior commissure
- Posteriorly by vocal process of arytenoid cartilage
- Importance of this space is edema of the space leads to Reinke edema. Reinke's space also prevents spread of glottic carcinoma to deeper structures.

Joints of Larynx

Cricothyroid and cricoarytenoid joints are synovial joints and may be affected by synovial joint disease.

Ligaments and Membranes of Larynx

The ligaments and membranes of larynx are as follows:

Conus Elasticus

- Conus elasticus extends from lower border of thyroid to cricoid cartilage
- Its free border is thickened to form vocal ligament.

Thyrohyoid Membrane

- Thyrohyoid membrane extends between hyoid bone and thyroid cartilage
- It is pierced by superior laryngeal nerve and vessels.

Quadrangular Membrane

Quadrangular membrane extends from the side of epiglottis to the vocal process and corniculate cartilage.

Mucous Membrane

Lining consists of stratified squamous epithelium, which lines the vocal cords, upper part of epiglottis and aryepiglottic folds, while rest of larynx is lined by pseudostratified ciliated columnar epithelium.

There are two folds of mucous membrane, i.e. false vocal cords (or vestibular folds) and true vocal cords (or vocal folds). Cricovocal membrane connects various cartilages internally with each other. Hyoepiglottic, thyroepiglottic and cricotracheal ligament connect the epiglottis with hyoid and thyroid.

Muscles of Larynx

The muscles of larynx are as follows:
- Extrinsic muscles
- Intrinsic muscles.

Extrinsic Muscles

- Elevators are stylopharyngeus and salpingopharyngeus; mylohyoid and digastric muscles
  Nerve supply of elevators:
  - Stylopharyngus by branch of IX nerve
  - Salpingopharyngus by pharyngeal plexus
  - Mylohyoid by branch of inferior alveolar nerve (V nerve)
  - Digastric anterior belly by myelohyoid nerve
  - Posterior belly by branch of facial nerve.
- Depressors are thyrohyoid, sternothyroid, sternohyoid and geniohyoid (**Figures 40.3A and B**).
  Nerve supply
  - Thyrohyoid by C1 through XII nerve
  - Sternothyroid by C2-C3 ansa cervicalis
  - Sternohyoid by C1,C2 and C3

Intrinsic Muscles

- Adductors of vocal cord are lateral cricoarytenoid (main), transverse arytenoid, thyroarytenoid and cricothyroid (**Figures 40.3 and 40.4A**)
- Abductor of vocal cord is posterior cricoarytenoid muscle
- Tensor of vocal cord: Cricothyroid muscle, vocalis and thyroarytenoid
- Relaxors of vocal cord: Vocalis and thyroarytenoid
- Opener of inlet: Thyroepiglotticus
- Closure of inlet: Oblique arytenoid and aryepiglottic.

Keyhole glottis
Keyhole glottis is seen in thyroarytenoid weakness and flag sign is typical of bilateral adductor palsy.

Nerve Supply of Muscles

- All the muscles are supplied by recurrent laryngeal nerve except cricothyroid, which is supplied by external laryngeal branch of superior laryngeal nerve
- As the left recurrent laryngeal nerve makes a longer course, hence, it is more susceptible to nerve palsy.

Recurrent Laryngeal Nerve

- Takes origin from vagus in neck close to 4th aortic arch vessels, i.e. subclavian artery right side and aortic arch on left side
- Recurrent laryngeal nerve (RLN) passes caudal to these vessels and are dragged caudally when vessels descend.

Nonrecurrent Laryngeal Nerve

- Non recurrent laryngeal nerve seen on right side only
- Because occasionally right 4th arch vessel fail to develop normally
- So right subclavian arises from aorta beyond left subclavian artery and then passes to right side behind esophagus
- So in these cases RLN is not drawn down and passes directly medially to larynx as nonrecurrent laryngeal nerve.

Sensory Nerve Supply

- Internal-laryngeal nerve branch of superior-laryngeal nerve supplies larynx above the vocal folds
- It runs submucosally in lateral wall of pyriform sinus and so is accessible for local anesthesia

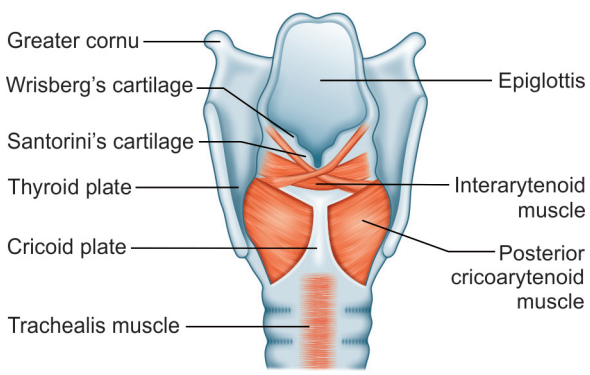


Figure 40.3A Muscles of larynx

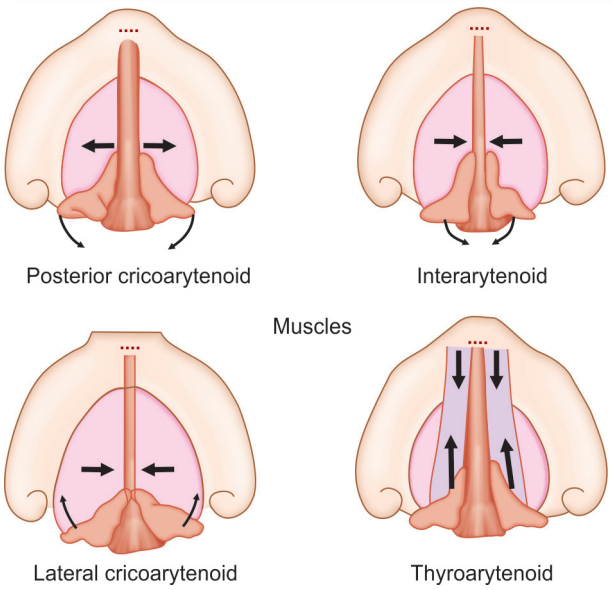


Figure 40.3B Intrinsic muscles of larynx

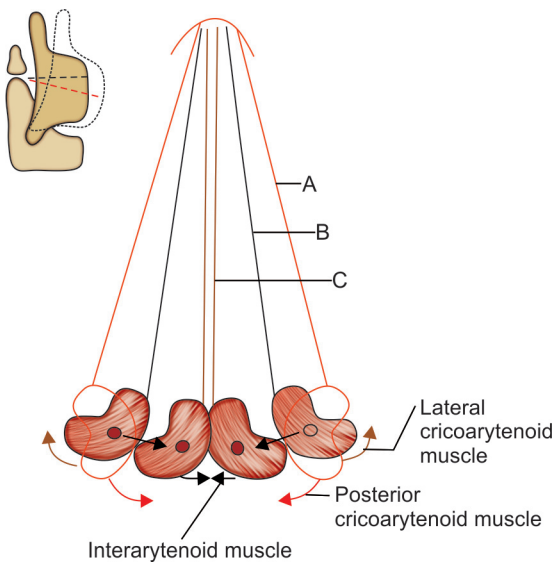


Figure 40.4A Movements of vocal cords by adductors and abductors. A. Abduction-posterior cricoarytenoid; B. Intermediate position; C. Adduction-lateral cricoarytenoid and interarytenoid

- Recurrent laryngeal nerve supplies larynx below the vocal folds.

Cavity of Larynx

Cavity of larynx extends from laryngeal inlet to the upper free border of cricoid cartilage and is divided into three parts (**Figure 40.4B**).

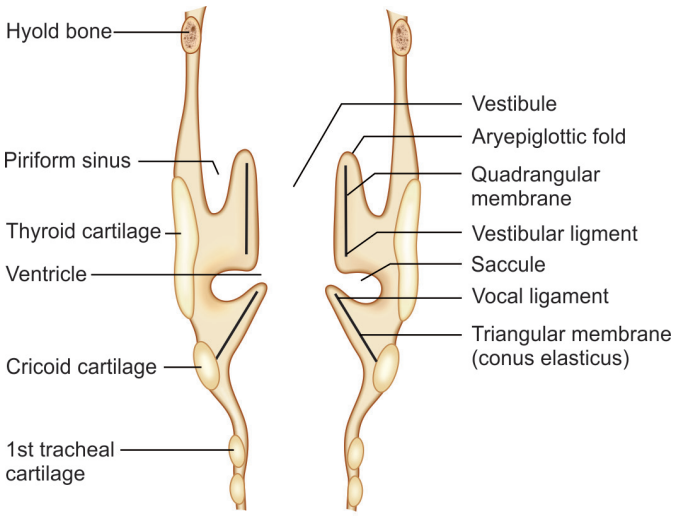


Figure 40.4B Sectional anatomy of cavity of larynx

1. Vestibule extending from laryngeal inlet up to level of vestibular folds. It is bounded by epiglottis, aryepiglottic fold and arytenoid cartilage.
2. *Ventricle:* It is the smallest middle part lying between true and false vocal cords. Ventricle opens laterally into sinus of larynx (a fusiform recess between vestibular and vocal folds).
3. *Subglottic part:* It lies between true cords and lower border of cricoid cartilage ending into trachea.

Saccule of Larynx

Saccule of larynx is a pouch of anterior part of sinus of larynx between the vestibular folds and inner surface of thyroid cartilage.

About 60 to 70 mucous glands lie in it and produce secretions for lubrication of vocal folds.

Vestibular Folds

They are two thick folds of mucosa, which enclose vestibular ligament fixed in front to thyroid cartilage immediately below the attachment of epiglottic cartilage.

Vocal Folds

1. These are two sharp pearly white folds of mucous membrane stretching from middle of angle of thyroid cartilage to the vocal processes of arytenoid cartilage.
2. These folds enclose vocal ligaments and form the lateral boundary of rima glottidis (**Figure 40.5**).
3. Due to absence of submucous layer and blood vessels, it is pearly white in color.
4. Vocal cords consists of the following layers from medial to lateral side;—stratified squamous epithelium, lamina

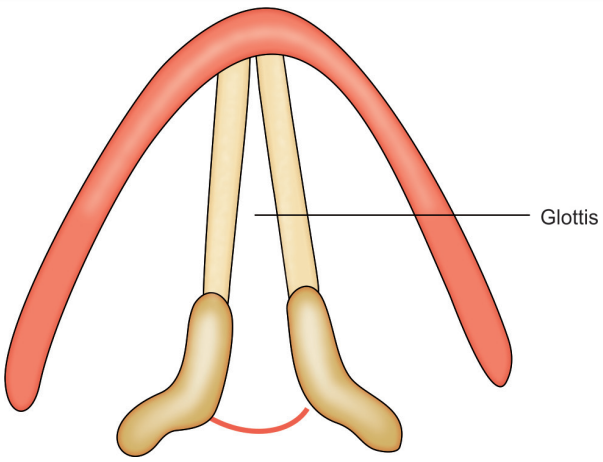


Figure 40.5 Rima glottidis

propria superficial, intermediate and deep layers, vocalis muscle forms the main mass of vocal cord.
5. Rima glottidis is a fissure between vocal folds and vocal processes of arytenoid cartilage.
6. Thus, anterior three-fifths is membranous and posterior one-fifth is cartilaginous.
7. Average length in males is 23 mm and in females is 17 mm.

Laryngeal Compartments

1. Glottis consists of vocal cords.
2. Supraglottis extends from hyoid bone superiorly to the glottis inferiorly bounded laterally by aryepiglottic folds.
3. Subglottis extends from lower border of glottis to inferior border of cricoid.

Blood Supply of Larynx

Superior laryngeal artery and vein above the vocal cords, while inferior laryngeal artery and vein below the vocal cords.

Lymphatics

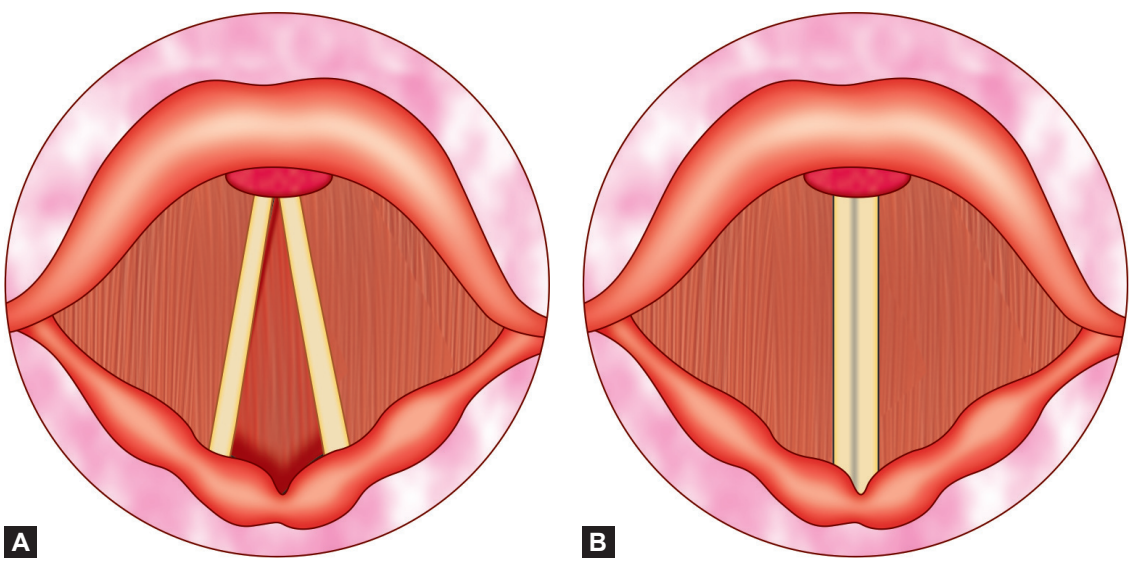
Glottis
Vocal cords have practically no lymphatics hence acts as a lymphatic watershed except for a small node called delphian node, which lies on cricothyroid membrane.

Supraglottis
Lymphatics after piercing the thyrohyoid membrane end in upper deep cervical chain, which lies on internal jugular vein.

Subglottis
Drains through prelaryngeal and paratracheal lymph nodes into lower deep cervical and mediastinal lymph nodes. Aryepiglottic fold has the richest lymphatic supply.

PHYSIOLOGY OF LARYNX

It acts as a:
1. Respiratory passage and air flow regulator.
2. Phonation and speech: It involves inspiration, adduction of vocal cords, bellowing action of chest due to contraction of muscles and rise of infraglottic pressure forcing the vocal cords apart and setting it into vibration. Speech is produced by articulation of tongue, lips, teeth and palate (**Figures 40.6A and B**).
3. Protects the lower respiratory passage.
4. Fixation of chest as in climbing and digging.
5. Initiates cough reflex.
6. Helps in promoting venous return.



Figures 40.6A and B Position of larynx. (A) During inspiration; (B) During expiration

Key Points

1. **Larynx extends** from C3 to C6 level and it descends to C6 level at 14 year-of-age.
2. **Cricoid cartilage** is the only complete ring present in the air passages.
3. **Posterior cricoarytenoid** is the only abductor of vocal cord.
4. **All the intrinsic muscles of larynx** are supplied by recurrent laryngeal except for cricothyroid, which is supplied by external laryngeal (branch of superior laryngeal).
5. **Epiglottis** is omega shaped in neonates and infants.
6. Infant's larynx differs from adult as it is situated high up (C2-C4), is of equal size in both sexes, is funnel shaped with narrow subglottis, the cartilages are softer and the epiglottis is narrow and folded. Its area is 24 sq mm and width is 6 sq mm.
7. **Glottis** consists of vocal cords, supraglottis extends from hyoid (superiorly) to glottis (inferiorly), subglottis extends from lower border of glottis to inferior border of cricoid.
8. **Vocal cords** have practically no lymphatics except for a small delphian node, which lies on crico thyroid membrane (lymphatic watershed of larynx).
9. Muscles attached to **oblique line of thyroid cartilage** are thyrohyoid sternothyoid and inferior constrictor.
10. Vocal cords at birth are 7 mm long at puberty 14 mm, adult female 15 to 16 mm and adult male 17 to 21 mm.
11. **Quality of voice** depends upon pitch, length of vocal cords and tracheal pressure.
12. **Ligament of Broyle** (yellow spot) is a small ligament connecting anterior commissure to thyroid cartilage.
13. Difference between **elastic and hyaline cartilage** is that elastic cartilage does not calcify and is seen in pinna, epiglottis cuneiform, corniculate and apices of arytenoid cartilage.
14. **Galen's anastomosis** is between recurrent and superior laryngeal nerve.
15. **Hyaline cartilages ossify**, while fibroelastic cartilages do not.
16. **Visor angle** is the angle between cricoid and thyroid cartilage.
17. **Adductors of Vocal cord—remember mneumonic: TALC: T**hyroarytenoid; **A**rytenoid transverse; **L**ateral cricoarytenoid; **C**ricothyroid

Chapter 41

History Taking and Method of Examination of Larynx

What Students Must Know!

- **Main Symptoms**
  - Hoarseness
  - Noisy Breathing
  - Pain in Throat
- **Past History**
- **General Physical Examination**
  - Neck Nodes Examination
- **Local Examination**
  - Laryngeal Crepitus
  - Indirect v/s Direct Laryngoscopy

HISTORY TAKING

The important symptoms of laryngeal diseases are as follows:

1. *Hoarseness:*
   Enquire about:
   - Profession
   - Age of onset
   - Progress of disease
   - History of operation or injury.

   The usual causes are benign and malignant lesions, recurrent laryngeal nerve palsy, allergic disorders, foreign bodies and inflammatory problems.
2. *Noisy breathing:*
   - Inspiratory stridor indicates laryngeal obstruction.
   - Expiratory stridor is present in other lesions lower down.
   - Sudden difficult breathing may occur in laryngeal edema or foreign bodies, while progressive difficulty indicates neoplasm.
3. *Cough:* Sudden cough indicates foreign body or allergy; while if associated with hoarseness of voice; it suggests laryngeal involvement.
4. *Pain in the throat and neck or referred pain:* It is not very common symptom and may be seen in injury, infection or advanced malignancy.
5. *Other symptoms:* These may be hemoptysis, weight loss or swellings in the neck region or foreign body or hawking sensation in the throat as seen in early neoplasms.

Past History

Relevant past and personal history of the patient so as to know his habits of tobacco chewing, smoking, misuse of voice or any history of trauma, operation or tuberculosis (TB), etc.

GENERAL PHYSICAL EXAMINATION

The general physical examination is done as usual, especially for the presence of neck lymph nodes, laryngeal crepitus or signs of malnutrition.

Local Examination

1. *External examination:* It is done for:
   a. Examination of external laryngeal framework
   b. Any evidence of perichondritis
   c. Neck nodes in various triangles of neck (**Figure 41.1**)
   d. Laryngeal crepitus
   e. Movements of larynx (it moves downwards during inspiration in laryngeal obstruction due to inspiratory dyspnea; but in tracheal obstruction, no such movement is seen).
2. *Indirect laryngoscopy (IDL) examination* (Manuel Garcia of London)
   a. It is an important outpatient department (OPD) procedure for diagnosis of laryngeal and hypopharyngeal disorders (**Figures 41.2 and 41.3**).

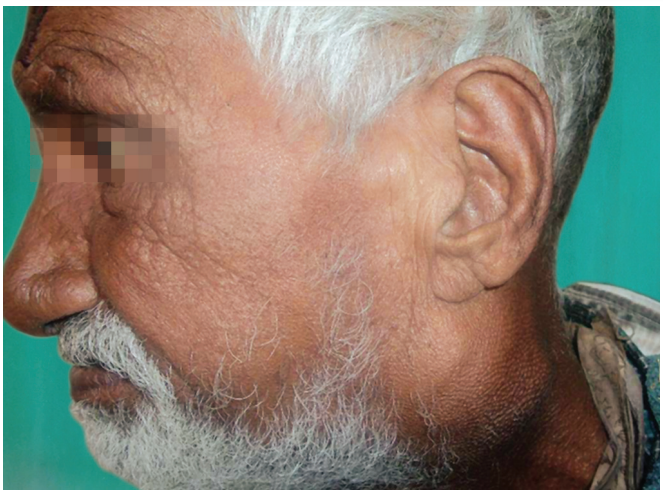


Figure 41.1 Lymph node metastasis neck

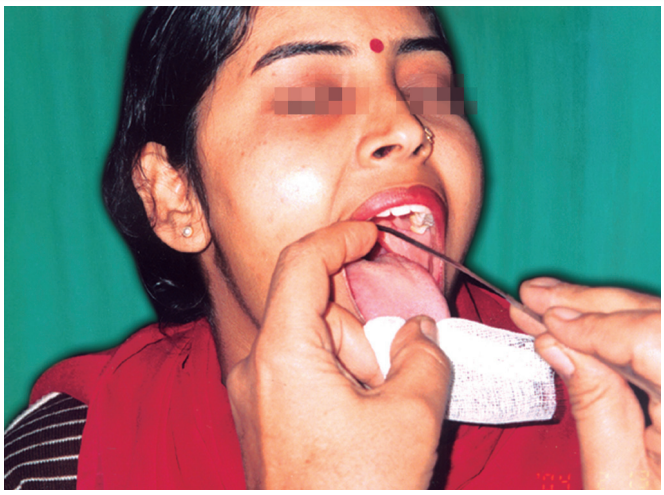


Figure 41.2 Method of doing indirect laryngoscopy examination

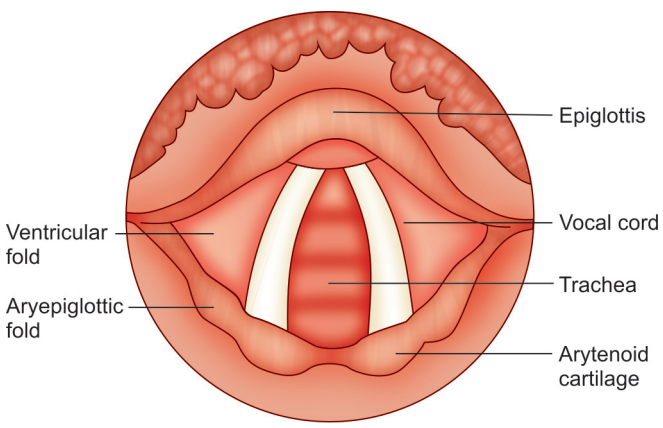


Figure 41.3 Structures seen in IDL procedure

b. It is called indirect as the structures are not seen directly but through the mirror in an indirect fashion.
c. Vocal cords appear white on IDL due to angle of incidence of light on vocal cords which is at right angle to the plane of superior surface so most of light is reflected back to the mirror.
d. The light strikes tangentially on rest of the larynx.

The examination IDL is misleading because of the following reasons:

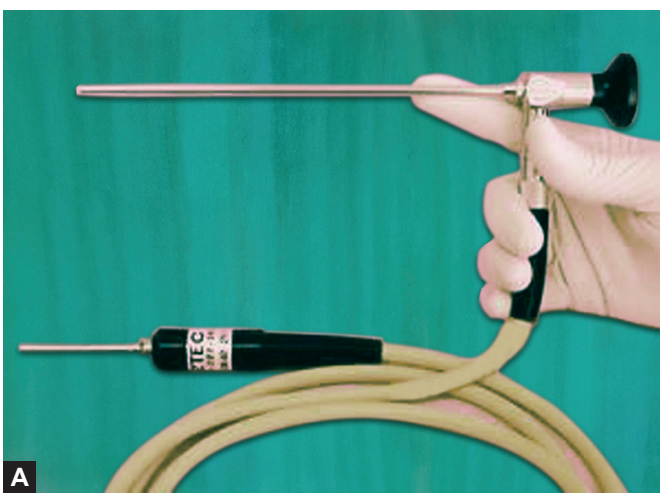
i. There is foreshortening of vertical axis hence shortening the vocal cords by one-third. This is the reason why round mirror appears oval.
ii. Depth perception of larynx is mis leading, the distance between mirror and vocal cords appears to be nearly 2 cm, while actually it is 6 cm.
iii. Anteroposterior reversion of image of anterior and posterior commissure.
iv. Illusion of outer border of vocal cords where as it is the shadow of vestibular folds.
v. Because of angulation of visual axis there is anamorphosis so any small lesion on vocal cord will appear to be posteriorly placed.
vi. Hidden areas such as floor of ventricle and its walls, anterior commissure are not visible.

Procedure and structures seen on IDL have already been described in hypopharynx (**Table 41.1**).

3. **Direct laryngoscopy** will be described in detail in Chapter of Endoscopy.
4. **Microlaryngoscopy procedure** differs from direct laryngo-scopy by the use of operating microscope, magnification, it is self-retaining, both hands are free, photography is possible and teaching of students can be done by attaching an arm.
5. Recently, fiberoptic laryngoscopy and rigid endolaryngo-scopy using 90 degree rigid endoscope introduced through the mouth after holding the tongue (**Figures 41.4A to C**) is being done to see the larynx and record the findings with a camera and it is an OPD procedure. and any leukoplakia patches (**Figure 41.5**) or presence of growth on the vocal cords (**Figure 41.6**) or movements of vocal cords can be seen (**Figure 41.7**).
6. *Radiological examination of larynx*
   a. X-ray neck anteroposterior and lateral view for foreign bodies, growth.
   b. Chest X-ray to see tubercular lesions or any mass.
   c. Barium swallow.
   d. Computed tomography scan (CT scan)/magnetic resonance imaging (MRI) and tomography to see the extent of tumors.
   e. Cine radiography.
   f. Contrast laryngography.

Table 41.1 Comparison between indirect laryngoscopy and direct laryngoscopy

Indirect laryngoscopy	*Direct laryngoscopy*
• Outpatient department procedure.	• Operation theater procedure.
• Indirect laryngoscopy (IDL) mirror is used for the examination.	• Direct laryngoscope is used for this procedure.
• Image seen is 2-dimensional.	• It is 3-dimensional image.
• Image is inverted.	• True image is seen.
• Anterior commissure, ventricle and subglottic area are not seen properly.	• Good visualization is possible.
• Anatomical problems, such as overhanging epiglottis, may not allow proper examination.	• Problems faced are less, but procedure is difficult in patients with short neck or dental anamolies.
• Only a diagnostic procedure.	• Both a diagnostic and a therapeutic procedure.



Figures 41.1A to C Laryngoscopy with 70 and 90 degree sinuscope

7. Stroboscopy using a stroboscope, which emits a light at fixed frequencies and is attached to a laryngoscope to see movements of vocal cord in slow fashion and is very helpful in speech analysis.
8. Pitch and frequency measurements.
9. Contact endoscopy in which a doubtful lesion is painted with methylene blue under direct laryngoscopy and tissue is seen for uptake of the dye indicating a malignant lesion.

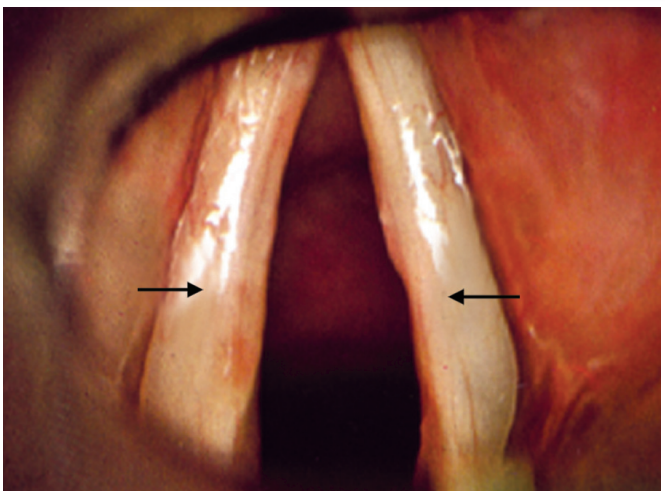


Figure 41.5 Leukoplakia of vocal cords

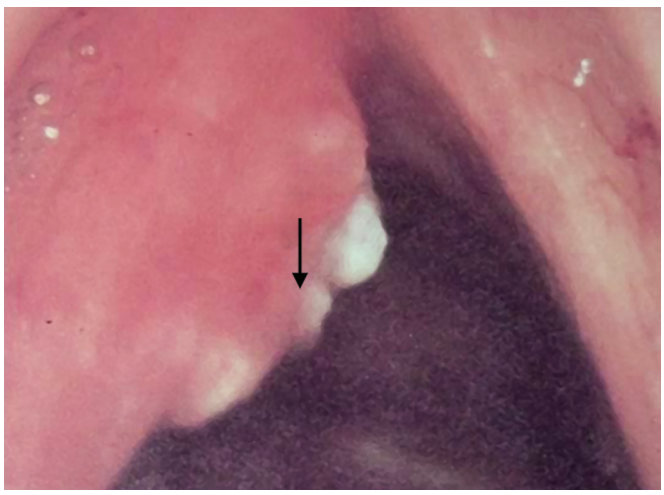


Figure 41.6 Carcinoma right vocal cord

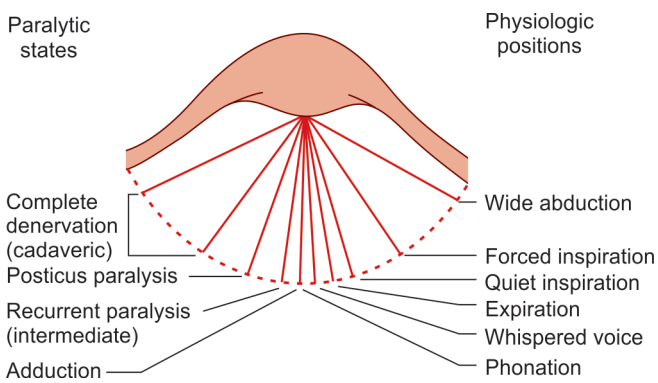


Figure 41.7 Position of vocal cords in physiological and diseased states

Key Points

1. In examination of neck, **absence of laryngeal crepitus** indicates a postcricoid growth or an abscess in the postcricoid area.
2. Primary in the base of tongue, laryngeal part of epiglottis, pyriform sinus and anterior commissure may be missed easily giving rise to **occult primary**.
3. **Inspiratory stridor** indicates laryngeal obstruction, while expiratory stridor indicates obstruction in lower part of respiratory tract.
4. **A foreign body in laryngotracheal region** is characterized by a history of sudden violent cough and choking sensation.
5. **Indirect laryngoscopy examination** differs from direct laryngoscopy in being a simple procedure with an inverted image with difficulty in visualization of anterior commissure, ventricles and subglottic region.

Chapter 42 Laryngotracheal Infections and Stridor

What Students Must Know!

- **Acute Infections**
  - Acute Laryngitis
  - Acute Epiglottitis
  - Acute Laryngotracheobronchitis
- **Foreign Bodies of Larynx**
- **Chronic Infections**
- **Specific Infections of Larynx**
  - Tuberculosis of Larynx
  - Syphilis of Larynx
  - Scleroma of the Larynx
- **Other Conditions Causing Speech Disorders**
  - Reinke's Edema
  - Vocal Cord Nodule
  - Vocal Cord Polyp
- **Stridor**
  - Laryngeal/Extra-laryngeal

ACUTE INFECTIONS

Acute Laryngitis

Acute laryngitis is a viral or bacterial inflammation of the larynx.

Causes

- It may just be a part of upper and lower respiratory tract infections as seen in influenza or common cold
- Sudden exposures, smoking and working in polluted environments are additional risk factors
- Overuse of voice during cold, inhalation of irritant fumes or trauma may also lead to acute laryngitis
- Interarytenoid area is mostly affected
- Adenoviruses are usually the causative organisms predisposing to secondary bacterial infection.

Clinical Features

- Hoarse voice, dysphonia or aphonia
- Fever, pain and malaise
- Cough, dyspnea and stridor in children
- Indirect laryngoscopy (IDL) examination shows congested vocal cords, edematous and sticky mucous on or close to the vocal cords. Epiglottis may also be congested. Movements of vocal cords may be slightly restricted.

Treatment

- Complete bed rest and vocal rest
- Antibiotics
- Anti-inflammatory drugs including steroids
- Soft-bland diet
- Avoid irritants, e.g. smoking, tobacco, alcohol
- Cough linctus
- Hot fomentation of neck.

Acute Epiglottitis

Acute inflammation of epiglottis is more commonly seen in children. It is usually caused by *Haemophilum influenzae*-type-B and causes are same as that leading to acute laryngitis.

Differential diagnosis of epiglottis and laryngotracheitis is given in **Table 42.1**.

Clinical Features

- Hot potato voice
- Respiratory obstruction causing dyspnea especially in children and may be the cause of death
- Fever and severe pain in the throat
- Difficulty in swallowing
- Tripod sign. Child uses his arms to fix the chest and leans forward to breathe
- Indirect laryngoscopy examination shows bright red edematous epiglottis obstructing the airways

Table 42.1: Differential diagnosis of laryngotracheitis (croup) and epiglottitis

Feature	*Croup*	*Epiglottitis*
Age	Less than 3 years	Over 3 years
Onset	Gradual (d)	Rapid (h)
Cough	Barky	None
Posture	Supine	Sitting
Drooling	No	Yes
Radiograph	Steeple sign	Thumb sign
Etiology	Viral	Bacterial
Treatment	Supportive like corticosteroids	Airway management and antibiotics

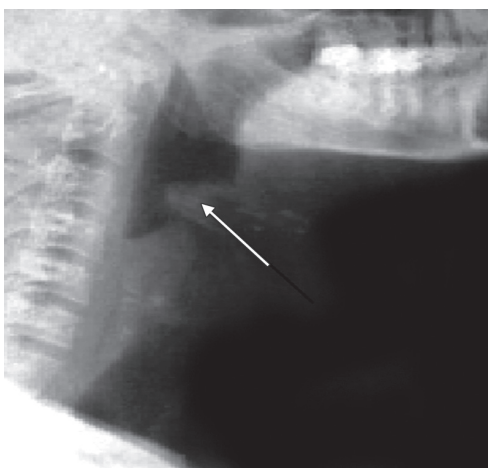


Figure 42.1 X-ray neck showing acute epiglottitis

- X-ray lateral view shows swollen and rounded epiglottis called thumb sign (**Figure 42.1**)

Treatment

- Complete bed rest
- Voice rest
- Systemic antibiotics amoxicillin or a combination with clavulanic acid. Or third generation cephalosporin or chloromycetin are the drugs of choice
- Corticoids (100 mg IV 4–6 hourly) and anti-inflammatory drugs
- Tracheostomy in case respiratory distress occurs.

Acute Laryngotracheobronchitis

Acute laryngotracheobronchitis is a dangerous infection seen mostly in children, which involves tracheobronchial tree.

Causative agents

Viruses such as myxovirus, parainfluenza virus type I and II *Streptococcus*, *Staphylococcus* and *H. Influenzae*.

Clinical Features

- Sudden onset of fever
- Painful croupy cough with hoarseness
- Respiratory distress with inspiratory stridor
- Toxemia, cyanosis and circulatory failure
- Examination shows crepts and ronchi due to sticky secretions
- IDL shows congestion and edema of laryngotracheal region with dry crusts on larynx

Steeple sign on X-ray showing a narrow subglottis is typical of this disease.

Treatment

- Admission to hospital is mandatory
- Intravenous antibiotics
- Anti-inflammatory drugs
- Oxygen inhalation
- Intravenous hydrocortisone injection
- Steam inhalation
- Toilet of tracheobronchial tree
- Tracheostomy for respiratory distress if required.

Acute Allergic Disorders

Acute allergic disorders may be seen as a result of drug reaction, local allergic reaction (such as angioneurotic edema) or because of contact mucositis.

Clinical Features

- No fever
- Hoarseness
- Dyspnea
- Croupy cough
- Pain on swallowing
- IDL shows larynx is swollen and pale.

Treatment

- Complete bedrest
- Antibiotics to cover the infection
- Heavy doses of IV steroids and anti-allergics
- Tracheostomy if required.

Diphtheria of Larynx

Diphtheria of larynx usually follows faucial diphtheria caused by *Corynebacterium diphtheriae*. It is not seen very commonly these days.

Clinical Features

- Patient is toxic
- Hoarseness of voice
- Dyspnea
- Mild to moderate fever
- Hoarse croupy cough
- Inspiratory stridor
- Grayish white membrane of tonsil extending towards hypopharynx and larynx.

Differential Diagnosis

- Foreign bodies of larynx
- Acute laryngitis
- Stridor
- Papilloma of larynx
- Allergic disorders
- Laryngeal swab for *C. diphtheriae* confirms the diagnosis.

Management

- Tracheostomy may be required immediately.
- Oxygen inhalation and IV fluids.
- Antibiotics and antidiphtheritic serum and steroids as described for faucial diphtheria.

FOREIGN BODIES OF LARYNX

Foreign bodies of larynx are seen less common as compared to foreign bodies of digestive tract. Foreign bodies such as pins, metals and plastic toys may get lodged at the level of glottis or supraglottis. It is mostly seen in children and may be life-threatening if it causes obstruction to the respiration.

Clinical Features

Child presents with dyspnea, cough, hoarseness, choking and may be cyanosis.

On Examination

There is hardly any time for examination. History and symptoms are very helpful. X-ray of neck, if the patient is settled, may help (**Figure 42.2**).

Treatment

- Urgent removal of foreign body is essential under general anesthesia by direct laryngoscopy.
- If the patient is in respiratory distress, tracheostomy needs to be done first.

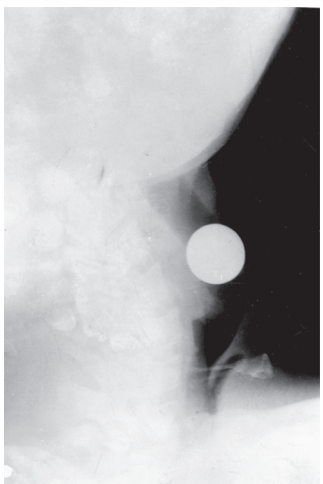


Figure 42.2 X-ray showing foreign body larynx

CHRONIC INFECTIONS

1. Chronic nonspecific laryngitis.
2. Chronic specific laryngitis.

Chronic Laryngitis

Chronic laryngitis is a chronic inflammation of the mucosa of the larynx. Exact cause may not be known, but repeated attacks of acute inflammation, excessive smoking, pollution, chronic infection of sinuses, vocal abuse or chronic irritating cough may be responsible for this problem.

Types

- Hyperemic
- Hypertrophic
- Edematous
- Atrophic.

Clinical Features

- Hoarseness of voice
- Breathy voice and cough
- Feeling of irritation and dryness of throat
- IDL examination shows hyperemic and edematous cords, which may be thickened, swollen and pale looking.

Treatment

- Remove the cause whatsoever
- Voice rest
- Steroids are quite helpful

Table 42.2: Granulomatous conditions that commonly affect the larynx

Conditions	*Parts involved*
• Tuberculosis	• Posterior third of larynx involved.
• Leprosy	• Supraglottic involvement.
• Scleroma	• Catarrhal stage; cells of Mikulicz's.
• Syphilis	• Painless ulcers; positive syphilis serology.
• Histoplasmosis	• Anterior laryngeal area.
• Sarcoidosis	• Supraglottic swelling, nodules/ granulomas.
• Granulomatosis of Wegener	• Subglottic involvement; necrotizing vasculitis; pulmonary and/or renal involvement.

- Avoid smoking
- Speech therapy
- Endoscopic stripping of vocal cords may be done.

SPECIFIC INFECTIONS OF LARYNX

The granulomatous conditions that commonly affect the larynx are given in **Table 42.2**.

Tuberculosis of Larynx

Tuberculosis of larynx is seen secondary to pulmonary Koch's in 20 to 40 years of age. Infection by mycobacteria leads to tubercle formation which breaks down forming an ulcer, which may further involve soft tissues and cartilages. Mostly, the posterior half of larynx is involved.

Clinical Features

- History of pulmonary Koch's
- Hoarseness of voice
- Weak voice
- Fever, malaise and otalgia
- Cough with expectoration
- IDL shows pale cords with tubercles, sluggish movements of both cords, granulation in interarytenoid region, edema of cords, and shallow ulcers in the lower part of vocal cords
- Mouse-nibbled appearance or moth eaten ulcers of vocal cords and turban epiglottis are seen.

Investigation

- X-ray chest
- Sputum for acid-fast bacteria (AFB)
- Biopsy
- Polymerase chain reaction (PCR) of the specimen for mycobacteria may be done.

Treatment

- Antituberculosis treatment (ATT) for 6 to 9 months.
- Voice rest.

Laryngectomy (rarely required if cartilage and other tissues are extensively involved).

Syphilis of Larynx

Congenital, acquired or tertiary syphilis may affect the larynx. It commonly affects the anterior commissure and anterior one-third of vocal cords and epiglottis.

Symptoms

- Hoarseness of voice
- Dyspnea
- Inspiratory stridor.

Signs

Indirect laryngoscopy (IDL) shows diffuse hypertrophy of mucosa, a gummatous ulcer may be seen on the anterior aspect of glottis.

Treatment

- Antisyphilitic treatment
- Tracheostomy may be required.

Scleroma of the Larynx

Scleroma of larynx occurs secondary to scleroma of the nose caused by *Klebsiella rhinoscleromatis* in which submucosal infiltration of subglottis occurs resulting in dyspnea and stridor.

Treatment is with steroids to reduce fibrosis and scarring beside streptomycin or doxycycline. If stenosis occurs, dilatation or plastic surgical procedure may have to be done.

Leukoplakia of Larynx

Leukoplakia of larynx is also called keratosis of larynx and consists of a patchy hyperkeratotic lesion on the surface of both vocal cords.

It is considered to be a premalignant condition.

Cause

- Unknown etiology
- Chronic irritants like tobacco, alcohol and syphilis
- Males are affected more than females.

Clinical Features

- Progressively increasing hoarseness of voice
- IDL shows whitish raised areas on anterior and middle third
- Biopsy and histopathologic examination (HPE) is essential to rule out malignancy.

Treatment

- Remove the cause
- Vocal rest
- Vitamin A may help
- Microlaryngoscopic stripping of both vocal cords
- Laser has also been used
- The patient should be kept under observation for any malignant change.

OTHER CONDITIONS CAUSING SPEECH DISORDERS

Before embarking upon various conditions causing speech disorders, it will be worth understanding physiology of speech.

1. Bernoulli's phenomenon plays an important part in the production of speech. According to this, when a fluid or gas passes from one large space (lungs) to another space (pharynx) through a narrow constriction (glottis), the velocity will be greatest and pressure the least at the site of constriction.
2. Because of this decreased pressure at the vocal cords level, these are drawn inwards closing the gap.
3. Another subglottic rise of pressure of air flows through the cords, setting into vibrations resulting in the production of sound, which is converted into speech by coordination of tongue, teeth, lips and palate.
4. Quality of voice depends upon the resonating chambers, i.e. lungs, pharynx and upper respiratory tract and it is a fixed relationship.

Reinke's edema

Reinke edema characterized by accumulation of fluid in the submucosal space of vocal cords. It is also called polypoid degeneration of cords.

Etiology

Reinke's edema is due to unresolved infection or trauma to the vocal cords.

Examination

Examination shows bilateral symmetrical polypoidal swelling along the length of vocal cords due to edema of the submucosal space, i.e. Reinke's space.

Treatment

- Microlaryngoscopic stripping of the vocal cords
- Use of Laser has also been done with good results.

Vocal Cord Nodule

Vocal cord nodule is also called Singer's nodes (**Figures 42.3 and 42.4**) and it consists of localized epithelial hyperplasia of the free edge of both vocal cords usually at the junction of anterior one-third and posterior two-thirds. It is usually seen in singers, actors, teachers and hawkers.

Causes

- Females are more involved than males
- More in 20 to 30 years, but may be seen in children also
- Misuse or abuse of voice is mainly the cause.

Pathogenesis

1. During singing or voice production, anterior two-thirds of vocal cord vibrates much more than the posterior one-third.
2. It is the point of maximum vibration on the vocal cord where there occurs more friction during faulty use of voice.
3. This friction leads to localized exudation of fluid where ultimately fibrosis occurs and calcification takes place leading to formation of vocal nodule.
4. Initially, the nodules may be reversible; but once fibrosis and calcification occurs, it becomes irreversible.

Clinical Features

- History of abuse of voice is present
- Hoarseness of voice, which worsens by evening due to fatigue

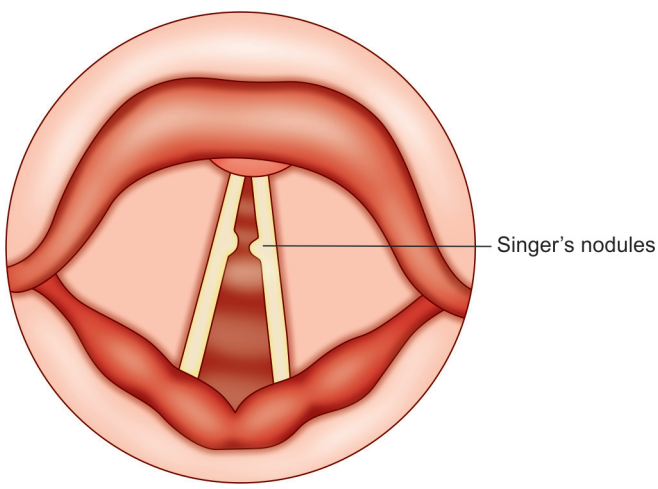


Figure 42.3 Singer's nodule

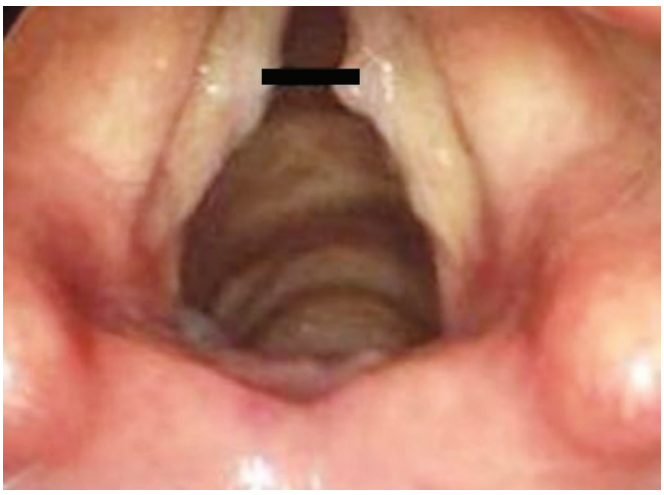


Figure 42.4 Vocal nodule

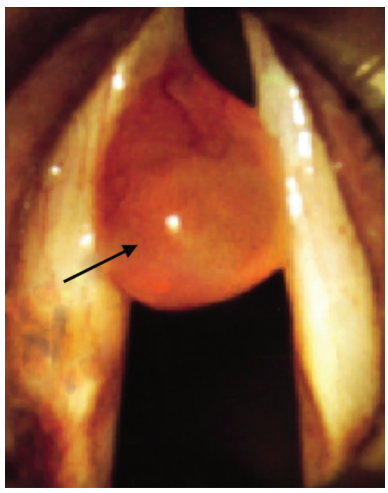


Figure 42.5 Vocal polyp

- IDL shows pinkish white nodules at the junction of anterior one-third and posterior two-thirds.

Differential Diagnosis

All causes of hoarseness of voice such as chronic laryngitis, papilloma, polyps, TB, syphilis and keratosis.

Treatment

- Voice rest
- Avoid misuse or abuse of voice
- Local causes such as sinusitis, and tonsillitis, etc. should be treated
- Microlaryngoscopic excision of nodules
- Laser excision of nodules
- Speech therapy should be given to prevent recurrence of vocal nodules.

Laryngocele

Laryngocele is an air containing sac of the ventricular saccule mostly found in adult males, particularly those playing wind instruments or glass blowers due to rise of intraglottic pressure. Herniation occurs through thyrohyoid membrane.

It may be external or internal laryngocele when sac lies outside the lumen, but within the confines of laryngeal cartilages.

Clinical Features

- May produce no symptoms
- Hoarseness of voice
- Cystic swelling reducible on pressure on the upper part of neck on one side of the midline
  Laryngogram is diagnostic.

Treatment

If causing symptoms, excision of the sac is done by external approach.

Vocal Cord Polyp

Vocal cord polyp is a polypoidal swelling arising from the connective tissue of the vocal cords seen in 30 to 50 years males. It occurs because of allergy, trauma, hematoma or chronic infection and due to chronic irritants such as smoking.

Mostly, it is single, smooth, pink and pedunculated mass arising from one cord (**Figure 42.5**). It produces cough due to up and down movements of mass during respiration. Large polyps give rise to dyspnea, stridor and choking.

Treatment

- Microlaryngoscopic excision
- Remove the cause.

Vocal Cord Cyst

Vocal cord cyst is the formation of a cystic swelling on the vocal cord surface usually in anterior commissure. These are usually unilateral and solitary cysts and may be sessile or rarely pedunculated. Cause may be due to cystic degeneration of a benign swelling of the vocal cord such as fibroma, nodule or a polyp.

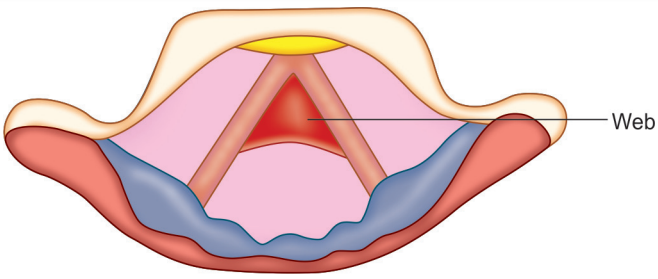


Figure 42.6 Laryngeal web

Clinical Features

- May be asymptomatic
- Hoarseness of voice.

Treatment

- Microlaryngoscopic excision of the cyst
- Use of laser is a recent technique undertaken in selected centers.

Laryngeal Web

These are mostly congenital and sometimes may be acquired, which usually follow trauma or surgical operation on the larynx (**Figure 42.6**).

Congenital web is usually due to failure of dissolution or defective widening of the cricoid duct. Most of the webs involve the anterior two-thirds of the vocal cords with varied thickness.

Symptoms are a hoarse cry with varying degree of dyspnea and stridor.

Treatment is done by splitting of the web with a knife or CO_2 laser endoscopically.

Contact Ulcer

Contact ulcer called kissing ulcer it is a saucer like unilateral or bilateral lesion seen on vocal process of arytenoids seen exclusively in males around 40 years. There is no epithelial defect. Other factors may be gastroesophageal reflux disease (GERD)/Hiatus hernia. Treatment is removal of the cause.

Stridor

- Stridor means noisy respiration indicating obstruction to passage of air into or out of lower respiratory tract
- In fact, it is a symptom of a disease
- Croup is a type of inspiratory stridor with a crowing noise and is seen in supraglottic or pharyngeal lesions
- While expiratory stridor is caused due to obstruction to the lower respiratory tract like that of thoracic trachea, bronchi (**Tables 42.3A to C**)
- Biphasic stridor is seen in lesions of glottis, subglottis and cervical trachea.

Causes of Stridor

The causes of stridor is listed in **Table 42.3A**.

Assessment of Patient with Stridor

History of the Patient

- Congenital or acquired
- Duration of stridor
- History of foreign body, cough, and choking

Table 42.3A: Causes of stridor

Children (laryngeal causes)			*Adults*		
Congenital	*Inflammatory*	*Traumatic*	*Neoplasm*	*Foreign bodies*	*Neurological disorders*
• Infantile larynx • Laryngeal web/stenosis • Laryngomalacia • Congenital hemangioma/cysts	• Acute laryngitis • Diphtheria • Allergic edema • Laryngotracheo-bronchitis	• Birth trauma • Burns and scalds • Accidental	• Papillomas • Cyst • Tumors		• Vocal cord palsy • Tetany

Table 42.3B: Extralaryngeal causes in children

Congenital	*Traumatic*	*Inflammatory*	*Neoplasm*	*Foreign bodies*
• Pierre-Robin syndrome • T-O fistula • Vascular loops	• Accidental injuries to neck/cheek	• Submental cellulitis • Neck abscesses (retropharyngeal)	• Thymus gland • Cystic hygroma • Lymph nodes	• Cricopharynx

Table 42.3C: Causes in adults

Infective	*Traumatic*	*Allergic*	*Neoplastic*	*Neurological*
• Edema of larynx • Epiglottitis • Neck abscess	• Foreign body trauma • Intubation • Laryngeal stenosis • Corrosive trauma • Accidental trauma • Strangulation trauma	• Angioneurotic edema	• Advanced cancer laryngopharynx • Thyroid neoplasm • Mediastinal tumors	• Bilateral abductor palsy

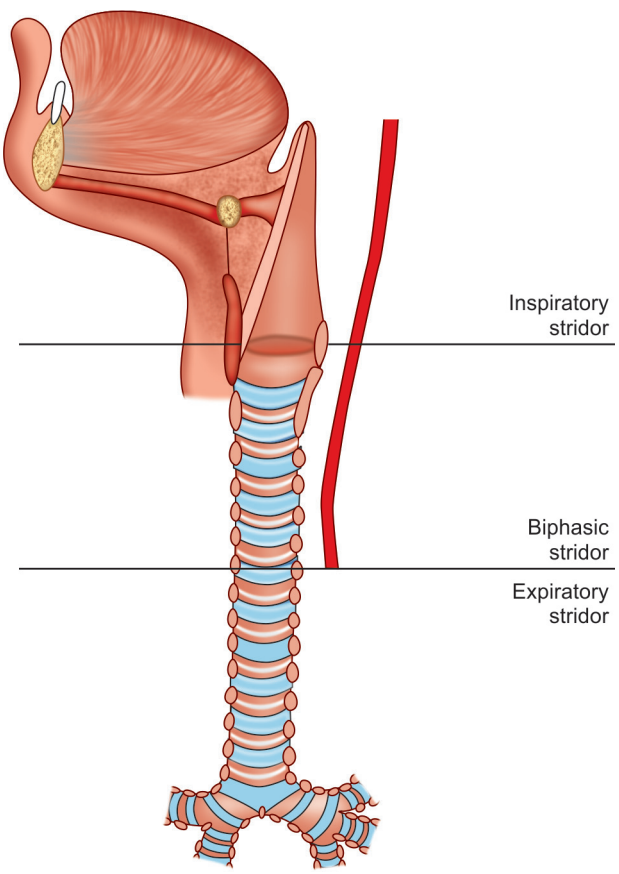


Figure 42.7 Origin of stridor

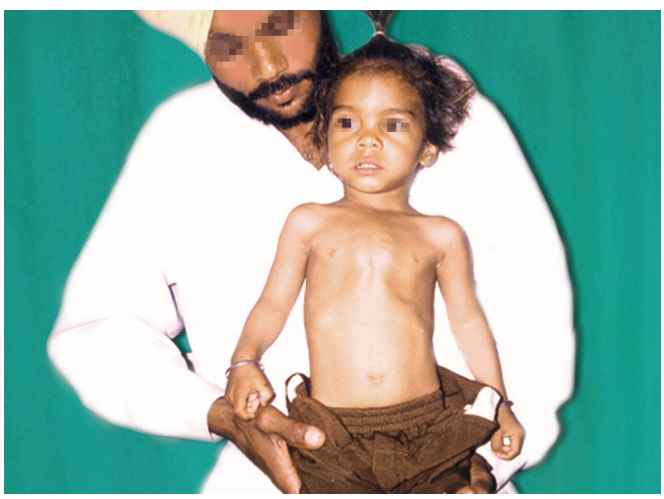


Figure 42.8 A child showing deformed chest with stridor

Figure 42.9 Stridor with cyanosis

- History of sore throat and fever
- History of trauma and swelling in the neck.

Clinical Examination

Inspection of neck and chest for evidence of respiratory distress (**Figures 42.7 to 42.9**).

Examination of nose, nasopharynx, throat, chest, respiratory and cardiovascular system.

Diagnostic Tests

- Radiological examination of soft tissue neck and chest for any collapse, atelectasis or foreign body
- CT scan if required
- Direct laryngoscopy and bronchoscopy are mandatory to find out the cause and for treatment purpose.

Treatment

- Hospital admission is must
- Look after the patient's airway
- Oxygenation and humidification
- Antibiotics with or without steroids
- Endotracheal intubation or tracheostomy if there is marked respiratory obstruction.

Key Points

1. **Tuberculosis of larynx** involves posterior half of the larynx, while syphilis commonly affects the anterior commissure and anterior one-third of vocal cords.
2. **Scleroma of the larynx** is caused by *Klebsiella rhinoscleromatis* and is treated by steroids.
3. **Leukoplakia of larynx** is considered to be a premalignant condition.
4. **Croup** is a type of inspiratory stridor with a crowing noise, while expiratory stridor is caused due to obstruction in the lower respiratory tract.
5. **Acute epiglottitis** in children, usually caused by *Haemophilus influenzae*-type B, presents with a hot potato voice. Important radiographic sign of epiglottitis is 'thumb-print' sign.
6. **Acute laryngotracheobronchitis** or croup is the most common cause of stridor in children.
7. Most frequent **causes of congenital airway obstruction** are laryngotracheomalacia, vocal cord paralysis, congenital subglottic stenosis and choanal atresia.
8. **Keel** used for glottic web or stenosis of larynx is called **McNaught's keel** and is kept for 5 weeks.
9. Most common cause of **stridor at birth** is laryngomalacia in which the vocal cords are perfectly normal.
10. In neonates, **laryngeal edema** of 1 mm reduces the area of larynx by 50 percent.
11. Contact or **kissing ulcer** shows no epithelial defect.
12. Best way to diagnose **laryngomalacia** is flexible laryngoscopy, while the patient is awake.
13. **Barking type of cough** is typical lof obstruction at subglottic level, while brassy cough is seen in obstruction at the level of oropharynx.
14. **Steeple sign** is a radiological feature of laryngotracheobronchitis showing a narrow subglottic lumen.
15. **Quinke's disease** is acute edema of uvula.
16. **Earliest sign** of tuberculosis of larynx is hyperemia with loss of adduction.
17. In **laryngocele** herniation occurs through thyrohyoid membrane.
18. **Bryce's sign** is a feature of laryngocele, i.e. when swelling is pressed a gurgling sound is heard.

Chapter 43 Hoarseness

What Students Must Know!

- **Introduction**
  - General Physical Examination
  - Local Examination
  - Radiological Examination
- **Causes of Hoarseness**
  - Laryngeal Causes
  - Extralaryngeal Causes
- **Management**

INTRODUCTION

Hoarseness of voice is roughness of voice caused due to faulty approximation of vocal cords, which further may be due to the following factors:

- Mass factor due to swelling, growth or tumors
- Fixation or paralysis of vocal cords
- Muscular weakness of tensors or myositis
- Loss of vibratory function due to edema, inflammation, trauma, etc.
  - **Hoarseness is a symptom and not a diagnosis**
  - So, for production of proper voice of good quality, approximation, stiffness and size of the vocal cords should be appropriate
  - To find out the causes of hoarseness, a thorough work up of the patient is mandatory in a systematic way
  - History taking, examination and investigations are important.

History

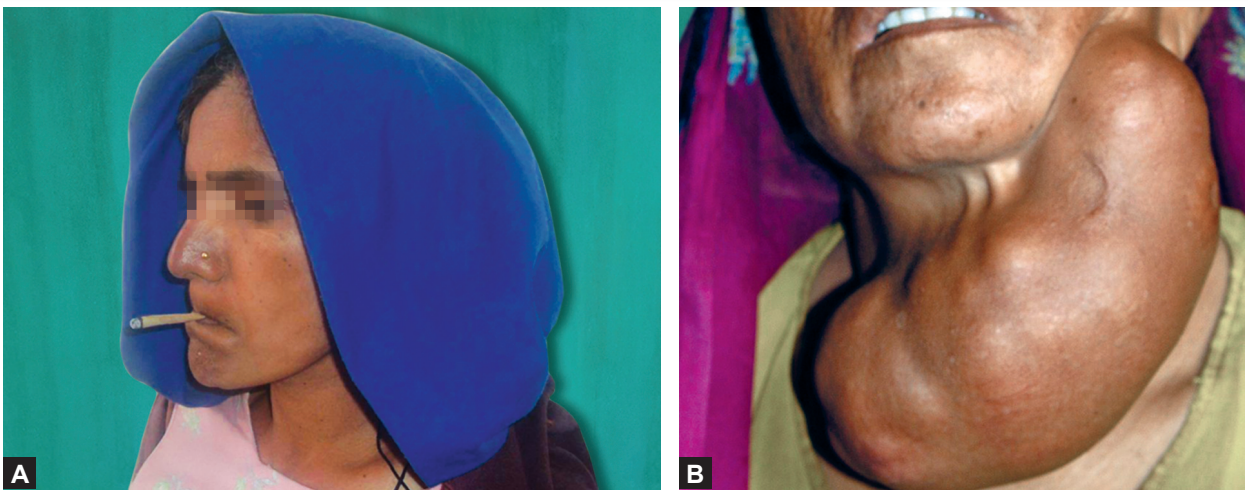
1. *Onset*
   a. *Sudden:* Acute conditions like vocal abuse, upper respiratory infection (URI), which may be viral or bacterial.
   b. *Insidious onset:* Indicates a chronic specific or non-specific laryngeal disease.
2. Duration and associated complaints.
3. *Age:* In younger age group hoarseness can be due to acute or chronic infections. In elderly malignancy should be one of the important possibilities.
4. *Sex:* Incidence of malignancy in elderly males is quiet high than females.
5. *Habits:* Smoking, drinking are predisposing factors of malignancy (**Figure 43.1A**).
6. *Occupation:* Voice users like—teachers, hawkers and singers are supposed to be voice abusers and prone to hoarseness. Workers in factories who are exposed to chemical fumes and dust may be candidates for hoarseness/malignancy.
7. *Past illness:* Past history of chronic specific disorders, radiation exposure or laryngeal/neck surgery.

General Physical Examination

1. *Pulse:* Different pulse rates on both sides may indicate congenital anomaly, e.g. coarctation of aorta.
2. *Nutrition:* Progressive cachexia is suggestive of disease like malignancy and tuberculosis.
3. *Thyroid:* Thyroid should be palpated in every case (**Figure 43.1B**)
4. *Lymph nodes:* Hard fixed, non-tender cervical lymph nodes may indicate the malignancy (**Figure 43.2**).

Local Examination

- Nose, throat, ears
- Indirect laryngoscopy (IDL)
- Direct laryngoscopy (DL)/biopsy/microlaryngoscopy
- Screening of cardiovascular system (CVS), respiratory and nervous system
- Panendoscopy (bronchoscopy, esophagoscopy).



Figures 43.1A and B (A) Smoking female; (B) Massive thyroid swelling

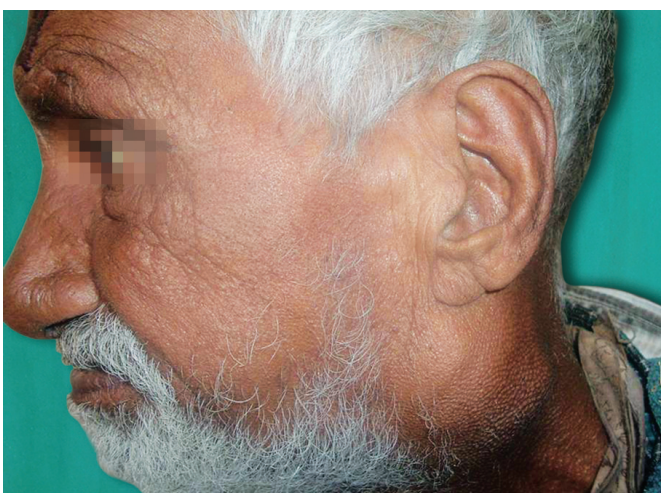


Figure 43.2 Lymph nodes in neck

Laboratory Investigations

- **Blood:**
  - Hemoglobin (Hb), total leukocyte count (TLC), differential leukocyte count (DLC), erythrocyte sedimentation rate (ESR) and venereal disease research laboratory (VDRL) test.
  - Blood sugar, and creatinine level.
  - Thyroid function tests.
- Urine.
- Mantoux test.

Radiological Examination

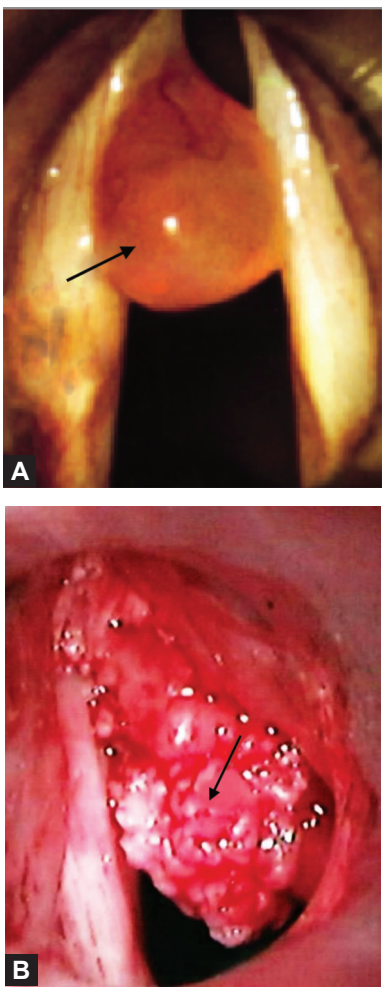
- X-ray chest—posteroanterior (PA) view
- X-ray soft tissue neck—lateral view for larynx/nasopharynx
- Computed tomography (CT) scan
- Laryngeal videoendoscopy
- Flexible endoscopy and stroboscopy
- Computerized imaging
- Electroglottography which measures the efficiency of glottic closure graphically
- Thyroid scan
- Barium swallow to rule out carcinoma esophagus.

CAUSES

Laryngeal Causes

1. **Congenital:** Web, stenosis, hemangioma, and laryngomalacia.
2. **Inflammatory:**
   a. Acute (viral or bacterial) infections like laryngitis, laryngotracheobronchitis, diphtheria, herpes zoster and poliomyelitis.
   b. Chronic infections like laryngitis, tuberculosis, lupus, syphilis, scleroma, leprosy and sarcoidosis.
3. **Traumatic:** Birth trauma, laryngotracheal trauma, surgery (laryngeal, thyroid), corrosive inhalation, prolonged intubation, radiation or submucosal hemorrhage.
4. **Neoplastic:**
   a. *Benign:* Papilloma, chondroma, Cyst, vocal polyp, granuloma, angioma, or fibroma (**Figure 43.3A**)
   b. *Malignant:* Carcinoma larynx, (**Figure 43.3B**) Ca of thyroid, esophagus, trachea or nasopharynx

- **Miscellaneous:** Vocal nodule, FB, laryngocele, amyloidosis, myesthenia gravis, dysphonia plica ventricularis, vocal cord paralysis, leukoplakia, Reinke's edema, angioneurotic edema, pachydermia vocal cords, hysteria, contact ulcers, vocal cords fixation due to arthritis, diabetes and cardiac disease.

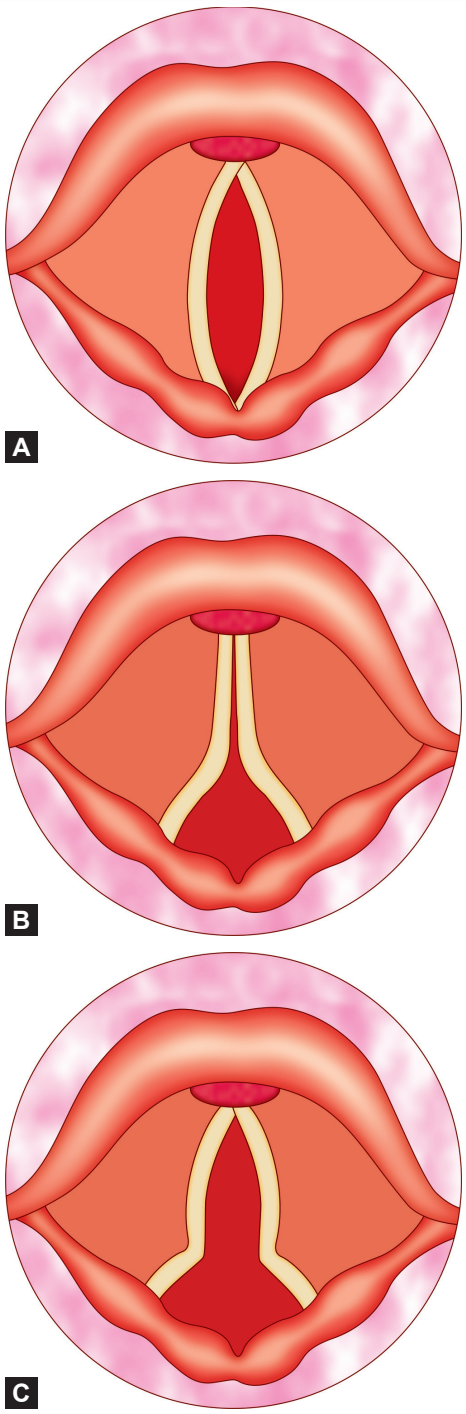


Figures 43.3A and B (A) Polyp of vocal cord; (B) Carcinoma of vocal cord

Appearance of glottis in different conditions is shown in **Figures 43.4A to C**.

Extralaryngeal Causes

- Myxedema
- Multiple sclerosis
- Peripheral neuritis
- Mercury and lead poisoning
- Aneurysms of arch of aorta
- Pharyngeal diverticulae
- Diabetes
- Mitral stenosis
- Metastatic lymph nodes in mediastinum.



Figures 43.4A to C Appearance of glottis in— (A) Thyroarytenoid weakness; (B) Interarytenoid weakness; (C) Both thyroarytenoid and interarytenoid weakness

MANAGEMENT

Treatment of the cause are as follows:

- Voice rest
- Antibiotics
- Anti-inflammatory analgesics
- Steam inhalation using soothing agents like tincture benzoin, menthol or eucalyptus oil
- Speech therapy

- Microsurgery of larynx is useful for diagnosis as well as treatment of causes of hoarseness of voice.

Role of Injection Teflon Paste

The paste is injected under direct vision by direct laryngoscopy with a calibrated syringe lateral to the paralysed vocal cord thus pushing it medially which improves the speech.

Role of Thyroplasty Operation

Known by the name of **Isshiki's thyroplasty—remember mneumonic:** Mohan Lal Sohan Lal.

- Type I is **Medialization** of vocal cord
- Type II is **Lateralization** of vocal cord to improve the air way
- Type III is **Shortening** of vocal cord to lower the pitch
- Type IV is **Lengthening** of vocal cord to raise the pitch of voice such as in aging vocal cords or after trauma.

Key Points

1. **Hoarseness** results due to inappropriate approximation of cords, changes of stiffness and inability to vibrate regularly.
2. Important **causes of hoarseness** of voice are infections, tumors (benign and malignant), paralytic lesions, traumatic and functional.
3. **Gutzmann's pressure test** if positive confirms puberphonia. In this test, thyroid prominence is pressed backwards and downwards producing low tone voice.
4. **Keyhole appearance** of glottis is seen in palsy of both thyroarytenoid and interarytenoid, while elliptical space between cords is present in weakness of thyroarytenoid.
5. **Stuttering** is a disorder of fluency of speech usually due to psychogenic causes and is best treated by psychotherapy, speech therapy and assurances to the parents and the patient.
6. **Ortner syndrome** consists of cardiomegaly and paralysis of recurrent laryngeal nerve.
7. **Dysphonia plica ventricularis** is characterized by low pitched unpleasant voice at the level of false vocal cords.
8. **Virilization of voice** is abnormally low pitched or masculine voice in women.
9. **Vocal fry** is a low pitched sound also called glottalization.

Chapter 44 Speech and Language Disorders

What Students Must Know!

- **Introduction**
  - Types of Speech Disorders
- **Stuttering**
  - Effects of Stuttering
  - Management
- **Other Speech and Language Disorders**
  - Dysgrammatism
  - Rhinolalia
  - Puberphonia
  - Hysterical Aphonia

INTRODUCTION

- Speech and language disorders includes speech-related problems resulting in impaired or ineffective oral communication with others.
- Its incidence varies between 6 to 8 percent in children under 12 years of age and is 2 to 3 times more in boys than girls.
- More common in first-degree relatives of patients.
- Normal language development occurs, when speech milestones are achieved at the expected age such as the following:
  - At 1 year, speaks 1 to 2 mixed words.
  - 2 years—vocabulary increases to 200 to 300 words, longer phrases, few prepositions verbs, and pronouns.
  - 3 years of age—900 to 1000 words and 3 to 4 word sentences understood by family members.
  - 4 years—1500 to 1600 words, uses conjunctions and speech, well understood by strangers.
  - 5 years—uses 2100 to 2300 words and discusses feelings
  - 6 years—is able to use complex sentences.
  - 8 years—reads simple books, verbalizes ideas and produces all types of speech sounds.

TYPES OF SPEECH DISORDERS

Phonological Disorders

Child tries to use appropriate words, but finds it difficult to pronounce the speech sounds correctly and so omit sounds or pronounce it in unusual manner.

It includes:

- Substitution of one sound for another
- Omission of sounds
- Poor sound production
- This disorder results in incorrect pronunciation of consonants or omission of phonemes and may result in dysarthria (slurred speech due to incordination of muscles of speech) or dyspraxia causing difficulty in planning and executing speech. This all gives impression of a 'Baby talk.'

Phonological disorders may present with:

- Expressive language disorder
- Reading disorder or
- Coordination disorder.

Causes of Phonological Disorder

- Perinatal problems.
- Genetic factors.
- Auditory processing problems.

- Hearing impairment.
- Structural or anatomical abnormalities.
- Neurological impairment resulting in:
  - **Dysarthria:** It results from impairment of neural mechanism regulating muscular control of speech and may be due to:
    - Head injury
    - Congenital conditions like cerebral palsy or in muscular dystrophy or Infections.
  - **Dyspraxia:** There occurs difficuly in execution of speech even in the absence of weakness or paralysis of muscles of speech.
- Environmental factors
- Other causes such as autism (mental disorder), vocal cord injury or Cri du-chat syndrome.

Clinical Features

- Unintelligible speech
- Leaves consonants at the beginning and end of speech words
- Problem with articulation
- Distortion of sounds
- Substitution of incorrect sounds for correct ones.

Diagnostic

Diagnostic criteria as per DSM-IV-TR criteria.

- Failure to develop expected speech sounds as per the age of the child
- Difficulty in speech interferes with academic or occupational achievements or with social communication
- If mental retardation is present speech, motor or sensory deficit are more than expected for that age.

Differential Diagnosis

- **Dysarthria:** Anomalies of lips, tongue and palate with marked deterioration of articulation of phonemes and vowels
- **Hearing impairment:** Development of speech is directly proportional to the degree of hearing impairment
- **Phonological disorders:** Language development within normal limits and deterioration of articulation of speech occurs with increased rate
- Mental retardation or autism language development not within normal limits.

Course and Prognosis

Spontaneous recovery rarely occurs after the age of 8 years. Prognosis will be better, if there is early intervention.

Management

- Speech therapy by a trained speech therapist is the best form of treatment. It is helpful, if the child is above 8 years of age and has a poor intelligibility and speech problem is causing difficulty in learning processes. Lastly it is essential, if there is problem in articulation of consonants and if there is omission and substitution of phonemes.
- Parental counseling is also very important.
- Supporting the child in his/her social interactions.
- Regular monitoring of the child in school and social relationship.

Stuttering

Definition

- Child has a normal vocabulary, but speech fluency is disrupted involuntarily by either pauses or sound repetitions or sound prolongations or silent blocks. This is called stuttering
- Prevalence rate in general population is 1 percent seen maximal at 2 to 7 years of age
- Male children are predominantly affected (3-4 times)
- Remissions are seen in 80 percent of children and is reduced to 0.8 percent in adolescents and disorder is seen in families of affected children
- As per Diagnostic and Statistical Manual of Mental Disorder, Fourth Edition Text Revision (DSM-IV-TR) study for a male person, 20 percent of his male children and 10 percent of their female children will also stutter.

Associated Features

Tongue clicking, lip pursing, facial grimacing, head jerking and abnormal body movements.

Effects of Stuttering

- Delay in development of language
- Anxiety symptoms and related disorders
- Lack of self-confidence
- Expressive language disorders
- Social isolation
- Upper body tics and facial grimaces.

What are the Causes of Stuttering?

Exact etiology is not known, but various theories have been proposed

- Psychoanalytic theory states that it occurs as a response to fears, conflicts or neurosis
- *Organic models:* It includes incompletel lateralization and abnormal cerebral dominance with an overexpression of left hand
- *Learning theory:* It includes semiautogenous theory, which suggests that stuttering is basically a learned response to early childhood dysfluencies.
  - Classical conditioning stuttering becomes conditioned to environmental factors
  - *Cybernetic model:* In this, speech is viewed as a process, which depends on appropriate feedback.

Stuttering occurs, if there is a break in the feed back loop
- To sum up genetic and environmental factors more likely result in stuttering.

Diagnosis

Disturbances in the normal fluency is inappropriate for that age, which is characterized by one or more of the following:
- Prolongations of sound
- Broken words
- Words substitution
- Repetition of words
- Interjection
- Interference with academic and occupational achievements.

Clinical Features

- Child is of 18 months to 8 years with a peak between 2 to 3 years and 5 to 7 years
- It begins over weeks and months starting with repetitions of words
- Frustration, while trying to communicate
- Eye blinking, while talking
- Head jerks and feeling of embarrassment, while trying to speak
- Toxic stuttering is blocking of speech at the beginning of words or sentences usually associated with rise of body temperature. Stuttering child while speaking is shown in **Figures 44.1A and B**.

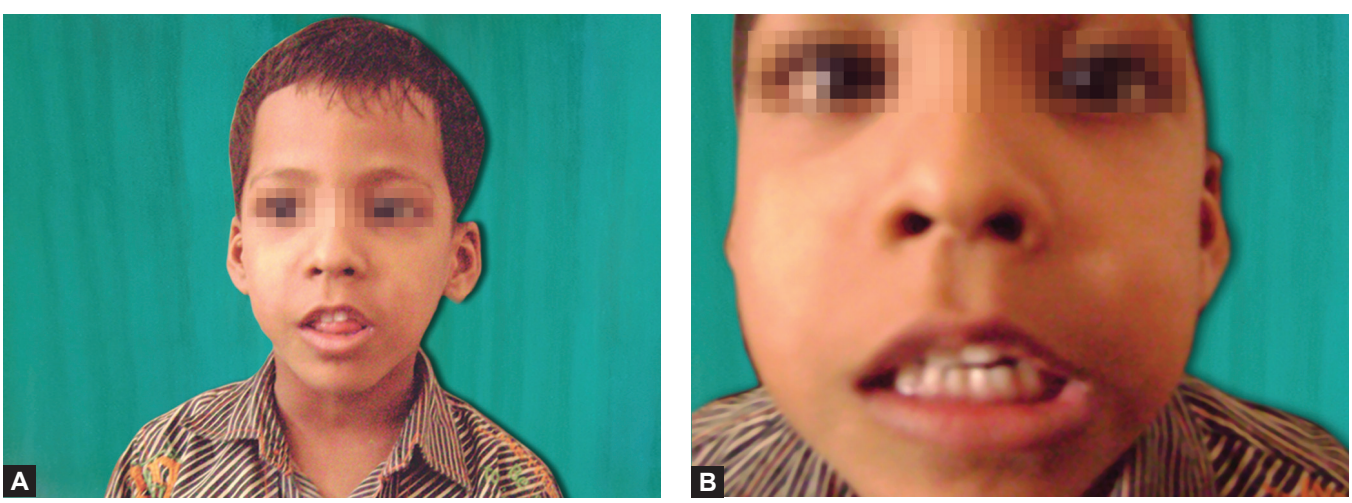
Various phases in development of stuttering
- *Phase I:* Seen in preschool children showing episodes of difficulty in normal speech with intervals of normal speech. Occurs during periods of excitement.
- *Phase II:* Chronic disorder seen in elementary school where child understands that he/she is a stutterer and it occurs with major parts of speech, i.e adjectives and adverbs.

3. *Phase III:* Seen at 8 years of age and above. Stuttering seen in response to specific situations, such as in class room, talking to strangers and talking on telephone.
4. *Phase IV:* Typically appears in late adolescence and adulthood.

Other similar situations
- *Spastic dysphonia:* It differs by the presence of abnormal breathing pattern.
- *Cluttering:* It is characterized by erratic and dysrhythmic speech pattern of rapid and jerky spurts of words and phrases. As a rule no specific treatment is required in adults as patients are not self-conscious about the disorder.
- *Normal speech dysfluency:* Unlike stuttering, child is comfortable and appears tense with his speech pattern.

Course and Prognosis

- Periods of remissions are seen frequently and has problems, when under pressure to communicate
- Mild stutterers recover spontaneously
- Child faces academic difficulties and has limitations in choosing occupation.



Figures 44.1A and B Stammering child, while speaking

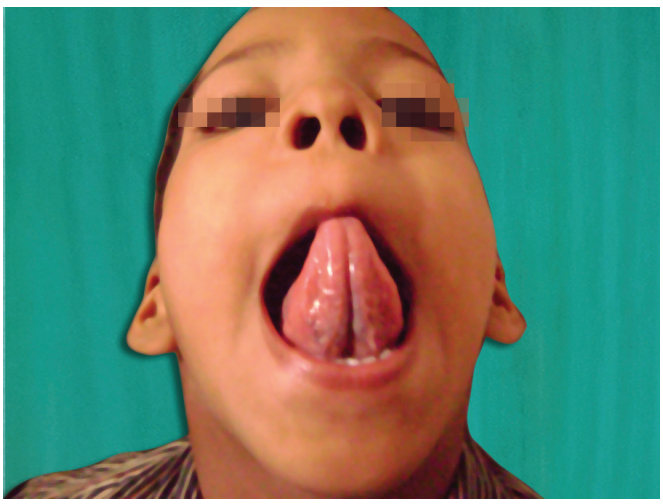


Figure 44.2 Tongue exercises in speech therapy

Management

- Assesment of child and his parents is quite important
- Relaxation techniques, breathing exercise, and speech therapy helps to slow the rate of speaking and modulates speech volume (**Figure 44.2**)
- *Distraction technique:* Stutterers are taught to talk slowly in relation to rhythmic movements of arms, hand or fingers.
- Hypnosis also helps temporarily
- *Psychotherapy:* It is indicated, when stutterers are anxious, depressed and have a poor self image and show an emotional disorder.
- Family counseling helps, when there is evidence of family's contribution to the symptoms or there is family stress.
- *Newer methods of treatment:* It includes elimination of secondary symptoms and encouraging the stutterer to speak out in an effortless manner. Entire speech pattern is reshaped with emphasis on slow, easy and gentle onset of voice.
- Psychopharmacological treatment with haloperidol, which causes relaxation.

OTHER SPEECH AND LANGUAGE DISORDERS

Dysgrammatism

- Dysgrammatism is inability to speak grammatically correct words due to error of word morphology
- It is normally seen physiologically at 2 to 3 years of life
- If it is still present after 3 years, it indicates developmental language disorder
- Extent of the disorder is assessed on the basis of various tasks such as spontaneous speech or by telling a story
- Treatment is integrated into a complex overall treatment plan.

Dyslalia

- Dyslalia is a sort of articulation disorder characterized by error of pronunciation
- Various types of dyslalia are:
  - Isolated dyslalia—defective pronunciation of a sound
  - Partial dyslalia—defective pronunciation of certain sounds
  - Multiple dyslalia many sounds are defective
  - Universal dyslalia—defective pronunciation of virtually all sounds
  - Constant dyslalia problem is always present
  - Inconstant dyslalia problem is sometimes present
  - Consistent dyslalia nature of problem is always the same
  - Inconsistent dyslalia—error may vary
- Dyslalia commonly affects the sibilants, particularly S sounds known as sigmatism or lisping.

Developmental Dyslalia

Also called physiologic dyslalia—there is isolated dyslalia at 3 to 4 years of age with normal vocabulary and normal grammar.

Organic dyslalia articulation disorder due to defect at peripheral receptive level (hearing impairment), central level or peripheral expressive level.

Rhinolalia

Rhinolalia is an altered speech due to abnomal airflow through the nose during phonation.

Types

- **Rhinolalia clausa (Hyponasal speech):** There is decreased nasal resonance during which speech is flat, muffled, nasal voice and is a known disturbances of voice and can be seen in deviated nasal septum (DNS), nasal polypi and nasal allergy.
- **Rhinolalia aperta (Hypernasal speech) (Nasal twang):** Nasal resonance is increased during speech as a result of velopharyngeal dysfunction creating an ineffectual seal between oral cavity and nasopharynx.
  It is seen in:
  - Cleft palate
  - Submucous cleft palate
  - Palatal paralysis
  - Perforation of palate

– Scarring of palate—after adenoidectomy or uvulopalotopharyngoplasty (UPPP).

Certain consonants are affected such as M becomes B, N becomes D and NG becomes G operation.

Rhinophonia is altered voice sounds and rhinolalia is altered sound production.

Diagnosis

- *Mirror test:* A cold mirror or a device called Czermar plate is held beneath the nose while vowels are pronounced. Fogging of the mirror indicates the nasal air escape that charahterizes hypernasal speech.
- *Ah-ee test:* Vowel sounds *ah-ee* are spoken in succession with hypernasality, the tester will hear a nasal sounding change in the vowel sounds. This does not occur in hyponasality.
- Back drop sign is an important finding in patients with paralysis of soft palate.
- Cheeck inflation test with the tongue protruded can detect an organic cause of hypernasality, if the soft palate is short, patient will be unable to inflate the cheek with air while tongue is protruded out.

Treatment

Rhinolalia includes treatment of underlying cause and intensive speech therapy.

Puberphonia

Persistence of high pitched voice at puberty is called puberphonia. A change in the voice usually occurs at puberty due to lengthening of vocal cords, when voice changes from high to low feminine voice. It occurs in emotionally immature boys. Treatment is reassurance to the patient and parents. Training of voice to produce-low-pitched sounds by pressing the thyroid prominence backwards and downwards helps in relaxing the overstretched vocal cords producing low-pitched sounds, it is called Gutzmann's pressure test. Prognosis in most of the cases is good.

Hysterical Aphonia

Hysterical aphonia is a functional disorder seen in emotionally labile females in younger age group. It occurs suddenly without any other symptoms and laryngeal findings. Patient can cough normally and movements of vocal cords can be appreciated. Treatment is assurance and psychotherapy.

Aphasia

Aphasia means partial or complete loss of speech after the completion of language acquisition.

Incidence is 60 new cases per 1 lac population.

Etiopathogenesis

Predisposing factors are:

- Arterial hypertension
- Disorders of fat metabolism
- Diabetes mellitus
- Generalized atherosclerosis.

More than 80 percent cases are due to cardiovascular problems, 90 percent are because of thromboembolic vascular occlusion.

Management is treatment of the cause and speech therapy.

Key Points

1. Incidence of speech and language disorders varies between 6 to 8% in children.
2. **Dysarthria** is slurred speech due to incoordination of muscles of speech and dyspraxia is difficulty in planning and executing speech.
3. **Stuttering** child has a normal vocabulary, but speech fluency is disrupted involuntarily by either pauses or sound repetitions or sound prolongations or silent blocks.
4. **Dyslalia** is a sort of articulation disorder characterized by error of pronunciation.
5. **Rhinophonia** is altered voice sounds and rhinolalia is altered sound production.
6. **Gutzmann's pressure test** is pressing the thyroid prominence backwards and downwards helping in relaxing the overstretched vocal cords producing low-pitched sounds.

Chapter 45 Neurological Disorders of Larynx

What Students Must Know!

- **Relevant Anatomy and Physiology of Larynx**
  - Semon's Law/ Wegener's Theory
  - Etiology of Nerve Palsy
- **Clinical Features**
  - Superior Laryngeal Nerve Paralysis
  - Recurrent Laryngeal Nerve Paralysis
- **Investigations in Laryngeal Paralysis**
- **Management**
  - Superior Laryngeal Nerve Paralysis
  - Recurrent Laryngeal Nerve Paralysis
  - Thyroplasty
- **Functional Aphonia**

RELEVANT ANATOMY AND PHYSIOLOGY OF LARYNX

The larynx is the chief organ of the body, responsible for:

- Protecting the lower airway
- Maintenance of the respiration
- For the production of speech
- Fixation of chest.
  - With the help of its extrinsic and intrinsic musculature innervated by the branches of vagus nerve, larynx prevents aspiration of food material, helps in production of speech and fixes the chest during exertion
  - Thus, disorders of the neural su pply of the larynx result in derangement of either or all of these functions.

  The larynx comprises of three main subdivisions:
- The supraglottis comprises of the epiglottis, the aryepiglottic folds, the arytenoids and the false cords including the ventricle
- The glottis extends from the apex of ventricle to the undersurface of the cords
- The subglottis extends from the level of vocal folds to the lower border of the cricoid cartilage.

Nerve Supply

The main cranial nerve innervating the larynx is the vagus via its branches—superior laryngeal nerve (SLN) and recurrent laryngeal nerve (RLN) (**Figures 45.1A and B**).

Vagus Nerve

- The vagus nerve originates in the nucleus ambiguous of the medulla oblongata
- The motor fibers or visceral efferents that supply the intrinsic muscles of the larynx and pharynx occupy two specific sites within the nucleus.
- One site becomes the SLN and the other RLN
- The vagus nerve leaves the medulla and enters the jugular foramen, along with the accessory nerve and jugular vein.
- Within the jugular foramen, the vagus nerve widens to form the superior ganglion.
- As the vagus nerve exits the jugular foramen, it widens again to form the nodose ganglion or the inferior ganglion,

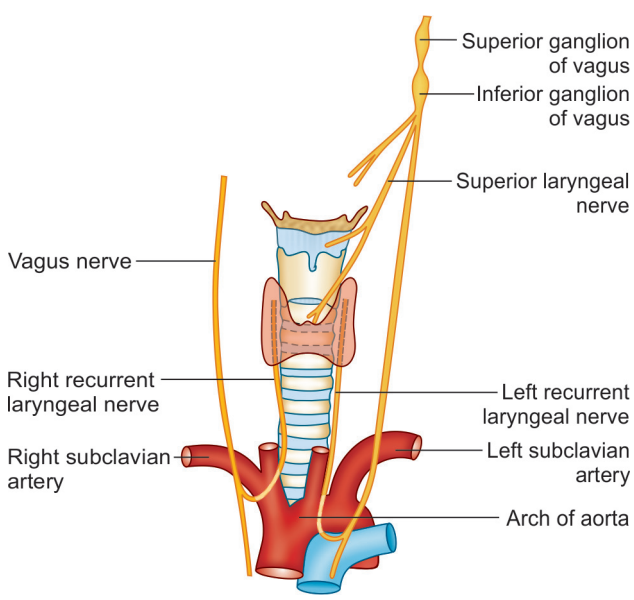


Figure 45.1A Course of recurrent laryngeal nerve

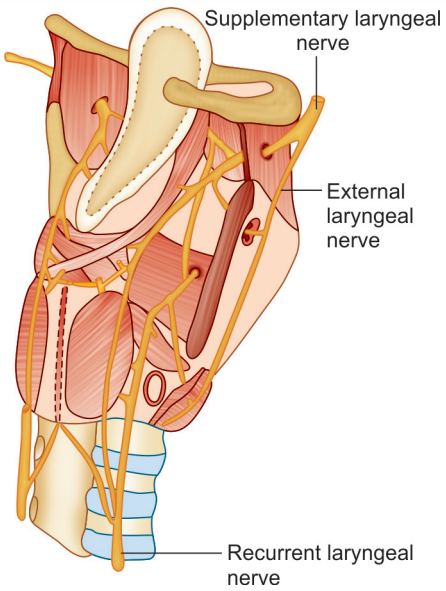


Figure 45.1B Galen's anastomosis

in which the nerve cell bodies containing the sensory or visceral afferents from the larynx and pharynx reside.

Superior Laryngeal Nerve

- Arises from the inferior ganglion of the vagus nerve and courses along the carotid artery to the larynx
- It enters the larynx through the thyrohyoid membrane, dividing into internal and external branches
- The internal branch provides sensory function (visceral afferent) and the external branch provides motor function to the cricothyroid muscle (visceral efferent).

Recurrent Laryngeal Nerve

- The right RLN fibers exit from the vagus nerve as the nerve crosses anteriorly over the subclavian artery.
- The RLN loops posteriorly around the subclavian artery to enter the larynx through the fibers of the cricopharyngeal muscle entering the larynx at the cricothyroid joint.
- The left RLN divides much further in the mediastinum, exiting the vagus nerve as it crosses anterior to the aorta and lateral to the ligamentum arteriosum (i.e. remnant of the patent ductus arteriosum between the aorta and the pulmonary vein)
- It then extends superiorly to enter the larynx opposite the right RLN
- The RLN branches into the posterior sensory branch and the anterior motor branch to the posterior cricoarytenoid, interarytenoids, lateral cricoarytenoid and thyroarytenoid muscles.

Thus, all the intrinsic muscles of the larynx except the cricothyroid are supplied by the recurrent laryngeal nerve, the superior laryngeal (external branch) completing the muscular innervation by supplying to cricothyroid muscle.

Table 45.1: Muscle actions

S. no	*Muscle*	*Supplied by*	*Action*
1.	Cricothyroid	SLN*	Tensor, Adductor
2.	Posterior Cricoarytenoid	RLN†	Abductor
3.	Lateral Cricoarytenoid	RLN	Adductor
4.	Interarytenoid	RLN	Adductor
5.	Vocalis	RLN	Adductor

*SLN: Superior laryngeal nerve, †RLN: Recurrent laryngeal nerve

Muscle Actions

In order to have a better understanding of the effects of nerve palsies, an understanding of the actions of the relevant muscles is necessary (**Table 45.1**).

Thus, lesions of the RLN affect either the abductors or the adductors. There are numerous theories to explain, why in certain cases only selective nerve fibers are affected.

Semon's Law

Semon's law states that in all progressive organic, lesions abductor fibers of the nerve are more susceptible and are the first to be paralysed as compared to adductor fibers. Possible explanation for this may be stronger adductor fibers and later development phylogeneticlly of abductor fibers making it more vulnerable. This theory is no more acceptable.

Wagner-Grossman Theory

1. Wagner-Grossman theory states that cricothyroid muscle innervated by superior laryngeal nerve keeps the cord in paramedian position due to its adductive function.
2. In the absence of cricoarytenoid joint fixation, an immobile vocal cord in the paramedian position has a total pure unilateral RLN paralysis, and an immobile vocal cord in the lateral (cadaveric) position has combined paralysis of both the SLN and RLN nerves.
3. Positions of vocal cords:
   - Median—vocal cords are in midline
   - Paramedian—1.5 mm from midline
   - Intermediate (cadaver)—3.5 mm from midline
   - Partial abduction—7 mm from midline
   - Full abduction—9.5 mm from midline.

NEUROLOGICAL DISEASE OF LARYNX

Etiology

The following are the causes of neurological disorders of larynx.

1. *Supranuclear*—rare.
2. *Nuclear:*

- Medullary tumors
- Syringobulbia
- Motor neuron disease.

3. *High vagal lesions (combined paralysis):*
   - Tumors of posterior fossa
   - Basal meningitis
   - Skull base fractures
   - Nasopharyngeal cancer
   - Metastatic nodes.
4. *Superior laryngeal nerve paralysis:*
   - Thyroid surgery
   - Penetrating neck trauma
   - Diphtheria
   - Metastatic cervical adenopathy.
5. *Recurrent laryngeal nerve paralysis:*

Right:

- Trauma
- Thyroid disease
- Thyroid surgery
- Carcinoma esophagus
- Cervical lymphadenopathy.

Left:

Neck

- Trauma
- Thyroid disease
- Thyroid surgery
- Carcinoma esophagus
- Cervical lymphadenopathy.

Mediastinum

- Bronchogenic cancer
- Carcinoma of thoracic esophagus
- Aortic aneurysm (**Figure 45.2**)
- Mediastinal lymphadenopathy
- Left atrial hypertrophy
- Intrathoracic surgery
- Idiopathic

Both:

- Thyroid disease
- Thyroid surgery
- Carcinoma esophagus
- Cervical lymphadenopathy
- Carcinoma of the larynx or hypopharynx.

In addition, there are a variety of causes listed as miscellaneous. These include:

- Hemolytic anemia
- Rheumatoid arthritis
- Syphilis
- Collagen vascular diseases.

The left RLN is affected in around 75 percent of cases owing to its longer course.

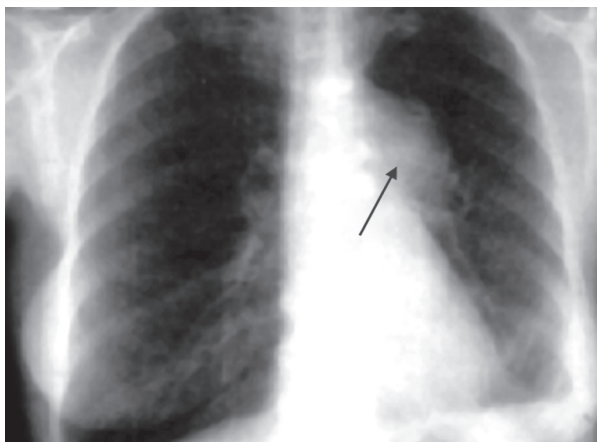


Figure 45.2 Aortic aneurysm causing recurrent laryngeal nerve (RLN) palsy

Clinical Features

Superior Laryngeal Nerve Paralysis

Unilateral paralysis

Unilateral paralysis results in paralysis of the ipsilateral cricothyroid muscle (loss of cord tension) and anesthesia of the supraglottic larynx.

1. The voice is weak owing to loss of cord tension and the additional adduction provided by the cricothyroid muscle. However, compensation occurs quickly and the patient may not notice the disability.
2. On indirect laryngoscopy, the ipsilateral cord is seen to be flabby, wavy and bowed (Askew position).
3. Occasional aspiration may occur owing to the supraglottic anesthesia.

Bilateral paralysis

There is bilateral paralysis of the cricothyroid muscle and the entire supraglottic larynx becomes insensitive.

- The voice is breathy, weak and lowered owing to the lack of complete adduction
- Repeated choking and coughing fits owing to glottic incompetence leading to aspiration
- Indirect laryngoscopy reveals bilaterally flaccid and bowed vocal folds
- Compensation of the voice may occur with return of the speaking voice
- Patient may need tracheostomy or even epiglottopexy to close the laryngeal inlet.

Recurrent Laryngeal Nerve Paralysis

Recurrent laryngeal nerve paralysis may be unilateral or bilateral and depending on the function lost, which may be abductor or adductor palsy.

Abductor paralysis—unilateral

1. The affected vocal fold lies in the paramedian position and the voice is initially hoarse. However, with time, compensation occurs and the voice may return to normal (**Figure 45.3**).
2. Carcinoma of the bronchus must be ruled out, if the left cord is affected.

Abductor paralysis—bilateral

1. The vocal folds are fully adducted and respiratory distress is a prominent feature owing to the lack of adequate glottic chink. Stridor may be present.
2. The voice is usually good.
3. Tracheostomy may be required as an emergency procedure
4. In long standing cases either one has to choose
   - Between permanent tracheostomy with a speaking valve or
   - Surgical procedure to lateralize the cord such as arytenoidectomy
   - Thyroplasty type II or
   - CO_2 laser cordectomy.

Bilateral partial recurrent palsy presents with adduction of vocal cords.

Adductor paralysis

- The affected cord lies in the lateral position and the voice is weak and husky, sometimes not more than a forced whisper
- Aspiration may be present, especially in bilateral palsies
- Bilateral palsies are often hysterical in nature.

Investigations in Laryngeal Paralysis

1. *Hematological*
   - Hemoglobin
   - Total and differential counts
   - Erythrocyte sedimentation rate (ESR)
   - Monospot or Paul-Bunnell test.
2. *Radiology*
   - Chest X-ray
   - CT scan/MRI of the head, neck and thorax
   - Barium swallow, if chest radiology is negative to exclude esophageal causes.
3. *Endoscopy:* This includes examination of the nasopharynx, larynx, pharynx and also bronchoscopy as well as esophagoscopy. The procedures are usually performed under general anesthesia.
4. *Miscellaneous studies:* This includes thyroid isotope scans and an ultrasound of the thyroid gland, echocardiography (ECG).

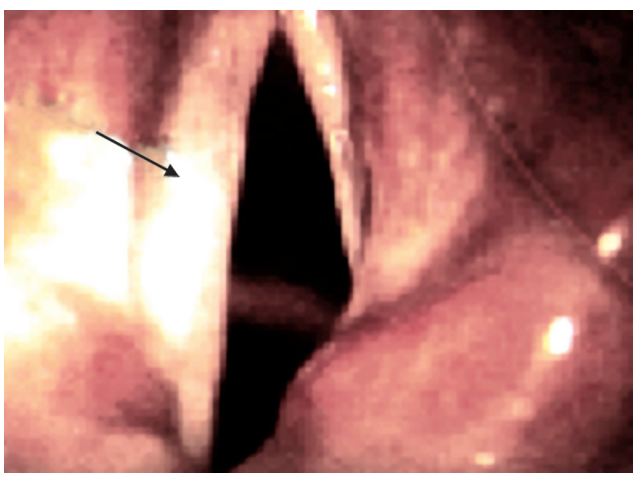


Figure 45.3 Left vocal cord palsy

Management

Superior Laryngeal Nerve Paralysis

- The definitive treatment will depend on the cause
- Speech therapy is helpful in resolving the problems of a weak voice
- Chronic repeated aspiration may require a tracheostomy or a surgical procedure such as epiglottopexy to close the laryngeal inlet
- Teflon injection into the paralysed vocal fold may also be done to medialise the cord.

Recurrent Laryngeal Nerve Paralysis

Abductor paralysis—unilateral

- Speech therapy is used to hasten the process of voice compensation
- However, surgical therapy may be necessary in professional voice users
- This consists of:
  - Vocal fold injection of Teflon paste
  - Arytenoid rotation
  - RLN reinnervation
  - Thyroplasty operation Type II.

Abductor paralysis—bilateral

In acute cases, a tracheostomy is necessary for the maintenance of the airway. A period of 6 to 12 months should be allowed to elapse before attempting a surgical procedure for this condition. A tracheostomy results in loss of phonation and this can be overcome with a speaking valve. Surgery in these cases consists of:

- Arytenoidectomy (Open/Endoscopic)
- CO_2 laser may be used
- Cordectomy
- Nerve muscle implant—using sternohyoid muscle
- Woodman's procedure.
- Thyroplasty Type II.

Adductor paralysis—unilateral

The treatment depends on the cause. If the lesion is caused by a carcinoma, then medialisation of the cord by Teflon or

collagen injection may help to reduce the aspiration and improve the voice, thus improving the quality of life.

If the lesion is not due to carcinoma, then a 6 to 12 months waiting period is considered for compensation to occur. Speech therapy is continued in the meantime. After this time, if the cord does not compensate and the patient is symptomatic, then the cord may be medialised by:

- Teflon/Collagen injecton
- Medialisation laryngoplasty
- Thyroplasty Type I
- Arytenoid adduction.

Adductor paralysis—bilateral

This is often hysterical in nature rather than organic in origin. The treatment in these cases is speech therapy with a psychiatric referral, if deemed necessary.

If the cause is found to be organic, the treatment is aimed at controlling aspiration and may consist of:

- Tracheostomy with cuffed tube
- Epiglottopexy
- Teflon injection
- Glottic closure by suturing the cords
- Total laryngectomy.

Phonosurgery

Phonosurgery was popularized by Hans von Leden in 1950 and it includes injections, microsurgery, laser and laryngeal framework surgery.

Injection technique in which the inert substances like liquid paraffin to displace the vocal cord medially towards midline by using a special syringe of Brunning. Its complication is granuloma formation and the risk of embolisation. Newer substances used are Teflon paste, gelfoam paste, fat or collagen.

Thyroplasty

Known by the name of Isshiki thyroplasty—1974.

Type I

It is **medialization of vocal cord** by injection of Teflon paste or a silastic prosthesis in unilateral vocal cord palsy.

A window of 5 x 12 mm is made in the ala of thyroid cartilage and an silastic implant or a cartilage graft is placed to medialise the vocal cord.

Type II

It is **lateralization of vocal cord** to improve the air way for bilateral vocal cord palsy.

Type III

It is **shortening of vocal cord** to lower the pitch by reducing the distance between anterior comissure and posterior commissure. Relaxation of vocal cord lowers the pitch and is a useful procedure in male patients with feminine voice.

Type IV

It is **lengthening of vocal cord** to raise the pitch of voice such as in aging vocal cords or after trauma. In this, distance between anterior and posterior commissure is increased. The procedure will be useful in females with masculine voice.It can be done by advancing the anterior commissure forward or by approximating thyroid and cricoid cartilages.

Functional Aphonia

The condition is usually seen in emotionally unstable young girls, who suddenly develops aphonia without any other symptoms. The cause is usually some personal or family problem. The patient cannot speak, but can cough. Indirect laryngoscopy (IDL) shows vocal cords in abducted position. Treatment is reassurance and psychological counselling.

1. All the **intrinsic muscles of larynx** are supplied by RLN except the cricothyroid, which is supplied by external laryngeal nerve, a branch of SLN.
2. **Sensory supply to the larynx** above the vocal cords is by internal laryngeal nerve and below the vocal cords is by RLN.
3. **Posterior cricoarytenoid** is the only abductor of the vocal cords, while the adductors are lateral cricoarytenoid, interarytenoid and external part of thyroarytenoid.
4. **Left RLN** is affected more than the right RLN, due to its longer course.
5. Carcinoma of bronchus is the most common cause of left RLN palsy, while thyroid surgery affects right RLN.
6. **McNaught keel** is made up of tantalum.
7. The **most common cause** of bilateral adductor palsy is functional. Flag sign is seen in such cases.
8. The important causes of **fixed vocal cords** may be carcinoma, fixation of cricoarytenoid joint and combined RLN and SLN palsy.
9. In **bilateral abductor palsy**, patient have good voice with stridor and may need emergency tracheostomy.
10. **Bilateral adductor palsy** manifests by aphonia, inability to cough and repeated attacks of pneumonitis.
11. **Thyroplasty type I** is medialisation and type II is lateralization of vocal cords.
12. **Ortner syndrome** is compression of RLN by atrium in mitral stenosis.
13. For **Androphonia**, type IV thyroplasty is done.
14. **Types of thyroplasty—remember mneumonic: Men Like Short Ladies**: M: **M**edialization; L: **L**ateralization; S: **S**hortening; L: **L**engthening.

Chapter 46 Laryngotracheal Trauma

What Students Must Know!

- **Laryngotracheal Trauma**
  - Etiology
  - Signs and Symptoms
  - Investigations
  - Treatment
  - Complications

LARYNGEAL AND TRACHEAL TRAUMA

Etiology

- The most common cause is due to road traffic accidents, which cause high-velocity blunt injuries
- Blows or kicks on the neck from sports, such as karate and basketball, which are responsible for low-velocity blunt injuries
- Bullet and knife wounds cause penetrating injuries
- Neck striking against a fixed wire or cable
- Falling on sharp-edged objects
- Other causes such as burns and scalds, intubation injuries or following radiotherapy reactions.

Mechanism of Injury

- Low-velocity blunt injuries are unlikely to fracture the thyroid. But fractures of hyoid are not uncommon and the main problem is soft tissue injury
- High-velocity blunt injuries will fracture the skeleton of the larynx. Thyroid cartilage in persons above 40 years will be compressed against cervical spine. It is unlikely to have enough elasticity to return to its original position, so it will shatter like an egg. But in persons below 40 years of age, it splays open when larynx is pushed against cervical spine and will spring back into its original position
- Hemorrhage and edema of supraglottic or subglottic region will be present
- Subcutaneous emphysema due to tears in laryngeal mucosa may be seen
- Dislocation of cricoarytenoid joint and cricothyroid joint
- Besides disruption of cricoid cartilage and trachea from each other, there may be injuries to tracheal rings also.

Symptoms

- Respiratory distress (dyspnea)
- Hoarseness of voice (dysphonia)
- Dysphagia
- Pain in the neck
- Hemoptysis.

Signs

- Bruising of skin
- Thyroid prominence is lost
- Tenderness on anterior aspect of neck
- Subcutaneous emphysema of the neck
- Gap may be palpable in the sites of thyroid, cricoid and hyoid bone
- Mirror examination may show the mucosal tears, edematous arytenoids, dislocated or subluxated arytenoids and vocal cords. There is asymmetry of the glottis.

  Direct laryngoscopy should be done in all cases (fiberoptic is preferred).

Investigations

- X-ray soft tissue neck will show:
  - Fracture of thyroid and cricoid cartilage
  - Subcutaneous emphysema
  - Change in contour of air column.

- X-ray cervical spine will show:
  - Associated injuries of cervical spine.
- Computed tomography (CT) scan: Axial plane should be done as soon as possible.

Treatment

- If injury is slight, hospitalization and observation for respiratory distress due to laryngeal edema, which should be treated with humidification, oxygen and steroids; and if edema progresses, a tracheostomy should be done.
- In more severe cases:
  - Tracheostomy
  - Open exploration, repair and reduction and fixation of the fracture
  - Mucosal tears repaired with catgut, loose fragments of cartilage are removed
  - Avulsed epiglottis removed.
- Linear fracture of thyroid is treated by reduction of fracture and by keeping piece of sheet between it and anterior ends of vocal cords for preventing them from joining together to form a web
- Fracture of hyoid bone is treated by exposing the bone and removing the piece of bone on either side of fracture, leaving a gap in the hyoid, which causes no functional problem
- In case of disruption of larynx and trachea, end-to-end anastomosis is indicated.

Complications

- Perichondritis
- Laryngeal abscess
- Laryngeal stenosis
- Vocal cord paralysis.

Key Points

1. The most common **cause of laryngotracheal (LT) trauma** is roadside accidents, being the second most common cause of death.
2. High-velocity injuries cause fracture of **calcified laryngeal cartilage** above 40 years of age.
3. **3'D' symptoms** in accident cases indicate laryngeal trauma (dyspnea, dysphonia and dysphagia).
4. **Subcutaneous emphysema** of neck is pathognomic of tear of laryngeal mucosa.
5. **Laryngeal stenosis** is an important complication of laryngeal trauma.
6. **Webbing** of anterior commissure can be prevented by a silastic keel.
7. Three-dimensional CT is really very informative in **laryngeal trauma**.
8. **Titanium plates** are used for immobilization of cartilage fragments.

Chapter 47 Tumors of the Larynx

What Students Must Know!

- **Introduction**
- **Benign Tumors of the Larynx**
  - Squamous Papillomatosis
  - Solitary and Multiple Pappillomas
- **Malignant Tumors of the Larynx**
  - Classification and Staging
  - Supraglottic Carcinoma
  - Glottic Carcinoma
  - Subglottic Cancer
  - Investigations in CA Larynx
- **Treatment of Laryngeal Cancer**
  - Radiotherapy
  - Surgery
- **Vocal Rehabilitation after Total Laryngectomy**
  - Esophageal Speech
  - Neoglottis Formation

INTRODUCTION

- The word cancer should be used very carefully as it is many times more lethal than cancer itself
- Tumors of the larynx can be both
  - Benign
  - Malignant.

BENIGN TUMORS OF THE LARYNX

Squamous Papillomatosis

Squamous papillomatosis can be as follows:

Solitary Papilloma (Adult)

A solitary papilloma usually occurs in the adults (30–50 years) and is more common in males (2:1). These usually arise from the anterior commissure or the anterior half of the vocal cord.

Clinical features

- Hoarseness is the presenting symptom
- On indirect laryngoscopy:
  - Pink warty growth
  - May be sessile or pedunculated
  - Friable and bleeds on touch.

Treatment

- Endoscopic endolaryngeal removal with cup forceps.
- Laser ablation.
  In recurrent cases, malignant transformation can occur.

Multiple Papillomatosis (Juvenile Papillomatosis)

- Although rare, but is the most common benign lesion of the larynx
- It occurs in children or infants
- It is aggressive and resistant to treatment, though it may regress spontaneously near puberty. **Two percent of cases can turn malignant after 15 to 20 years**
- The etiology of this condition is not definitely known
- Though it is usually said to be caused by a virus of human papillomavirus group (HPV 6 or 11)
- It may have a hormonal etiology.

Clinical features

- It usually presents with hoarseness
- Inspiratory dyspnea with stridor develops as the lesion progresses
- Indirect laryngoscopy shows:
  - Multiple papillomas, which may completely fill the laryngeal inlet
  - Sessile or pedunculated, friable and bleed on touch.
- Occur on true and false vocal cords, but may spread to the epiglottis and the tracheobronchial tree.

Treatment options

- Excision by endoscopy or microlaryngeal surgery. Most common treatment for recurrent papillomatous is removal of lesions by CO_2 laser or surgical debulking with adjuvant alpha interferon or podophyllin application
- Serial CO_2 laser ablation.
- Diathermic cautery of each papilloma may be performed.
- Cryosurgery.
- Interferon therapy, use of antiviral drugs like cidofovir, acyclovir or hormones or vaccines have been used.
- Tracheostomy may be required to keep the airway patent.
- Cis-retinoic acid, hematoporphyrins, ribavirin are also being used. Other treatments are:
  - — Measles vaccine in the surgical bed
  - — Anti-estrogenic drugs
  - — Photodynamic therapy

Vocal Nodules

It is also called singer's nodule or teacher's nodule or screamer's nodule. Vocal nodules are usually seen in the male children, young adult women, teachers, singers and people, who are talkative.Usually are bilateral, grayish, white-small and sessile masses.

Etiology

The prolonged, forceful vibrations cause localized vascular congestion with edema at the point of maximum trauma leading to edema of the submucosa. This area at the junction of the **anterior one-third and posterior two-thirds** of the vocal cords become hyalinized in chronic cases to form vocal nodules.

Clinical Features

- Chronic hoarseness
- Recurrent attacks of dysphonia
- Singers may complain of decreased flexibility and range for higher notes
- Vocal fatigue
- Indirect laryngoscopy shows:
  - — Clearly demarcated single nodule at junction of anterior one-third and posterior two-thirds.
  - — Color, size, contour and symmetry may vary.

Treatment

- Microlaryngeal surgical excision
- Laser excision of nodules
- Voice rest and speech therapy.

Other Benign Laryngeal Tumors

- Vocal cord polyps (**Figure 47.1**)
- Intubation granuloma

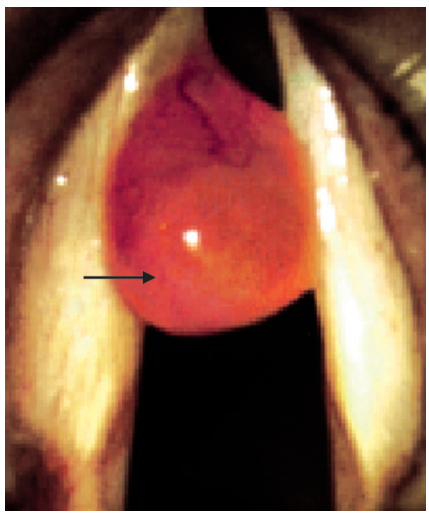


Figure 47.1 Vocal polyp

- Hemangioma
- Fibroma
- Chondroma
- Pleomorphic adenoma
- Lipoma
- Neurofibroma
- Rhabdomyoma.

These benign tumors are not common and treatment involves endoscopic excision in symptomatic cases.

MALIGNANT TUMORS OF THE LARYNX

- Carcinoma larynx is widely prevalent in our country
- It forms 2.6 percent of all body cancers
- Males affected more in a 10:1 ratio
- It is most commonly seen in 40 to 70 years of age group.

Etiology

- Chronic smokers have a higher incidence of laryngeal malignancy as compared to non-smokers
- Combination of alcohol and smoking increases the risk 15-fold as compared to each factor alone
- Chronic irritation, previous radiation to neck for benign lesions or laryngeal papilloma may induce laryngeal carcinoma
- Occupational exposure to asbestos, mustard gas, chemical or petroleum products and atmospheric pollutants are considered carcinogenic.

Classification and Staging

The larynx is divided into supraglottic, glottic and subglottic regions for the purpose of anatomical classification of carcinoma of larynx (**Figure 47.2**). This is an important division due to the drainage of lymphatics.

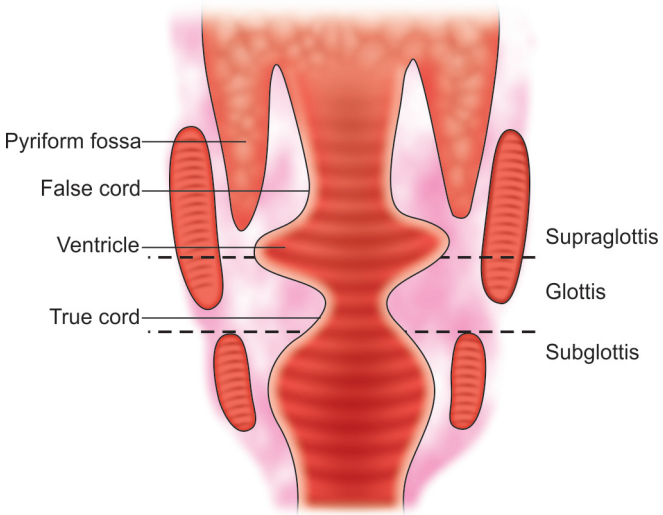


Figure 47.2 Divisions of larynx into supraglottic, glottic and subglottic regions

The area above the vocal cords, drain upwards via the superior lymphatics to upper deep cervical group of lymph nodes and subglottic lymphatics drain to the prelaryngeal and paratracheal glands.

Classification According to Site

- **Supraglottis includes:**
  - Epiglottis laryngeal surface
  - Aryepiglottic folds
  - False vocal cords
  - Ventricles and
  - Vestibule.
- **Glottis:**
  - True vocal cords
  - Anterior commissure
  - Posterior commissure.
- **Subglottis:** Walls of subglottis up to lower border of cricoid cartilage.

Cancer at each site is further classified by TNM system.

- T — Indicates tumor and its extent: T1–T4
- N — Nodal involvement and its degree: N1-N3
- M — Distant metastases: Mx, M0, M1

Staging for Glottic, Supraglottic and Subglottic Tumors

The staging for glottic, supraglottic and subglottic tumors are as follows.

Primary tumor (T):

- T1s : Carcinoma *in situ*
- T1 : Tumor confined to the region with normal mobility
- T1a : Tumor confined to one site of the region
- T1b : Tumor extending to two sites of the same anatomical region
- T2 : Tumor with extension to adjacent region without fixation
- T3 : Tumor confined to the larynx with one or both cord fixation or deep infiltration
- T4 : Tumor with direct extension beyond the larynx.

Nodes (N):

- N0 : No evidence of regional lymph node involvement
- N1 : Movable homolateral regional nodes
- N2 : Involvement of movable contralateral or bilateral regional lymph nodes
- N3 : Fixed regional lymph nodes.

Distant metastases (M):

- M0 : No evidence of distant metastases
- M1 : Evidence of distant metastases.

Staging of carcinoma larynx

- Stage I : T1, N0, M0
- Stage II : T2, N0, M0
- Stage III : T3, N0, M0
  T1, T2, T3, N1, M0
- Stage IV : T4, N0, N1,M0
  Any T, N2, N3, M0
  Any T, any N, M1.

Supraglottic Carcinoma

Supraglottic carcinoma is relatively less frequent than glottic cancer and mainly involves the epiglottis, then the false cords followed by aryepiglottic folds.

Spread

- Supraglottic carcinoma may spread locally and invade the neighboring areas, i.e. vallecula, posterior third of tongue and pyriform fossa
- Cancer of infrahyoid, epiglottis and anterior ventricular band may extend into pre-epiglottic region and penetrate the thyroid gland
- It may also spread through regional lymphatics to the upper and middle deep cervical lymph nodes
- Bilateral metastasis may be seen in cases of epiglottic cancer
- Rarely, spread may occur through the blood, usually to the lungs, liver and bones.

Pathology

About 90 to 95 percent of laryngeal malignancies are squamous cell carcinoma with various grades of differentiation. Supraglottic malignancy is usually anaplastic.

Clinical Features

Supraglottic growths (**Figures 47.3 and 47.4**) are often silent.

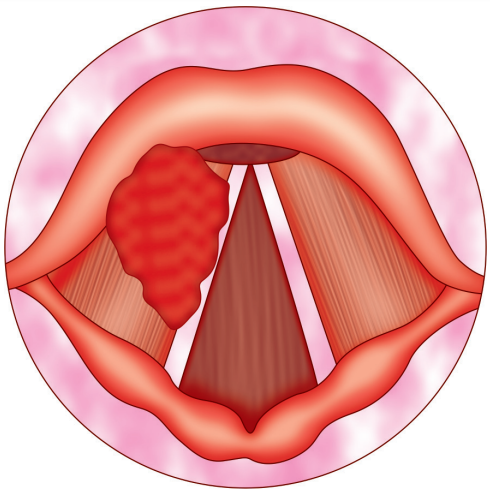


Figure 47.3 Supraglottic carcinoma extending onto the vocal cord

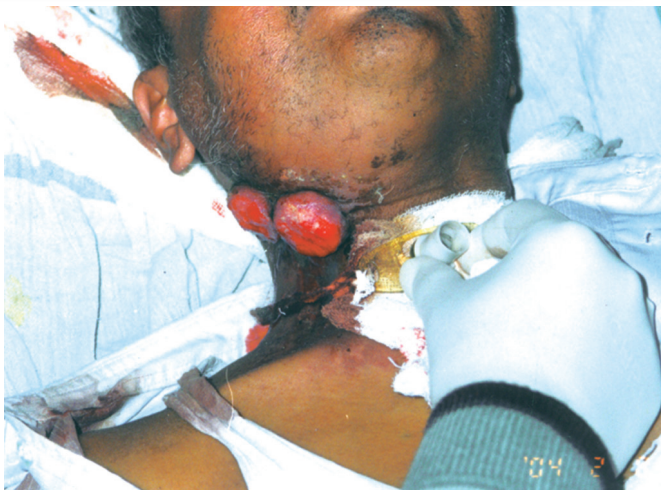
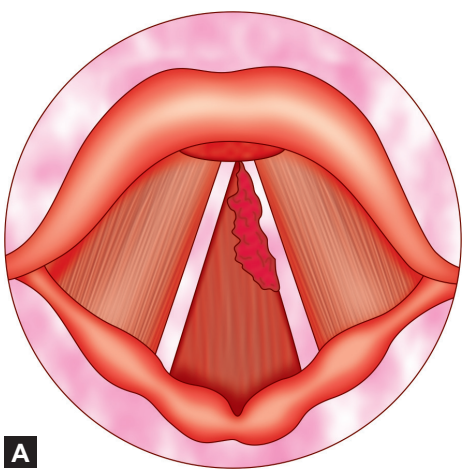
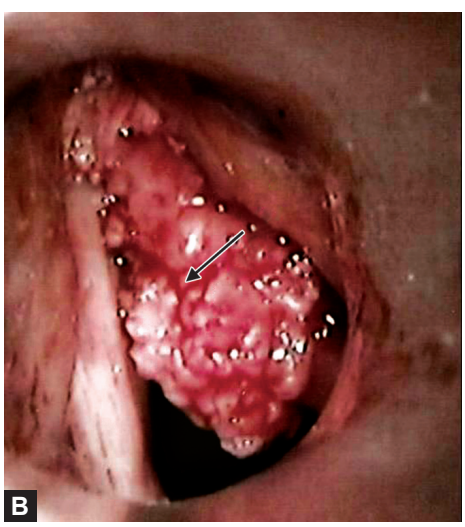


Figure 47.4 A patient with supraglottic carcinoma having burst out secondaries neck with tracheostomy tube





Figures 47.5A and B Glottic carcinoma

Symptoms

Earliest symptoms:

- Dysphagia
- Throat pain and referred pain in the ear
- Mass of lymph nodes in the neck
- Foreign body sensation in the throat or a lump in the throat may be felt by the patient.

Late symptoms:

- Change of voice from 'hot potato speech' (as if the patient is speaking with a mouthful of hot potatoes) to hoarseness as the vocal cords get involved.
- Blood-stained sputum and cough
- Stridor and inspiratory dyspnea
- Halitosis
- Weight loss.

Signs

- On indirect laryngoscopy, a cauliflower–like growth or an ulcer is seen.
- Pooling of saliva may be present due to irritation and dysphagia.
- Hard metastatic lymph nodes may be present. The upper or middle groups of the deep jugular chain is affected. Bilateral involvement may occur, if the growth crosses the midline.

Glottic Carcinoma

- Glottic carcinoma (**Figures 47.5A and B**) is the most common site of laryngeal carcinoma
- It has also been called 'welcome cancer'
- It usually arises from the free margin of the upper surface of true vocal cords in its anterior two-thirds

- Hoarseness of voice is the earliest symptom, so patient presents early for treatment so prognosis of glottic carcinoma is always better.

Spread

Local
It may spread by continuity:
- Forwards to the anterior commissure and to the anterior portion of the opposite vocal cord
- Backwards to the arytenoid cartilage and interarytenoid region
- Upwards towards the ventricle
- Downwards to the subglottic region
- Laterally towards the cartilage, leading to vocal cord fixation. It may also lead to perichondritis, with widening of the larynx, which is a very painful condition.

Lymphatic spread
There are a few lymphatics in vocal cord and hence, nodal metastasis is rarely seen in cordal lesions. When the disease spreads beyond the region of membranous cord, the commonly involved lymph nodes are pretracheal and paratracheal nodes, followed by middle jugular nodes, which present as hard painless swellings.

Pathology

Majority of malignancies are squamous cell carcinomas.

Adenocarcinoma, basal cell carcinomas or sarcomas are rarely seen. TNM classification as described earlier can be applied here.

Clinical Features

Symptoms

Early symptoms:
- Hoarseness may be one of the earliest symptoms
- Dry cough
- Raw sensation in the throat.

Late symptoms:
- Blood-stained sputum with cough
- Stridor
- Dyspnea
- Painful widening of larynx
- Palpable lymph node metastases.

Signs
Indirect laryngoscopy shows the growth arising from anterior half of vocal cords from its edge or the upper surface.

Fixed vocal cords in carcinoma larynx is due to:
- Deep invasion of thyroarytenoid (vocalis) muscle
- Cricoarytenoid joint involvement
- Involvement of arytenoid/cricoid cartilage
- Perineural invasion
- Due to large size of tumor causing mechanical fixation.

Treatment
Radiotherapy (External beam therapy with Cobalt 60) is the best in stage I and II and is curative in 95 percent of cases. Advantage of radiotherapy is preservation of voice. In late and advanced cases surgery in the form of conservative or total laryngectomy with pre or postoperative radiotherapy would be advisable.

Subglottic Cancer

The lesions of subglottis are rare and it involves the 1 cm area below the true vocal cords (**Figure 47.6**).

Spread

Local
It may spread by continuity:
- Downwards to the trachea
- Upwards to the vocal cords
- Circumferential inside the larynx.

Lymphatic spread
It may occur to pretracheal, paratracheal and mediastinal lymph nodes.

Clinical Features

The earliest symptom may be stridor or laryngeal obstruction, but this is often late.

Hoarseness of voice is a late feature and indicates spread of disease to undersurface of vocal cords, infiltration of

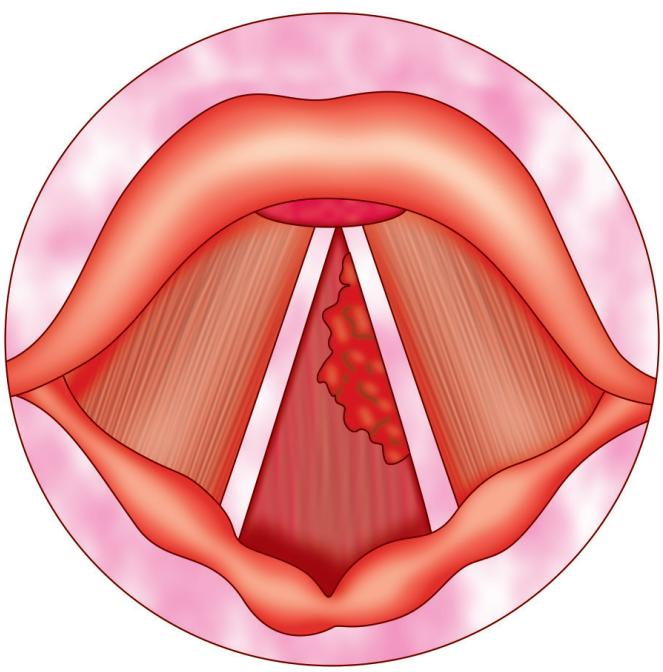


Figure 47.6 Subglottic carcinoma

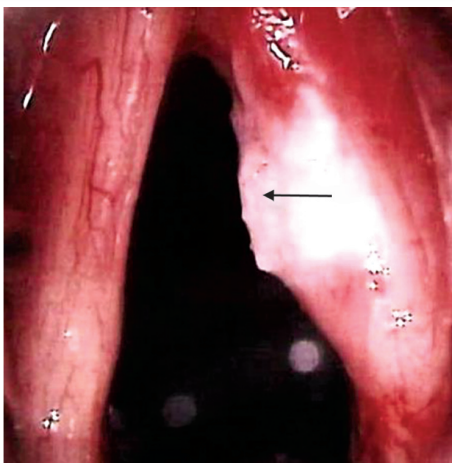


Figure 47.7 Endoscopic view of growth vocal cords of larynx

thyroarytenoid muscle or involvement of recurrent laryngeal nerve at cricoarytenoid joint.

INVESTIGATION IN CARCINOMA LARYNX

- Biopsy performed by direct laryngoscopy or micro-laryngoscopy
- Endoscopy to estimate extent of growth (**Figure 47.7**)
- Routine investigations, e.g. examination of blood, urine, blood sugar, blood urea and electrocardiogram, pre-operatively
- Venereal diseases research laboratory (VDRL) test
- Radiograph of the chest is advised to rule out tuberculosis and secondaries
- Soft tissue radiograph of the neck, lateral and anteroposterior view; laryngograms with radiopaque contrast study and tomograms may help to decide the extent of the growth
- CT scan reveals the extent of the growth
- Supravital staining and biopsy.

Toluidine blue is applied to the laryngeal lesions and then washed with saline and examined under the operating microscope. Carcinoma *in situ* and superficial carcinomas take up the dye, while leukoplakia does not. Thus, it helps to select the area for biopsy in a leukoplakic patch.

TREATMENT OF LARYNGEAL CANCER

- Treatment depends on the site of lesion, extent of lesion presence or absence of nodal and distant metastases.
- Carcinoma *in situ* of vocal cord is treated by stripping using microlaryngeal surgery and stage I and II by megavoltage radiotherapy.
- For stage III and IV carcinoma larynx surgery with radiation therapy (RT) is the best option.
- Currently, two principal modalities of curative treatment are used:

1. Radiotherapy
2. Surgery:
   a. Conservative laryngeal surgery. Patient retains his voice and is good for young patients with limited tumor. It includes partial vertical; horizontal partial hemilaryngectomy, subtotal and near total laryngectomy.
   b. Total laryngectomy
   c. Combined therapy.

Radiotherapy preserves the larynx, so the patient retains the voice as well as the normal air passage. Surgery is the sure way of removing the disease as against radiotherapy, particularly in large growths.

Radiotherapy

- Radiotherapy technique is the treatment of choice for early lesions, which neither impair cord mobility nor invade cartilage or cervical nodes.
- In T1 lesions of the vocal cords and anterior commissure, it has the advantage of natural voice preservation and cure rate of more than 90 percent.
- For advanced lesions, postoperative radiotherapy destroys the residual tumor and spilled over cells during surgery.
- Usual dose is 200 rads/day, 5 days a week, up to 6,000 to 7,500 rads being the total dose.

Surgery

Conservation Surgery of the Larynx

Conservation surgery technique can preserve voice and also avoid a permanent tracheostome. It includes:

- Excision of vocal cords after splitting the larynx (cordectomy via laryngofissure)—when tumor is superficial and limited to one vocal cord
- Partial lateral laryngectomy—when tumor extends slightly more on to the true vocal cords (**Figure 47.8**)
- Partial frontolateral laryngectomy—when vocal cord and anterior commissure is involved
- Supraglottic partial laryngectomy—in case of lesions of epiglottis, vestibule and supraglottis (**Figure 47.9**).

Total Laryngectomy

Total laryngectomy includes:

- Resection of whole of larynx up to 1 cm below the true vocal cords.
- Resection of part of anterior wall of pharynx.
- Repair of pharyngeal wall.
- Tracheostome formation above the suprasternal notch.

Laryngectomy may be combined with block dissection for nodal metastases.

Indications (T3 or T4 Carcinoma Larynx)

- Complete fixation of one vocal cord
- Marked subglottic or transglottic spread

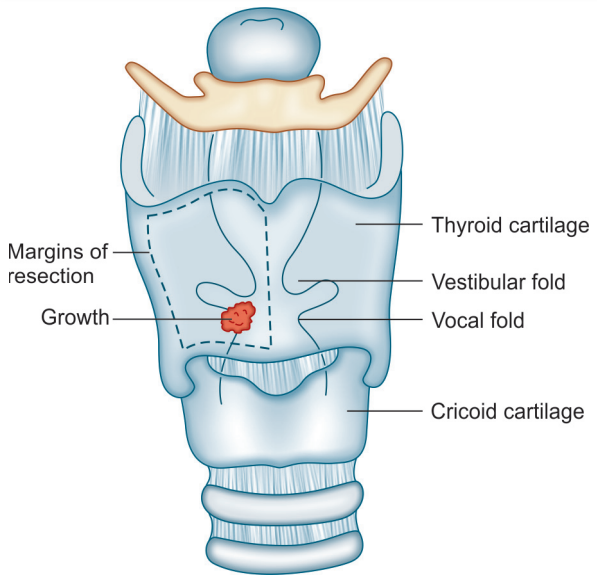


Figure 47.8 Hemilaryngectomy

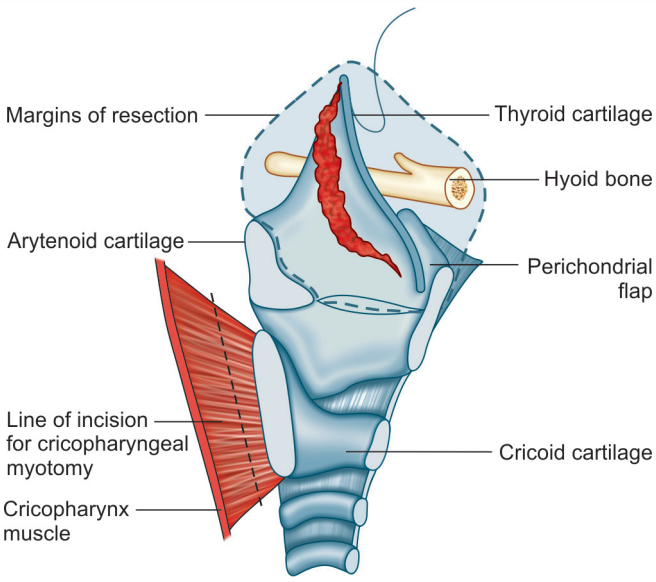


Figure 47.9 Supraglottic laryngectomy

- Wide extension to opposite cord or involvement of anterior or posterior commissure.

Radical Neck Dissection

Radical neck dissection is planned along with the laryngectomy, when there is presence of regional lymph nodes which are mobile.

Combined Therapy

For stage III and IV carcinoma larynx, surgery may be combined with pre- or postoperative radiation to decrease incidence of recurrence. Preoperative radiation may also render fixed nodes resectable.

VOCAL REHABILITATION AFTER TOTAL LARYNGECTOMY OR POSTLARYNGECTOMY SPEECH

Speech rehabilitation can be done by the following procedures.

Esophageal Speech

The patient is taught to swallow air and hold it in the upper esophagus and then slowly burp out the air into the pharynx. The patient is able to speak 6 to 10 words before swallowing the air. The disadvantage is that the quality of speech is rough, but loud and understandable.

Artificial Larynx

Electrolarynx

It is a battery operated electronic vibrator. The sound source is kept in contact with the neck and the patient uses normal articulatory mechanism to speak. Disadvantage is that the voice is metallic and device is expensive.

Transoral Pneumatic Device

It is another type of artificial larynx. Here, vibrations produced in a rubber diaphragm are carried by a plastic tube into the back of the oral cavity, where sound is converted into speech by modulators. This is a pneumatic device, which uses expired air from the tracheostome to vibrate the diaphragm.

Neoglottis Formation for Tracheoesophageal Speech

This consists of creation of a fistula between the trachea and the pharynx. Thus, air is shunted from the trachea to the pharynx and it produces vibrations in the local tissues and the speech is generated. Although the speech is better controlled and the patient can speak more words at a time, it involves a second surgery with problems of aspiration and stenosis.

Key Points

1. **Solitary papilloma** occurs in adults and is a premalignant condition of the larynx.
2. **Glottic carcinoma** carries the **best prognosis**, because of the early diagnosis and relatively a few lymphatics.
3. **TNM classification** of carcinoma larynx is important to finalize the modalities of treatment and to work out the prognosis of the case.
4. **CT scan** is the best investigation to find out the nature and extent of growth, besides direct laryngoscopy examination.
5. **External beam radiotherapy** is considered the better form of treatment in T1 M0 No early lesions because of the advantage of voice preservation and cure rate of more than 90 percent.
6. **Total laryngectomy** is done in T3 or T4 carcinoma larynx, when there is fixation of the cord or there is subglottic or transglottic spread of the tumor.
7. Speech after total laryngectomy is provided by **esophageal speech, artificial larynx or by neoglottis formation.**
8. Best treatment for **supraglottic cancer** is total laryngectomy with block dissection of neck.
9. Most frequent cause of laryngeal granuloma is laryngopharyngeal reflux (LPR).
10. **Juvenile papillomatosis** is caused by HPV 6 and 11.
11. **Verrucous carcinoma** of larynx is treated by partial or total laryngectomy.
12. Before performing cancer surgery, remember the adage **"Young surgeons kill their patient (by over enthusiasm), while old surgeons watch them die."**
13. Most common site of metastasis in carcinoma larynx is lungs.
14. Most common site for **vocal nodule** is junction of anterior one-third and middle one-third.
15. **Contact ulcers** are seen at the medial edge of vocal processes of vocal cords.
16. In carcinoma larynx, invasion of **paraglottic space** causes fixation of vocal cords and distance between false cords and pyriform sinus increases due to edema.
17. **Transglottic tumors** are the one which, involve more than two regions after crossing the ventricle.
18. **Tuberculosis of larynx** is indicated by:
    - Turban epiglottis
    - Mouse-nibbled appearance of vocal cords
    - Club-shaped arytenoids
    - Pale appearance of larynx
    - Interarytenoid mammillations.
19. Aryepiglottic growths are called **marginal tumors** because of spill over to adjacent regions.
20. Verrucous Carcinoma are also called Ackermann's tumor.

Chapter 48 Surgical Anatomy of Tracheobronchial Tree

What Students Must Know!

- **Tracheobronchial Tree**
  - Surgical Anatomy
- **Relations of Trachea**
  - Anterior
  - Posterior
  - Lateral
  - Nerve Supply
  - Blood Supply
  - Lymphatics
- **Bronchopulmonary Segments**
  - Functions of Tracheobronchial Tree
  - How to Examine Tracheobronchial Tree

TRACHEOBRONCHIAL TREE

Surgical Anatomy

1. Surgical anatomy develops from median tracheobronchial groove of the lateral wall of primitive foregut in the 4th week of IUL.
2. Trachea is a membrano cartilaginous tube of about **10 to 12 cm in length extending from 6th cervical vertebra to its bifurcation at the 4th thoracic vertebra.** Anteroposterior (AP) diameter is 16 to 20 mm and transverse diameter is 20 mm.
3. Approximately 5 cm of trachea lies in the neck and rest in the thorax.
4. It has approximately 16 to 20 cartilaginous rings out of which six lie in the neck. The rings are deficient posteriorly.
5. Lining mucosa is ciliated columnar epithelium.
6. Trachea bifurcates at 25 cm from upper incior at the carina, which appears as a sharp keel-like shining ridge when trachea bifurcates into two main bronchi.
7. Angles of right and left bronchi to trachea in adults are 25 to 30 degree (right) and 45 degree on left side.
8. In children it is 55 degree on both sides up to 5 years.

Relations of Trachea

Anterior

- Skin, superficial and deep fascia
- Strap muscles
- Thyroid isthmus
- Jugular arch and innominate artery.

Posterior

- Esophagus
- Recurrent laryngeal nerve.

Lateral

- Lobes of thyroid gland
- Common carotid artery
- Inferior thyroid artery
- Vagus nerve.

Nerve Supply

- Vagus nerve
- Recurrent laryngeal nerve
- Sympathetic trunk.

Blood Supply

Inferior thyroid artery.

Lymphatics

Pre- and para-tracheal lymph nodes.

Right main bronchus is shorter (2.5 cm), wider and straighter than the left bronchus (5 cm) and is in

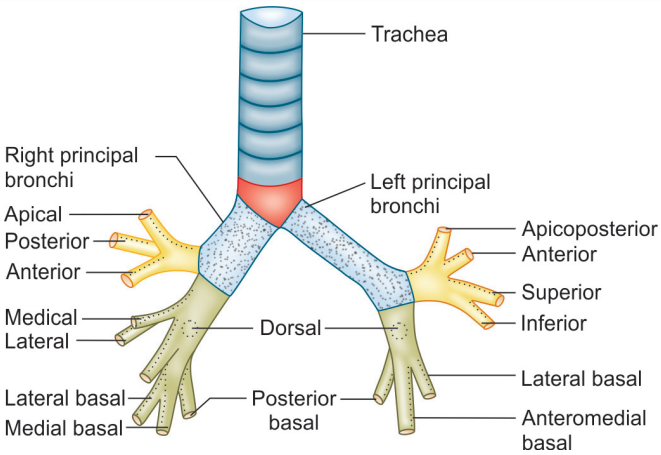


Figure 48.1 Anatomical divisions of tracheobronchial tree

continuation of trachea; hence, foreign bodies lodge more in right bronchus.

Bronchopulmonary Segments

Bronchopulmonary segment (**Figure 48.1**) is a segment of lung with its segmental bronchus. Various bronchopulmonary segments are as follows.

Right Bronchus

Upper lobe bronchus
- Apical
- Posterior
- Anterior.

Middle lobe bronchus
- Lateral
- Medial.

Lower lobe bronchus
- Superior
- Medial basal
- Lateral basal
- Posterior basal
- Anterior basal.

Left Bronchus

It is narrow, longer and more horizontal.

Upper lobe bronchus
- Apical posterior
- Anterior.

Lingular lobe bronchus
- Superior
- Inferior.

Lower lobe bronchus
- Superior
- Lateral basal
- Posterior basal
- Medial basal
- Anterior basal.

Functions of Tracheobronchial Tree

Tracheobronchial tree helps in respiration, phonation, protection of lungs and warms and moistens the air.

How to Examine Tracheobronchial Tree?

- Detailed careful history taking
- Examination of neck and chest
- Indirect laryngoscopy (IDL) examination
- X-ray chest and soft tissue neck lateral view
- Bronchography
- Computed tomography (CT) scan
- Sputum exfoliative cytology
- Bronchoscopy
- Mediastinoscopy, which is performed through suprasternal incision to inspect anterior mediastinum and the structures therein.

Key Points

1. **Total length of trachea** is around 10 cm. It has about **16 to 20 cartilaginous rings**.
2. Trachea extends from **6th cervical vertebra** to its bifurcation at the level of 4th thoracic vertebra.
3. Foreign bodies are more common in **right bronchus** as it is shorter, wider and straighter.
4. **Bronchopulmonary segment** is an independent unit formed by a segment of bronchus and lung segment.

Chapter 49

Diseases of Tracheobronchial Tree and Foreign Bodies in Air Passages

What Students Must Know!

- **Diseases of Trachea and Bronchi**
  - Acute Tracheitis
  - Laryngotracheobronchitis
  - Growths of Tracheobronchial Tree
  - Lung Abscess
  - Tracheoesophageal Fistula
- **Foreign Bodies in Tracheobronchial Tree**
  - Predisposing Factors
  - Types of Foreign Bodies
  - Clinical Features
  - Diagnosis
  - Treatment

DISEASES OF TRACHEA AND BRONCHI

Acute Tracheitis

1. Acute tracheitis is an inflammation of the lining membrane of trachea, which may follow laryngitis and bronchitis. It may be caused by bacteria or viruses.
2. The patient presents with cough and retrosternal pain or discomfort along with difficulty in respiration and croupy noise. Mild constitutional symptoms may be present such as body aches and fever.
3. It is treated by antibiotics and anti-inflammatory drugs along with antitussive agents and steam inhalation.

Laryngotracheobronchitis

Laryngotracheobronchitis seen mostly in children, infection present in the larynx and tracheobronchial tree and has already been discussed in detail.

Lung Collapse

Lung collapse occurs when there is bronchial obstruction due to various causes with inability of air to reach segment of lung which collapses. Obstruction may be due to foreign body, new growth, plug of mucus or blood clot after trauma.

The patient has acute pain and difficulty in breathing with mediastinal shift to same side. On auscultation, there is absence of breath sounds over the collapsed area.

X-ray chest confirms the findings of collapse.

Treatment

- Complete bed rest
- Causative factor should be removed immediately
- Bronchoscopic suction
- Antibiotics to control infection
- Deep breathing exercises with physiotherapy helps in better drainage and eration of collapsed lung.

Lung Abscess

Lung abscess may result after aspiration of mucus or blood, as seen postoperatively or due to an impacted foreign body in the bronchi.

Clinical Features

The patient has constitutional features such as fever, malaise, looks unwell and has dyspnea.

Examination shows restricted or no air entry and radiology confirms the diagnosis.

Treatment

- Systemic antibiotics
- Bronchial suction
- Encourage postural drainage
- Lobectomy may have to be done.

Growths of Tracheobronchial Tree

Growths of tracheobronchial tree may be benign such as chondroma, papillomas, angiomas or fibromas.

Malignant growths may be primary or secondary. These are usually squamous cell carcinoma, oat cell carcinoma or adenocarcinoma.

Causes

- Smoking is an important factor
- Gases from burning of diesel, tar, petrol or other chemicals
- Contact with radioactive substances.

Symptomatology

- Slow onset, males 40 to 60 years are affected more
- Persistent cough, dry or may be blood stained
- Loss of weight with discomfort in the chest
- Hemoptysis
- Voice changes
- Wheezing and dyspnea
- On examination, signs of consolidation may be seen
- Vocal cord paralysis may be seen on indirect laryngoscopy (IDL) exam.

X-ray must be done to see consolidation, pulmonary opacity, pleural effusion or emphysema. Computed tomography (CT) scan is also useful.

Diagnosis is confirmed by bronchoscopic biopsy or cytology of secretions.

Treatment

Lobectomy or pneumonectomy is the best method of treatment as radiotherapy only acts as a palliative measure.

Tracheoesophageal Fistula

Tracheoesophageal fistula (**Figure 49.1**) is of two types.

1. Congenital
2. Acquired

Congenital Tracheoesophageal Fistula

- It is associated with atresia of esophagus child presents with regurgitation of all feeds with attacks of coughing, choking and cyanosis on taking feed
- Diagnosis is confirmed by inability of nasogastric tube to pass down and by using contrast, which confirms to fistula
- Treatment is surgical repair by transthoracic approach.

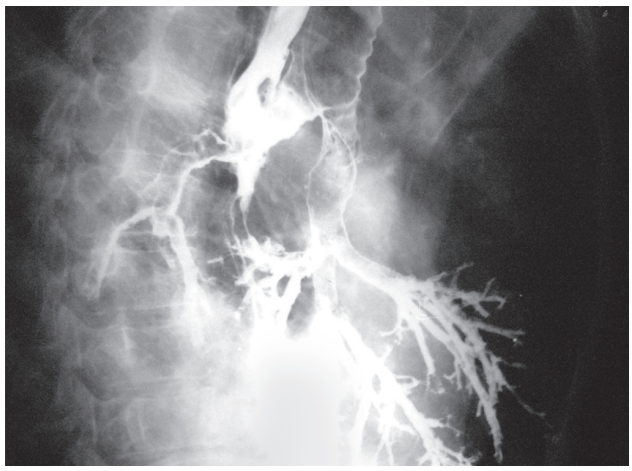


Figure 49.1 Tracheoesophageal fistula on contrast study

Acquired Tracheoesophageal Fistula

- It may occur as a result of malignancy, iatrogenic following rigid endoscopy or trauma due to foreign body or penetrating wound
- Coughing and choking after taking food is the main symptom
- Treatment is by conservative management such as intravenous (IV) fluids, nil orally, Ryle's tube and antibiotics
- Surgical repair is done if indicated.

FOREIGN BODIES IN TRACHEOBRONCHIAL TREE

Tracheobronchial foreign bodies are usually seen in children, which are inhaled into the respiratory tract.

Predisposing Factors

- Laughing, crying or sudden tapping on back, while swallowing, due to sudden indrawing of breath
- Comatosed patients
- Pharyngeal or laryngeal palsies
- Hurried swallowing may cause inhalation of foreign bodies.
- To know which bronchi is more vertical. Remember **mneumonic "Inhale a bite, goes down the right":**

Types of Foreign Bodies

- Vegetable (or organic), e.g. fruit nuts, food particles, peas or groundnuts
- Non-vegetable (or inorganic) such as buttons, metal objects, plastic or glass beads.

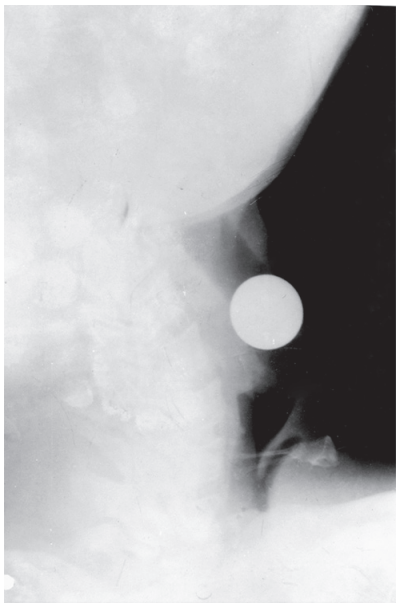


Figure 49.2 X-ray chest showing a foreign body (coin) in respiratory passage

Clinical Features

Sudden onset of cough or a unilateral wheezing should give rise to suspicion of foreign body in tracheobronchial tree.

1. There may be no symptoms at all.
2. At the onset, there may be bout of coughing, dyspnea and wheeze. Cyanosis and death may occur.
3. Once these symptoms settle down, again there may be no symptoms although signs may be present depending upon the nature of foreign body. Vegetable foreign bodies initiate chemical reaction, while metallic foreign bodies may remain silent for a sufficiently long time.
4. Ultimately, later on, it may produce atelectasis of the lung segment leading to lung abscess. Obstructive emphysema occurs if bronchus is partially obstructed by foreign body due to check valve obstruction.
5. Symptoms of tracheobronchitis occur more in cases of vegetable foreign bodies.
6. Tracheal flutter is felt as a click or flap by finger palpation of trachea.
7. Examination of chest may show rales, evidence of emphysema, atelectasis or lung abscess.

Diagnosis

1. History and clinical examination of the patient.
2. Chest X-rays—they may be normal or may show signs of collapse, emphysema or shift of mediastinum due to collapse (**Figure 49.2**).
3. CT scan is also a useful technique.
4. Diagnostic bronchoscopy—remember 'Jackson dictum' — failure to undertake bronchoscopy is more disastrous than the risk involved in doing bronchoscopy.

Differential Diagnosis

- Bronchopneumonia
- Atelactasis
- Diphtheria.

Treatment

1. Antibiotics by IV route.
2. Anti-inflammatory agents like steroids to prevent laryngeal edema.
3. **Heimlich maneuvre** stand behind the patient putting both arms around lower chest and give sudden abdominal thrusts, which pushes the residual air upwards and foreign body may get dislodged.
4. Bronchoscopy is performed for diagnosis as well as removal of foreign body with a grasping forceps.
5. Tracheostomy, when there is dyspnea, stridor or suspected laryngeal edema. Some times, it is done for suction and removal of foreign body through the tracheostomy opening.
6. Thoracotomy has to be done for peripherally located or impacted foreign body, which could not be removed by bronchoscopy.
7. Lobectomy has to be done rarely on long-standing cases of neglected foreign body.

Key Points

1. Most of **tracheal neoplasms** are malignant (90%) with squamous cell carcinoma and adenocarcinoma accounting for the majority.
2. Differential diagnosis of a **bronchial foreign body** includes bronchopneumonia, atelactasis and diphtheria.
3. Important causes of **lung collapse** are new growth, mucus plug or blood clot after trauma.
4. **CT scan** is useful in differentiating between consolidation of lung, pulmonary opacity, pleural effusion and emphysema.
5. **Tracheostomy** is useful in patients with increasing dyspnea, stridor, laryngeal edema or for suction and removal of foreign body through the tracheostomy opening.
6. **Deep breathing with physiotherapy exercises** and postural drainage is important for aeration of collapsed lung and lung abscess.
7. **Hurried swallowing,** comatosed status of patient and pharyngeal or laryngeal palsies may predispose to foreign body ingestion in tracheobronchial tree.
8. **Steeple sign** on X-ray showing narrow subglottis is typical of laryngotracheobronchitis; while thumb sign, dangerous to perform, is seen in acute epiglottitis.
9. The most **common LASER** used in laryngotracheal lesion is CO_2 laser.
10. **Heimlich maneuver** is used for expulsion of foreign body from upper air way.

Section 6 Diseases of Esophagus

Chapter 50

Anatomy and Physiology of Esophagus

Chapter Outline

DEVELOPMENT

It develops at 4th week of intrauterine life (IUL) from differentiation of endodermal lining of foregut.

The most common anomalies, which can develop are as follows.

Congenital Atresia

- Congenital atresia can be with or without tracheo-esophageal fistula
- In 85 percent cases, it is the lower segment of esophagus, which communicates with the trachea
- The anomaly must be recognized as early as possible
- In first 24 hours, the baby presents with attacks of coughing, cyanosis and regurgitation of milk
- It is confirmed by passing a soft catheter, which gets arrested at 10 cm
- Radiologically, it is confirmed by putting dionosil, 1 mL, down the catheter (never use barium) and it should be aspirated after the X-ray
- Defect is corrected by right-sided thoracotomy incision at 5th intercostal space.

Esophageal Stenosis

There is an organic narrowing, which can be treated by repeated dilatation.

Short Esophagus with Hiatus Hernia

In most of the cases, this condition is secondary to reflux esophagitis due to hiatus hernia.

Dysphagia Lusoria

1. In this condition, there is compression of esophagus by an abnormal artery, such as following:
   a. Right subclavian arising from descending aorta, forming vascular rings
   b. By double aortic arch
   c. Patent ductus arteriosus
   d. Abnormal innominate artery (**Figure 50.1**).
2. Diagnosis is confirmed by barium swallow, which shows posterior indentation of esophagus or by arteriography.
3. Treatment is done by a thoracic surgeon. A left thoracotomy is done and abnormal vessel is divided or transposed.

SURGICAL ANATOMY OF ESOPHAGUS

- Esophagus is a muscular tube connecting the lower part of pharynx to the stomach.
- It is approximately **25 cm long, extending from 6th cervical vertebra (lower border of cricoid cartilage) to 11th thoracic vertebra** where it ends at the cardiac end of stomach.

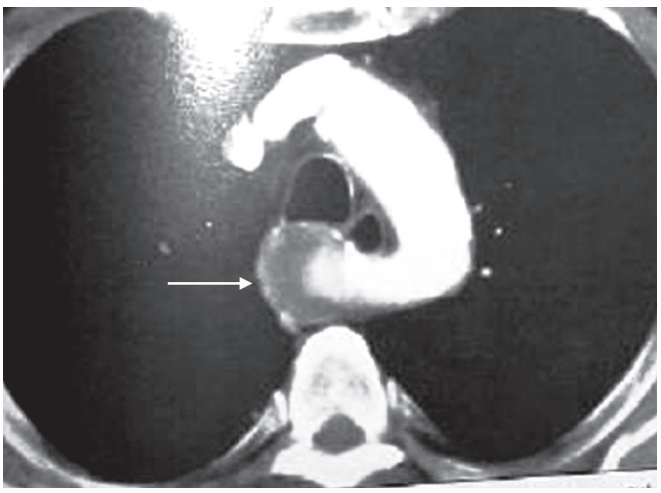


Figure 50.1 Axial CT scan showing aberrant right subclavian artery causing dysphagia lusoria

- Lower 4 cm of esophagus lies below the diaphragm.
- In newborn, length is 8 to 10 cm and diameter is 5 mm
- Whereas in adult, it is 25 cm and diameter is 20 mm at rest and may increase to 30 mm.
- It is in the midline at the beginning, deviating to the left side at the root of neck.
- It again passes to the midline till 7th thoracic vertebra and then again it deviates, to the left side till it passes through the diaphragm.
- Two high pressure zones exist in esophagus, i.e. upper and lower esophageal sphincter each about 3 to 5 cm in length.

Constrictions in the Esophagus

- At 15 cm from upper incisor, at 6th cervical vertebra, i.e. cricopharyngeus level
- At 25 cm from upper incisor, where it is crossed by aortic arch at 4th thoracic vertebra
- At 27 cm from upper incisor, crossed by left main bronchus at 5th thoracic vertebra level
- At 40 cm, where it pierces the diaphragm at the level of 10th dorsal vertebra (**Figure 50.2**).

Significance of these constrictions is that the endoscopist has to be careful at these levels, while negotiating to remove foreign bodies, which are most likely to stick at these levels to avoid esphageal perforation (**Table 50.1**).

Walls of Esophagus

Walls of esophagus has four layers.

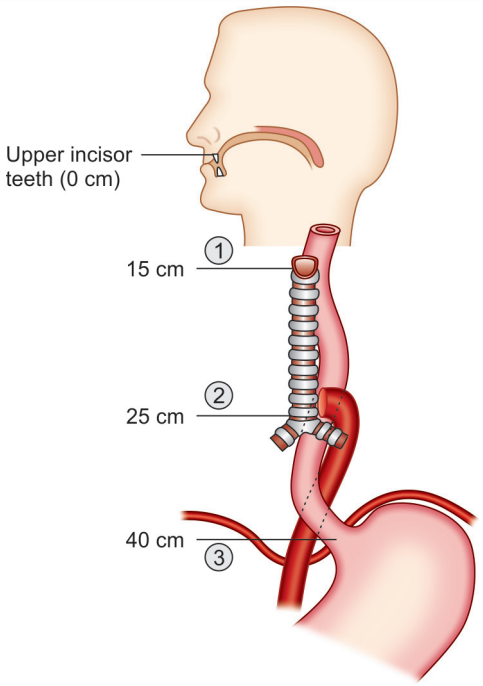


Figure 50.2 Levels of normal constrictions

Mucous Membrane

1. Mucous membrane is nonkeratinizing, stratified squamous epithelium
2. It is in the form of longitudinal folds, which disappear on distension.

Submucosa

Submucosa contains the blood vessels and Meissner's nerve plexus along with esophageal glands, which lubricate the mucosa.

Muscular Coat

- Muscular coat consists of outer longitudinal and inner circular coat
- Longitudinal coat is thicker, while circular fibers are continuous with cricopharyngeus, which is a part of inferior constrictor muscle
- In upper third muscle fibers are striated, nonstriated in lower one-third and mixed in middle part of esophagus.

Fibrous Coat

- Fibrous coat consists of irregular, dense connective tissue containing elastic fibers

Table 50.1: Important relations of esophagus

Relation	*Cervical*	*Thoracic*	*Abdominal*
Front	Trachea; recurrent laryngeal neuropathy (RLN)	Trachea; right pulmonary artery, left bronchus, pericardium and diaphragm	Post-surface of left lobe of liver, peritoneum
Behind	Vertebrae with muscles and prevertebral fascia	Vertebrae with muscles, thoracic duct, azygos vein, right posterior intercostal artery	Left crus of diaphragm, phrenic artery, vagus nerve (variable relation)
Lateral	Common carotid vessels, thyroid gland and thoracic duct on left side	Left: aortic arch Subclavian (SC) artery Thoracic duct left RLN	Right: right pleura Azygos vein right vagus

Table 50.2: Blood supply nerve supply and lymphatics of esophagus

	Cervical	*Thoracic*	*Abdominal*
Blood supply	Inferior thyroid branch of left subclavian	Branches of descending aorta, bronchial arteries, intercostal arteries	Branches of left gastric artery, left inferior phrenic artery, abdominal aorta branch
Veins	Inferior thyroid vein	Azygos vein	Azygos and left gastric vein (portal and systemic veins anastomosis takes place here)
Nerve supply	Recurrent laryngeal nerve Sympathetics from plexus around inferior thyroid artery splanchnic nerve	• Vagal trunk • Esophageal plexus greater splanchnic nerve	Vagal trunk • (Anterior and posterior gastric nerves) • Greater and lesser • Sympathetic trunk
Lymphatics	Deep cervical lymph nodes and paratracheal nodes	Post-mediastinal nodes and tracheobronchial nodes	• Left gastric nodes • Left thoracic duct directlye

- Blood supply, nerve supply and lymphatics of esophagus (**Table 50.2**).

PHYSIOLOGY OF DEGLUTITION

Deglutition is the process by which a bolus, liquid or solid, is transferred from buccal cavity to the stomach. Deglutition process involves three phases.

Oral Phase

- In this stage, the anterior part of tongue is raized and pressed against the hard palate; by this process, bolus passes posteriorly
- Movements of the tongue are affected by longitudinal and transverse muscles of tongue
- Hyoid bone moves forward and upward and becomes fixed due to hyoid bone muscles such as geniohyoid, myelohyoid and digastric
- Styloglossus elevates the posterior part of tongue; and by approximation of anterior pillars, bolus passes into the oropharynx through oropharyngeal isthmus
- Nasopharynx is closed by raising of soft palate with the posterior pharyngeal wall.

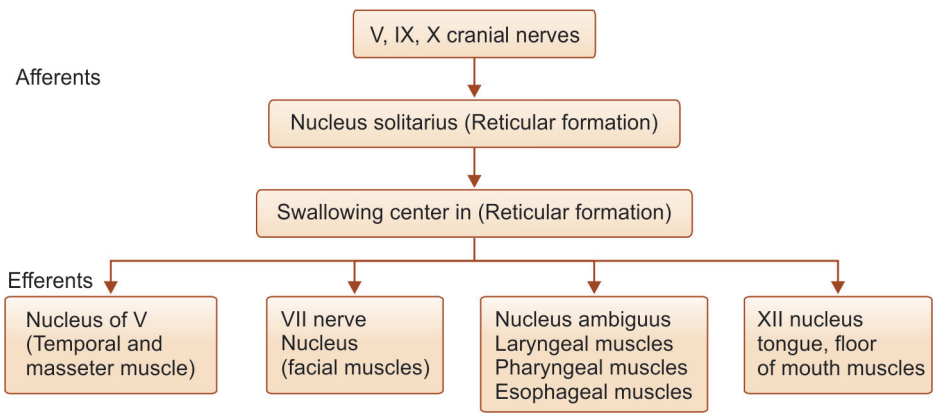
Pharyngeal Phase

- Due to contraction of superior constrictor and palatopharyngeal sphincter, the bolus cannot pass up into nasopharynx
- Further, the larynx is drawn upwards behind the hyoid bone and there is approximation of aryepiglottic folds, thus closing the larynx
- Due to influence of gravity and contraction of constrictors, bolus slips over the posterior aspect of epiglottis to reach the lower end of pharynx
- Palatopharyngeus muscle pulls the pharynx upwards, shortens it and bolus passes into lateral food channel through pyriform sinus into the esophagus
- In recurrent laryngeal nerve palsy, inlet of larynx is not closed; hence, spill over of food into larynx may take place.

Esophageal Phase

- Cricopharyngeal sphincter is normally closed at rest
- When swallowing occurs, it relaxes but does not open
- The bolus passes through it by means of thrust from the tongue assisted by gravity

Flowchart 50.1 Outline of reflex of swallowing



- As soon as the bolus enters esophagus, peristaltic waves start at the upper part of pharynx and move rapidly and smoothly downwards pushing the bolus through esophagus
- Secondary peristaltic waves arise locally in the esophagus in response to distension, thus transporting the bolus further down
- Tertiary esophageal contractions are irregular, non-propulsive contractions, which occur during emotional stress.

NERVOUS CONTROL OF DEGLUTITION

Auerbach's plexus carrying sympathetic fibers lies between the muscular layers. Recurrent laryngeal nerve supply the striated muscles of upper third, while nonstriated fibers are supplied through vagus nerve.

An adult swallows 600 times/day with 50 swallows during sleep and 200 during eating. Swallowing depends on peripheral stimuli from oropharynx, as well as messages from higher centers (**Flowchart 50.1**).

SYMPTOMATOLOGY OF DISEASES OF ESOPHAGUS

Difficulty in Swallowing

- Difficulty in swallowing is called dysphagia, while pain during swallowing is called odynophagia, which is usually due to esophagitis
- In patients of dysphagia, always enquire if the act of swallowing can be initiated or there is some reluctance to swallow, because of inflammation of throat or because of laryngeal incompetence
- It should be enquired, whether there is sticking of food in the throat or low down
- Also, find if there is difficulty in swallowing solids or liquids or both
- Whether it is progressive in nature
- In weak sphincters, the liquids are more difficult to swallow than solids.

Regurgitation

- Regurgitation is important to clarify, whether there is forceful vomiting of gastric contents or a gentle regurgitation of undigested food indicating, a dilated viscus above an obstruction such as cardiac achalasia or cardiospasm
- Heartburn usually occurs due to gastric contents spill over into esophagus through failure of lower esophageal constriction, to work efficiently (seen in sliding type of hernia).

Pain

Pain occurs due to ulcerative lesion of esophagus, or it may be a spasmodic pain associated with neuromuscular and obstructive lesions, while swallowing solid food.

Bleeding

It may occur in portal hypertension, inflammatory lesions or neoplastic lesions of esophagus.

Respiratory Symptoms

- Attacks of bronchitis or bronchopneumonia due to laryngeal spill over or tracheoesophageal fistula
- Hoarseness, due to vocal cord palsy in the absence of bronchial tumor should arouse suspicion of esophageal lesions.

General Symptoms

- Loss of weight
- General malaise
- Tiredness due to anemia.

PHYSICAL EXAMINATION OF PATIENT

- Examination of chest, abdomen and liver, CVS, CNS
- Evidence of wasting, weight loss, dehydration, anemia, palpable lymph nodes, spider naevi, ascites and pooling of secretions in pyriform sinus
- Laryngeal crepitus, if absent, points towards postcricoid growth
- Vocal cord palsy.

DIAGNOSTIC HELPS IN DYSPHAGIA

Radiological Techniques

- Plain chest X-ray, neck for displacement of mediastinum, aortic aneurysm, shape and size of heart, enlargement of left atrium in mitral valve disease causing compression of esophagus.
- Lateral soft tissue neck X-ray for prevertebral shadow, which if more than the size of body of vertebra indicates postcricoid growth, cellulitis or abscess (**Figure 50.3**). Surgical emphysema suggests a perforation of esophagus.
- Barium swallow study is important to see the type and extent of lesion (**Figure 50.4**).
- Computerized tomography (CT) scan of neck and thorax to detect a space-occupying lesion.

Endoscopy

Endoscopy may be rigid or flexible fiberoptic endoscopy. It helps to confirm the radiological findings and to take a biopsy of the growth.

Hematological Investigations

- Hb TLC and PBF to see type of anemia
- FBS
- VDRL.

Manometry

Manometry measures the pressure in the esophagus and is a good technique in evaluation of esophageal disorders. A catheter incorporating pressure transducers, at various intervals along its length is positioned in the esophagus. With each swallow strength timing and sequencing of pressure events in esophagus are recorded.

pH Measurement

pH measurement helps to find out the gastroesophageal reflux. A special pH electrode is placed in the lumen of esophagus and pH is recorded.

Other Tests

Other tests includes acid clearing, Bolus scintigraphy, video-fluoroscopic swallowing study (VESS) acid perfusion tests and technetium-99 scanning.

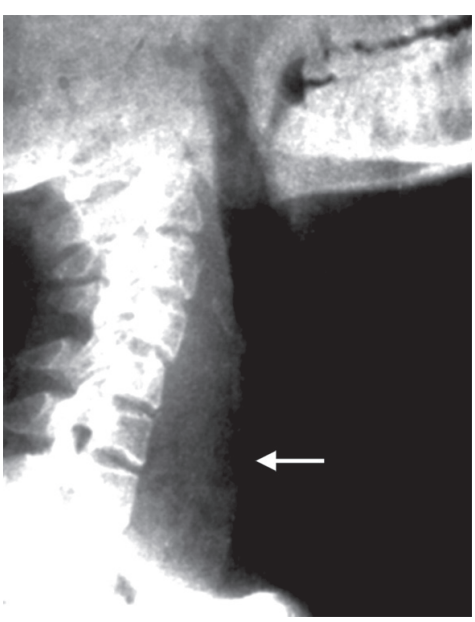


Figure 50.3 Neck X-ray lateral view with increased prevertebral shadow

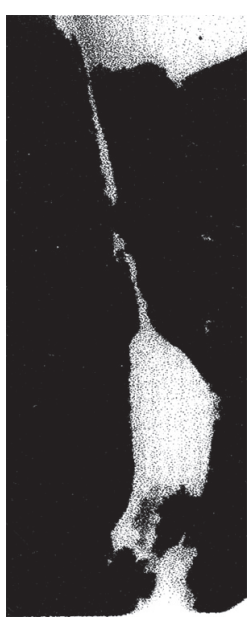


Figure 50.4 Barium swallow study of esophagus

Key Points

1. **Esophagus is 25 cm** long with 20 mm diameter at rest, starts at 6th cervical vertebra and ends at 11th thoracic vertebra.
2. **Various constrictions** in the esophagus are:
   - C—Cricopharynx : 15 cm from upper incisor—C6
   - A—Aortic arch : 25 cm from upper incisor—T4
   - L—Left bronchus : 27 cm from upper incisor—T5
   - D—Diaphragm : 40 cm from upper incisor—T10
3. **Dysphagia lusoria** may be caused by right aberrant subclavian artery, double aortic arch, persistent ductus arteriosus or abnormal innominate artery.
4. On X-ray, **soft tissue neck lateral view,** if prevertebral shadow is more than the size of body of vertebra, it indicates postcricoid growth or abscess in that area.
5. **Regurgitation of food** back into esophagus does not occur due to:
   - Pinchcock effect of diaphragm
   - Esophagogastric angle
   - Esophagogastric sphincter
   - Negative intrathoracic pressure.

Chapter 51 Disorders of Esophagus

Chapter Outline

FOREIGN BODIES IN ESOPHAGUS

- Foreign bodies esophagus is one of the most common emergency seen in ear, nose and throat (ENT) practice.
- Many types of foreign bodies can be swallowed by the different subjects.
- Its incidence is seen more in young children and also in edentulous old patients with poorly fitting dentures and psychiatric patients.
- The most common foreign bodies seen are coins, bones, open safety pins, dentures and lumps of meat (**Figures 51.1A and B**).
- The most common sites for impaction of foreign bodies are at the level of cricopharyngeus, at the level of arch of aorta, hiatus or at the level of benign or malignant strictures.

Clinical Features

- History of swallowing a foreign body is usually present.
- There is discomfort, excessive salivation and total dysphagia. Sharp objects may give signs and symptoms of mediastinitis.
- The patient often points towards the site of impaction of foreign body, particularly if it is lodged in the upper part of esophagus.
- When it is in the lower or middle third, pain may be referred to the back or behind the sternum. Pain is of sharp and cutting nature and occurs at the same site on swallowing.
- Pain occurs due to mechanical reasons or due to inflammatory reaction and spasm.
- Respiratory symptoms may appear subsequently due to regurgitation of food or saliva.

Examination

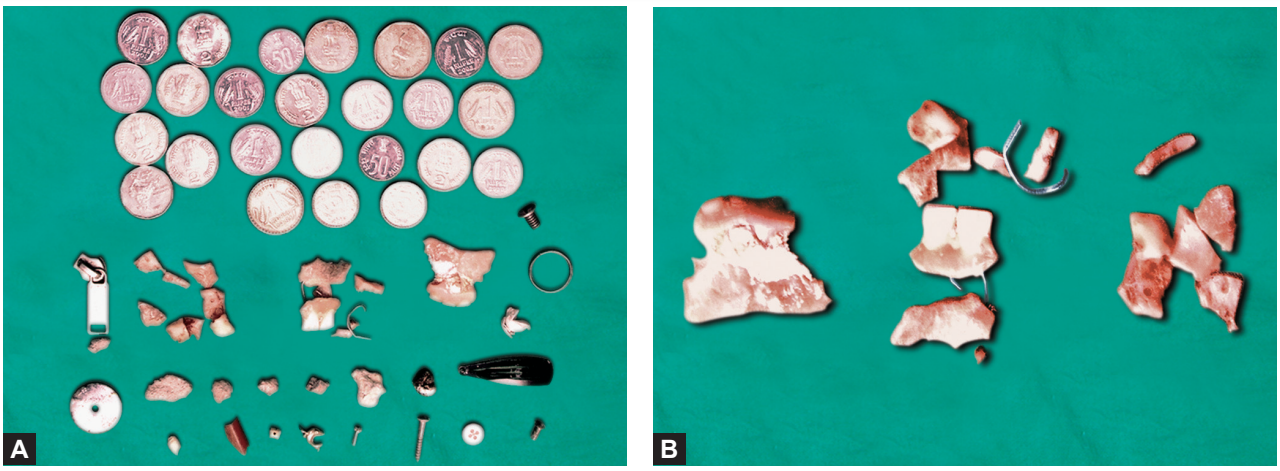
Oropharynx, base of tongue and tonsillar areas should be examined for any foreign body or signs of inflammation. Indirect laryngoscopy (IDL) examination should be done to see any foreign body or excessive pooling of saliva in pyriform sinus. Surgical emphysema may appear, if perforation has taken place.

Radiological Examination

- Lateral view X-ray neck esophageal foreign bodies lie in coronal plane, where as laryngotracheal foreign bodies are seen in a sagittal plane
- X-ray chest posterior-anterior (PA) view
- Screening may be helpful to localize the foreign body by using a thin barium paste
- Esophagoscopy is both a diagnostic as well as a therapeutic procedure (**Figures 51.2A to C**).

Treatment

- Spontaneous expulsion of foreign body is very rare
- Best management is removal of foreign body



Figures 51.1A and B Common foreign bodies

Esophagoscopy under local or general anesthesia.

- A recent X-ray is a must before undertaking esophagoscopy. Esophageal speculum or esophagoscope is introduced, foreign body located and grasped with an alligator forceps. Sharp objects are removed very carefully without causing damage to the walls of esophagus.
- If foreign body is impacted badly, it has to be extracted by cervical esophagotomy or transthoracic esophagotomy approach.
- A foreign body, if passes to the stomach normally passes in the stools without any problem and in such cases stool examination and serial X-rays abdomen should be taken.

Complications

- Periesophageal abscess
- Esophagitis
- Mediastinal emphysema
- Mediastinitis
- Pneumothorax
- Pleural effusion
- Tracheoesophageal fistula
- Esophageal stenosis.

CORROSIVE BURNS OF ESOPHAGUS

- Corrosive burns of esophagus may be accidental or suicidal and the usual agents are caustic soda, acids, silver nitrate and phenol
- These cause deep necrosis and ulceration of all layers of esophagus causing subsequent scarring, stricture and perforation
- Patient presents with burns of lips, oral cavity, severe pain and shock. Laryngeal edema and airway obstruction.

Treatment

- IV fluids
- Pain killers
- Antibiotics
- Corticosteroids
- Nasogastric tube feeding
- Tracheostomy if required
- Esophagoscopy.

Management of Stricture

By repeated endoscopic dilatation or by cervical esophagogastrostomy or colon/jejunal interposition.

GASTROESOPHAGEAL REFLUX DISEASE

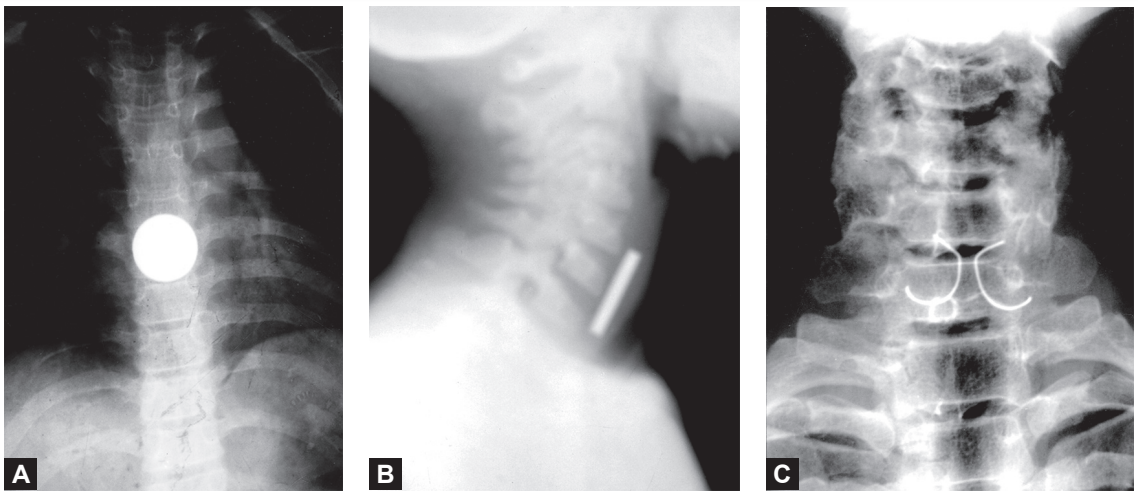
Gastroesophageal reflux disease (GERD) is abnormal reflux regurgitation of stomach contents into esophagus through the relaxed cardiac sphincter. Exact cause is not known, but may be due to changes in pressure relationship between lower esophagus and stomach. This may be due to increased intra-abdominal pressure or relaxation of lower esophagus or may be spontaneous with delayed emptying of stomach.

Clinical Features

Patient may present with symptoms of pharyngitis, foreign body sensation in throat laryngitis, irritating cough, change in voice, laryngospasm, burning sensation esophagus.

Diagnosis

- pH monitoring
- Manometry to measure pressure in lower esophageal sphincter



Figures 51.2A to C (A) X-ray foreign body esophagus—coin AP view; (B) Lateral view; (C) X-ray foreign body esophagus—denture wire (AP view)

- Bernstein test also called acid perfusion test, which tests the acid sensitivity of esophagus
- Endoscopy.

Treatment

- Raising head end of the bed
- Diet and weight control
- Drugs like cimetidine, omeprazole, cisapride.

PERFORATION OF ESOPHAGUS

The causes of perforation of esophagus may be as follows.

Iatrogenic

Endoscopy

Even in expert hands, perforation may take place through posterior thin wall of pharynx or the wall may be crushed between the shaft of instrument and rigid osteoarthritic cervical spine.

Esophageal Dilatation

With bougies may cause rupture above the stricture.

Biopsy

Deeper biopsy from the growth may lead to perforation.

Foreign Bodies

A sharp foreign body, such as denture or safety pin, may cause perforation of wall of esophagus.

Suicidal

Cut throat or gunshot injuries, etc.

Clinical Features

- Pain on swallowing fluid or saliva.
- Fever and retrosternal pain are ominous signs of a possible perforation
- Dyspnea, fever, cardiorespiratory embarrassment.
  - X-rays of neck and chest reveal air in mediastinum, pleural cavity or in the neck.
  - Barium study helps to locate the site of perforation.
  - *Mackler's triad:* Chest pain, vomiting and subcutaneous emphysema, seen in 14 percent of patients.
  - *Hamman's sign:* Crunching or rasping sound audible with each heartbeat indicative of air in the mediastinum.

Management

Conservative Management

It includes:
- Broad-spectrum antibiotics
- IV fluids (nothing orally)
- Ryle tube feeding.

Surgical Management

- If cervical esophagus is perforated, an incision along the anterior border of sternomastoid with retraction of carotid sheath gives access to the site of perforation which is sutured in two layers

- If mid or lower esophagus is involved, a thoracotomy must be performed to repair the defect
- In delayed case drainage of infected area is done
- Mortality is more than 51 percent, if treatment is delayed for more than 24 hours.

Complications

Death occurs due to septicemia or its sequelae such as hepato-renal failure and disseminated intravascular coagulation.

HIATUS HERNIA

Hiatus hernia may be defined as **displacement of stomach up through the esophageal hiatus of diaphragm** into the lower mediastinum. This disease is seen in persons over 51 years of age and more so in fatty, fertile, females of 50 years when gallstones, diverticulitis may also be associated with hiatus hernia.

Various Types

Sliding Type (85%)

In sliding type, gastroesophageal junction ascends into the chest resulting in gastroesophageal reflux.

Rolling Type (5%)

A portion of stomach rolls up along the side of esophagus through an enlarged hiatus (paraesophageal).

Mixed Type (10%)

Both suding and rolling types are seen in this.

Clinical Features

- Heartburn on bending or lying flat
- Retrosternal discomfort
- Nausea and vomiting
- Dysphagia due to muscular spasm or motility disorder (**Table 51.1**)
- In paraesophageal type, symptoms are due to anemia, abdominal discomfort, dyspnea and pseudoangina.

Diagnosis

- Lateral X-ray of chest may show gas shadow behind the heart
- Fluoroscopic studies using contrast barium also help to confirm the diagnosis
- Manometric and pH studies also help
- Esophagoscopy is done to see the degree of esophagitis.

Barrett esophagus is the esophagus lined by gastric type of mucosa producing hydrochloric acid.

Management

- Asymptomatic—no treatment
- Symptomatic.

Medical Management

- Head of bed should be raised and avoid bending
- Weight control
- Avoid heavy meals, alcohol and tobacco
- Antispasmodics and antacids (H_2 receptor antagonists such as cimetidine).

If this treatment fails for 6 months, surgical treatment is indicated.

Surgical Management

The aim of surgical treatment is to put the gastroesophageal junction below the diaphragm at its normal anatomical position and also to prevent reflux mechanism.

Approaches
- Thoracic approach (better results)
- Abdominal approach.

Various operations:
- **Belsey Mark IV operation:** A posterolateral thoracotomy is made through 8th rib and size of hiatus ring is reduced. A valve is created at gastroesophageal junction to prevent reflux.
- **Nissen fundoplication:** It may be done through chest or abdomen. In this operation, fundus of stomach is wrapped around the lower 5 cm of esophagus.
- **Leigh-Collis gastroplasty:** It is also performed through thoracoabdominal approach.

STRICTURES OF ESOPHAGUS

Stricture may be congenital, traumatic, benign or malignant.

Benign Strictures

They are caused by:
- Reflux esophagitis
- Ingestion of caustic substances
- Postoperative Ryle tube
- Drugs causing esophagitis, e.g. potassium with antidiuretics or antiarthritic drugs.

Malignant Strictures

They usually follow malignant growths of esophagus.

Table 51.1: Causes of dysphagia

Oropharyngeal causes	*Laryngeal causes*	*Neuromuscular*	*Functional*
• Quinsy	• Advanced laryngeal cancer	• Neuritis	• Globus hystericus
• Trismus	• Laryngeal edema	• Jugular foramen syndrome	
• Tumors		• Motor neuron disease	
• Retro and parapharyngeal abscess			

Esophageal causes	
Causes in the wall	*Causes outside the wall*
• Aphthous ulcers	• Retrosternal goiter and carcinoma thyroid
• Ludwig angina	• Enlarged heart
• Paralytic lesions	• Bronchogenic carcinoma
• Cleft palate	• Aortic aneurysm
• Impacted molar	• Pharyngeal pouch
• Foreign bodies	• Cervical lymph node metastasis
• Pharyngeal pouch	• Cervical spondylosis
• Plummer-Vinson (PV) syndrome	• Myasthenia gravis
• Koch abscesses	• Central lesions
• Syphilis	
• Congenital stricture and web	
• Tracheoesophageal fistula	
• Esophagitis	
• Spasm and diverticulae	
• Tumors	
– Benign	
– Malignant	
• Esophageal varices	

Note: Investigations, D/D and management has already been discussed

Clinical Features

Dysphagia, loss of weight, anemia or pain if chronic ulcer is present.

In corrosive strictures, the greatest damage occurs to the oral cavity or lower third of esophagus and the real danger comes from laryngeal edema, disturbed acid base equilibrium, bronchopneumonia.

Investigations

- Chest X-ray for mediastinal lesion
- Barium swallow (**Figure 51.3**)
- Endoscopy.

Treatment

Benign strictures are treated by bougienage.

Types of bougies are:

- Hurst or Maloney mercury bougies.
- Chevalier Jackson bougies.
- Eder-Puestow type of dilators are passed over a fine wire guide placed in position with fiberoptic esophagoscope.

If the bouginage therapy fails, surgical treatment in the form of resection of segment with reconstruction using colon, jejunum or stomach may be undertaken.

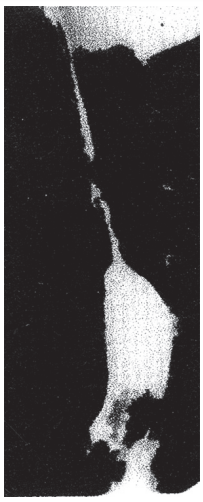


Figure 51.3 Barium swallow study showing stricture esophagus

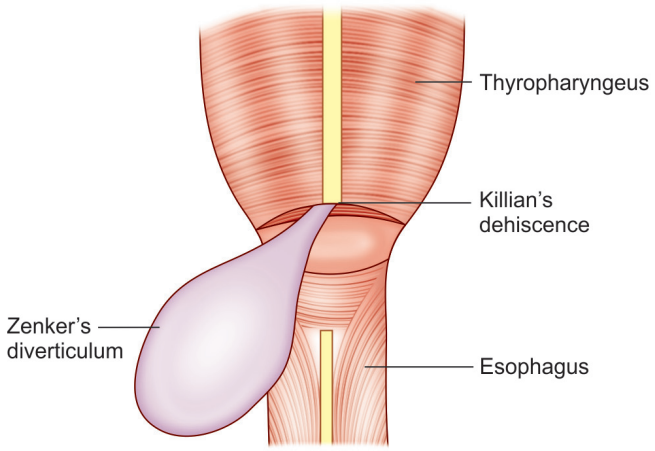


Figure 51.4 Zenker diverticulum

DIVERTICULAE OF ESOPHAGUS

These may be upper, mid or low esophageal diverticulae.

Upper Esophageal Diverticulae

The diverticulae which protrudes between the oblique and horizontal fibers of inferior constrictor muscle, is called Killian dehiscence. It will be better called pharyngeal pouch (**Figure 51.4**).

Clinical Features

Regurgitation, dysphagia, weight loss, voice changes due to overflow of sac contents into the larynx causing chemical irritation and laryngitis (or it may be because of pressure of sac on recurrent laryngeal nerve).

On Examination

The patient is emaciated, neck may show a swelling on left side in anterior triangle, which is soft and gurgles on palpation (**called Boyce sign**).

Contrast radiography confirms the diagnosis.

Treatment

Dohlman operation—endoscopic dilatation of cricopharyngeal sphincter with diathermy of diverticuloesophageal septum.

Diverticulectomy—by external surgical approach.

Mid Esophageal Diverticulae

Mid esophageal diverticulae are of traction type discovered on barium swallow study.

Low Esophageal Diverticulae

Low esophageal diverticulae are also referred to as para-diaphragmatic diverticulae and may be associated with hiatus hernia and esophageal spasm.

Treatment

- Long segment myotomy to overcome motility disorders
- Diverticulectomy is not done unless it has a narrow neck.

SPASMODIC CONDITIONS OF ESOPHAGUS

- *Localized:*
  - Plummer-Vinson syndrome.
  - Cardiac achalasia.
- *Diffuse:*
  - Cork screw esophagus, in which the patient is usually of nervous disposition, above 60 years of age and is treated by cholinergic antagonists and dilatation.

Plummer-Vinson Syndrome

In Plummer-Vinson syndrome, there is progressively increasing dysphagia to solids with hypochromic microcytic anemia. Paterson-Brown-Kelly (1919) described this syndrome first followed by Plummer and Vinson (1921). It is seen in the middle-aged females and is a precancerous condition.

Causes

- Iron deficiency
- Vitamin deficiency
- Autoimmune diseases.

Clinical Features

- Middle-aged women, complaining of dysphagia
- Smooth pale tongue devoid of papillae
- Cracked lips of corners of mouth
- Spoon-shaped brittle nails (koilonychia)
- Enlarged spleen (due to iron deficiency)
- Bone marrow devoid of iron stores
- Blood shows picture of hypochromic anemia
- Achlorhydria
- Dysphagia due to spasm of cricopharyngeal sphincter associated with the formation of webs.

Investigations

- Hemogram shows hypochromic microcytic anemia
- Barium swallow shows cricopharyngeal web
- Esophagoscopy confirms the presence of web and helps in taking a biopsy from suspicious area
- On gastric analysis, achlorhydria is found.

Treatment

- Iron supplements with vitamins orally, IM or IV route
- Dilatation of the cricopharyngeal sphincter and excision of web
- Sometimes, blood transfusion may be given, if there is severe anemia
- Ryle tube and liquid diet may help in regeneration of desquamated mucous membrane of esophagus
- Regular follow-up, to rule out development of postcricoid growth.

Nut Cracker Esophagus

- There are present high amplitude peristaltic esophageal contractions
- Patient presents with chest pain and high manometeric esophageal pressure of 180 mm of Hg.

Barret Esophagus

There occurs metaplasia of lining mucosa of lower third of esophagus to columnar epithelium due to GERD. It carries a risk of adenocarcinoma 40 times more. Mucosa looks markedly red on examination. Treatment of the cause, i.e. GERD is done.

Cardiac Achalasia

Cardiac achalasia is a condition in which there is failure of relaxation of lower esophageal sphincter during deglutition and this may be due to failure of integration of parasympathetic impulses which results in disorganized esophageal peristalsis.

It is also a precancerous condition. The exact cause is not known but may be due to degeneration of Auerbach's plexus, leading to incoordination of peristalsis causing failure of relaxation of sphincter and thereby, retention of food takes place in lower esophagus.

Clinical Features

- 40 years females
- Insidious onset
- Regurgitation of undigested food after many hours
- Retrosternal discomfort
- Foetid flatulence
- Aspiration pneumonitis
- Ill health, weakness and loss of weight
- Radiological findings: These are—a smooth, pencil-shaped narrowing of lower segment, dilatation and tortuousity of lower esophagus, lack of gas bubble in stomach and incoordinated peristalsis.
- Esophagoscopy: Esophagoscope appears to have entered a gaping cave filled with dirty water, which taps with respiration.

Treatment

- Anticholinergic drugs orally before meals.
- Esophageal dilatation of sphincter with Hurst mercury bougies.
- Surgical relaxation of sphincter by cardiomyotomy.
  - Heller's operation (Esophagocardiomyotomy): About 8 to 10 cm long, anteriorly placed incision is given through longitudinal and circular muscle fibers of esophagus down to the mucosa, which will then point through the divided muscle.

Globus Hystericus

Globus hystericus is a functional disorder of females, in which the patient complains of a feeling of lump in the throat. It is mostly due to psychological problems or fear of having cancer. Clinical examination reveals no abnormal findings.

It is treated by assurances to the patient that there is no serious disease and the patient may further require psychiatric consultation.

GROWTHS OF ESOPHAGUS

Benign Growths

Benign growths are not commonly seen and form only 10 percent of the esophageal neoplasms. These are seen in younger age group and the most commonly seen lesions are leiomyoma, polyps or cysts of esophagus. These benign lesions are confirmed on endoscopy and barium swallow study. Treatment is resection of the tumor by thoracotomy approach and followed by reconstruction.

Malignant Growths

These are commonly seen in men between 51 and 70 years of age and high incidence is seen in Japan, China and South Africa. Predisposing factors may be cigarette smoking, alcohol consumption, ingestion of nitrosamines or damaged esophagus by corrosives.

Various types may be infiltrative, ulcerative or proliferative type.

- Squamous cell carcinoma (most common)
- Adenocarcinoma, fibrosarcoma and leiomyosarcoma are less common tumors.

Spread of tumor takes place by local extension within the lumen to trachea, aorta and pericardium. Lymphatic spread occurs to periesophageal, cervical, supraclavicular and mediastinal lymph nodes. Hematogenous spread may occur to the liver, lungs and bone.

Clinical Features

- Dysphagia of progressive nature, first for solids and then for liquids
- Regurgitation (pseudovomiting)
- Anorexia
- Pain is a late feature
- Respiratory symptoms such as cough or hoarseness of voice due to involvement of recurrent laryngeal nerve.

Diagnosis

- Diagnosis is made by clinical history and examination
- **Radiological examination:** Barium swallow study of esophagus shows irregular filling defect or stricture. Mucosal destruction and typical 'Rat-tail deformity' can be seen in advanced carcinoma of mid and lower third of esophagus
- Esophagoscopy and biopsy confirms the diagnosis
- Ultrasound to exclude secondaries from liver
- Exfoliative cytology is lavage of esophagus and examination of fluid for malignant cells.

Management

Management can be:

- Curative
- Palliative—which means just to decrease the symptoms of the disease.

Curative treatment is carried out if the growth is in the early stage and the patient is fit to undergo operation.

- **Postcricoid carcinoma:** Best treatment is:
  - Radiotherapy 6000 to 7000 rads in 6 to 7 weeks
  - Pharyngolaryngectomy with gastric transposition or colon transposition.
- **Carcinoma upper one-third esophagus:**
  - Because the patient usually comes late, best treatment is radiotherapy.
  - Mckeown three stage esophagectomy with anastomosis of fundus of stomach to cervical esophagus.
- **Carcinoma middle one-third esophagus:**
  - Radiotherapy is preferred.
  - Esophagogastrectomy with anastomosis above the level of aortic arch.
- **Carcinoma lower one-third esophagus:**
  - Esophagogastrectomy through thoracoabdominal incision
  - Jejunal Roux-en-Y loop: It involves two anastomosis and is used to prevent bile and pancreatic juice entering the esophagus
  - Transverse colon interposition.

Complications of surgery may be:

- Postoperative shock and hemorrhage
- Myocardial infarction and atrial fibrillation
- Breakdown of anastomosis causing fistula formation
- Distension, malnutrition, loss of appetite, infection of chest and urinary tract infection (UTI).

Palliative treatment

It is carried out in cases where the patient is not able to undergo major surgical procedure, growth is inoperable or in cases of extensive metastasis.

Palliative treatment enables the patient to swallow.

- Tube is inserted into the esophagus through the growth.

  Various tubes are:
  - Souttar tube (coiled German silver wire)
  - Celestin tube (armoured rubber tube with a long tail)
  - Livingstone type
  - Atkinson type
  - Mousseau barbin type.

  These tubes are not suitable for growth of upper end of esophagus because of causing laryngeal irritation.

  Palliative short circuit operation with radiotherapy.

LASER: Neodymium-doped yttrium aluminum garnet(Nd:YAG) LASER is being used to vaporize tumor tissue for palliation only.

How patient dies in carcinoma esophagus?

- Pneumonitis due to perforation in tracheobronchial tree
- Progressive cachexia and dehydration
- Mediastinitis
- Erosion of aorta.

Key Points

1. The most common **site for impaction** of esophagus foreign body is at the level of cricopharynx, the length of which varies between 3 cm and 5 cm.
2. The most common site of **esophageal perforation** is Killian dehiscence, which is also called 'Gateway of tears'.
3. **Acute sudden pain** being referred to back in the interscapular region, fever, dyspnea and emphysema in the neck point to esophageal perforation.
4. **Barrett esophagitis** is a precancerous condition.
5. **Plummer-Vinson syndrome**, usually seen in females, is associated with dysphagia, severe anemia, koilonychia, achlorhydria and is a precancerous condition.
6. In **cardiac achalasia**, there is dysphagia to liquids, whereas in carcinoma esophagus there is dysphagia to solids.
7. Barium swallow shows **pencil tip appearance** in achalasia cardia and rat-tail appearance with mucosal destruction in carcinoma esophagus.
8. The most common cause of **esophageal perforation** is rigid esophagoscopy.
9. **Rosary bead appearence** in barium swallow study is due to diffuse esophageal spasm.
10. **Hurst mercury bougies** are used for dilatation of stricture esophagus.
11. Most commonly **secondary deposits** in the esophagus are from the breasts and not the lungs.
12. In **low grade cancer**, cancer cells look like normal cells while in high grade cancer cells resemble abnormal cells and grow quickly.
13. **Schatzki's ring** forms at the junction of squamous and columnar epithelium at the lower end of esophagus causing dysphagia in old age.

Section 7 Diseases of Head and Neck

Chapter 52 Thyroid Gland

What Students Must Know!

- **Surgical Anatomy**
  - Functions of Thyroid Gland
  - Hypothyroidism
- **Thyroid Swelling**
- **Thyrotoxicosis**
- **Management of Thyroid Swelling**
  - Solitary Nodule
  - Subtotal Thyroidectomy
  - Steps of Operation
- **Malignancies of Thyroid Gland**

INTRODUCTION

1. It is an endocrinal gland, which overlies the anterior and lateral surface of trachea.
2. In Greek, *thyroeides* means shield like.
3. Sometimes thyroid gland may not be present at all or may be partly present at its normal site.
4. Lingual thyroid is a term used, when it is present at the base of tongue (**Figure 52.1**). In such situations, it is mandatory to check the normal thyroid functions, before contemplating any procedure on the abnormal thyroid.

SURGICAL ANATOMY

- It consists of two lobes connected to each other by isthmus and lies opposite to 2nd to 4th tracheal rings (between 4th and 6th cervical vertebrae)
- Each lobe measures 4 × 2 × 0.2 cm in size at the upper part of isthmus and the total weight of the gland is 20 to 25 g
- Thyroid gland is covered with pretracheal part of cervical fascia forming the surgical capsule
- The upper tough thickened part of fascia is called 'Ligament of Berry' and is attached to larynx, that is why larynx moves with deglutition
- External laryngeal nerve lies in **Joll's triangle** deep to upper pole of thyroid gland
- Recurrent laryngeal nerves are closely related to inferior thyroid vessel in tracheoesophageal groove in the **Beahr's triangle**.

Blood Supply

Arterial Supply

- Superior thyroid artery (a branch of external carotid artery)
- Inferior thyroid artery, a branch of thyrocervical trunk which arises from subclavian artery.

Venous Drainage

- Superior, middle and inferior thyroid veins
- Superior thyroid vein drains into common facial or internal jugular vein (IJV)

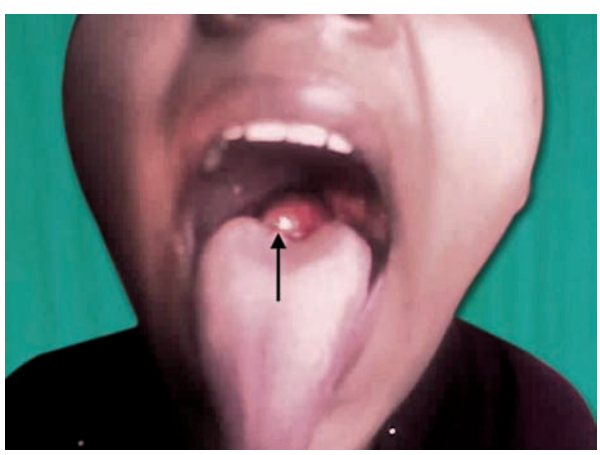


Figure 52.1 Lingual thyroid

- Middle thyroid vein drains into IJV
- Inferior thyroid vein drains into left brachiocephalic vein.

Lymphatics

- Upper, middle and lower deep cervical lymph nodes
- Pretracheal and paratracheal lymph nodes, which open into supraclavicular and mediastinal lymph nodes.

Nerve Supply

- Thyroid gland is supplied by autonomic nervous system
- Recurrent laryngeal nerves and external laryngeal nerves, which are closely related with thyroid gland
- Because of these relationships, a careful and meticulous dissection of thyroid is required during thyroidectomy (subtotal or total).

Functions of Thyroid Gland

- Thyroid gland is a physiologically important endocrinal gland
- Follicles of thyroid gland contain thyroglobulin, a protein
- This protein combines with inorganic iodine and forms two important hormones called T3 (triiodothyronine) and T4 (thyroxine)
- Parafollicular cells called C cells secrete calcitonin, which is important for calcium metabolism.

HYPOTHYROIDISM

Decreased physiological function of thyroid gland manifests as hypothyroidism.

Etiology

- Thyroid agenesis
- Pendred syndrome
- Infantile hypothyroidism (cretinism) due to maternal or fetal deficiency of iodine
- Autoimmune-Hashimoto's thyroiditis
- Iatrogenic
  - Post-thyroidectomy
  - Radioiodine therapy.

Myxedema (Adult Hypothyroidism)

A severe form of hypothyroidism is called myxedema and subclinical forms are more common.

Clinical Features

- The patient feels lethargic, tired
- Intolerance to cold
- Weight gain in spite of loss of appetite
- Constipation

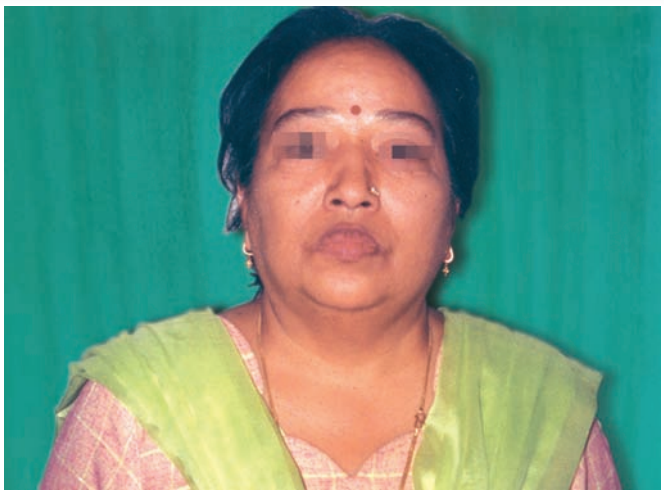


Figure 52.2 A patient of hypothyroidism

- Disturbed menstrual cycle
- Hoarse rough croaky voice.

Signs

- The patient gives hypoactive, lethargic look, sitting calmly
- Dry hairy skin
- Bradycardia
- Cold extremities
- *Bradykinesia:* There is typical delayed ankle jerk
- Sensorineural hearing loss (SNHL) and Bell's palsy are rare manifestations
- Thyroid may be palpable, as there may be history of surgery or radioiodine therapy (**Figure 52.2**).

Investigations

- Show decreased T3 and T4 along with increased thyroid-stimulating hormone (TSH)
- Antithyroid antibodies may be seen in Hashimoto's disease.

Treatment

1. Thyroxine is available in 25, 50 and 100 μg tablets. It is started with low dose.
2. Dose is monitored with T3, T4 and TSH levels in the blood.

THYROID SWELLING

Generalized enlargement of thyroid is called goiter (**Figures 52.3 and 52.4**). A discrete swelling in one of its lobes is called solitary nodule or isolated nodule. A solitary nodule requires further evaluation to rule out underlying malignancy.

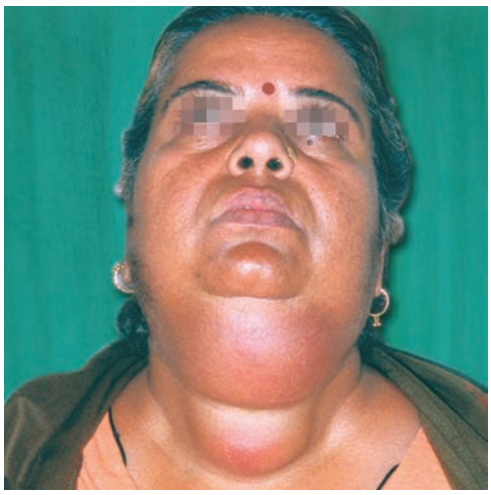


Figure 52.3 Large thyroid goiter (Front view)

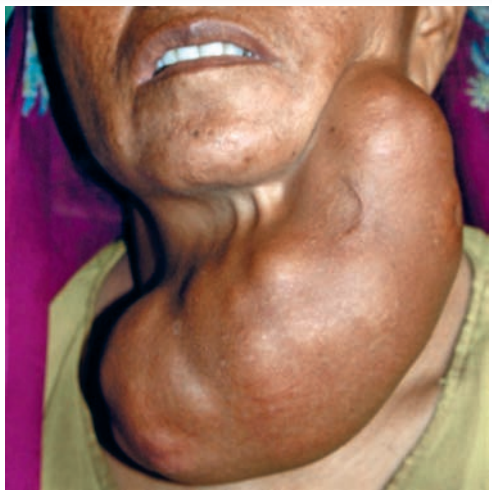


Figure 52.4 Massive thyroid goiter

Classification of Thyroid Swelling

Simple Goiter

- Diffuse
- Multinodular (the patient is euthyroid and it is due to iodine deficiency in the diet).

Toxic

- Diffuse (Graves' disease)
- Toxic solitary nodule
- Toxic multinodular goiter (MNG)
  Toxic nodule and toxic MNG are also called 'Plummer's disease'.

Neoplastic

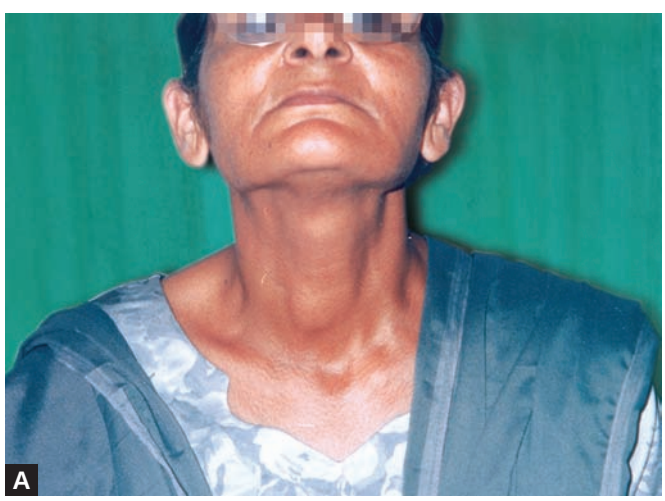
- Benign (adenoma)
- Malignant.

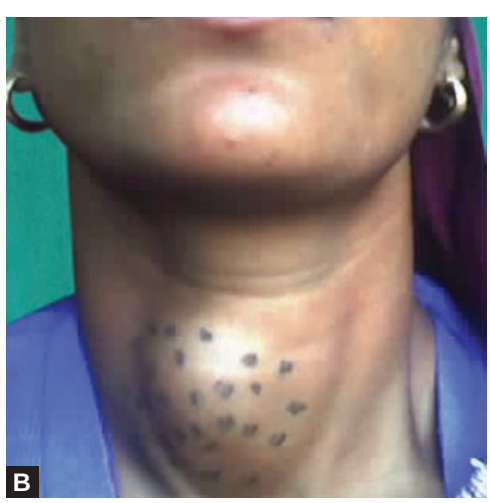
Inflammatory

- Viral
- Bacterial (acute, TB, syphilis)
- Hashimoto's disease
- Riedel's thyroiditis
- De Quervain's thyroiditis.

Solitary Nodule

1. A clinically palpable discrete swelling, when rest of the gland is not palpable is called solitary or isolated nodule.
2. Importance of solitary nodule lies in the fact that in 15 percent of cases it is malignant
3. In 35 percent cases solitary nodule is a follicular adenoma
4. Solitary nodule (**Figures 52.5A and B**) may be due to:





Figures 52.5A and B Solitary thyroid nodule

i. Nodular goiter
ii. Thyroiditis
iii. Cyst
iv. Neoplastic:
   - Benign (adenoma)
   - Malignant.

THYROTOXICOSIS

Increased T3 and T4 levels in the blood manifest as thyrotoxicosis.

Etiology

- Graves' disease
- Toxic solitary nodule
- Plummer's disease
- Toxic nodular goiter
- Subacute thyroiditis
- Struma ovarii.

Symptoms

- Tiredness
- Intolerance to heat
- Weight loss in spite of increased appetite
- Palpitation
- Diarrhea
- Emotional lability.

Signs

- The patient gives anxious, hyperactive look
- Tachycardia, atrial fibrillation
- Hot moist palm
- Exophthalmos.

  Various eye signs on examination are:
  - **Dalrymple's sign:** Lid retraction with widening of palpebral fissures
  - **Von Graefe's sign:** Lid lag
  - **Joffroy's sign:** Absence of wrinkling on forehead
  - **Stellwag's sign:** Stray look with infrequent and incomplete blinking of eyelid
  - **Kocher's sign:** Staring and frightened appearance of eyes on attentive fixation
  - **Gifford's sign:** Inability to evert upper lid
  - **Graves sign:** Failure to close eyes in sleep
  - **Mobius sign:** Absence of convergence of eyes.
- Brisk tendon reflexes
- Weakness of proximal muscles
- Thyroid bruit on auscultation
- Tremors of fingers on examination
- On palpation, there is diffuse swelling in Graves' disease and nodular or multinodular swelling in nodular goiter
- **Kocher's test**—Slight push on lateral lobe of thyroid gland leads to stridor.

MANAGEMENT OF THYROID SWELLING

Diagnosis

History and Examination

- Complete history regarding onset, duration of swelling and associated symptoms should be taken
- Complete examination of the patient with special reference to eyes, examination of heart for any arrhythmia, limbs for weakness and fine tremors
- Swelling is examined for its site, size, shape, margins, surface, consistency, movement with swallowing, fixity with underlying structures and skin
- Auscultation done for any bruit present (Graves' disease).

Investigations

1. **Thyroid function tests:**
   - T_3, T_4 and TSH estimation
   - Radioactive iodine uptake test
   - Thyroid-releasing hormone (TRH) stimulation test TSH stimulation test.
     - Ultrasonography (USG) to differentiate between discrete or dominant, cystic and solid nature of the swelling. USG guided fine-needle aspiration cytology (FNAC).
2. **Isotope scan:** It is done by using Tc-99 and I-131.
   Scan is classified as:
   - Hot nodule: → Overactivity (malignancy).
   - Warm nodule: → Active with normal activity.
   - Coldnodule: → Hypoactive (80%).
3. **Radiological examination**
   - Neck X-rays for any calcification, obstruction of airway
   - Computed tomography (CT) scan
   - Magnetic resonance imaging (MRI)
   - Fine-needle aspiration cytology (FNAC) 21G needle is used. Accuracy is 90 percent and all thyroid conditions can be diagnosed except follicular, which is diagnosed by biopsy only. Accuracy of FNAC can be improved by molecular markers, immunochemistry and reverse transcription polymerase chain reaction (PCR).
4. Indirect laryngoscopy for any vocal cord paralysis
5. Barium swallow for any obstruction in esophagus
6. Trucut biopsy
7. Echocardiography.

Treatment

- Medical
- Radioactive iodine
- Surgical (subtotal/total thyroidectomy).

Medical Treatment

- Antithyroid drugs are used to relieve the symptoms of hyperthyroidism.
  - Thiouracil and imidazoles (Carbimazole) are most frequently used drugs. Carbimazole is given in the dose of 10 to 15 mg three times a day.
  - Agranulocytosis is the most dangerous complication of therapy.
  - Potassium iodide 60 mg three times a day is used to shrink the size of the gland 10 days before surgery.
  - Propranolol (beta 2 adrenergic blocker) is used along with for symptomatic relief of tremors and anxiety.

Radioactive Iodine

Radioactive iodine is effective in single dose.

Carcinogenecity and late onset hypothyroidism are limiting factors for its use.

Surgical Treatment (Subtotal Thyroidectomy)

Indications are:

- Pressure symptoms
- Suspicion of malignancy
- Cosmetic appearance.

SUBTOTAL THYROIDECTOMY

Steps of Operation

- General anesthesis (GA) is administerd
- After preparation of part and position of patient in supine with sandbag under the shoulders
- Horizontal midline incision is given in skin crease midway between notch of thyroid cartilage and suprasternal notch
- Skin with subcutaneous tissue and platysma are raised upwards to the lavel of thyroid cartilage notch and downwards to suprasternal lavel
- Deep cervical fascia is devided between the sternothyroid muscles up to thyroid capsule
- Muscles are not divided and should be retracted and mobilized off the thyroid
- After exposure of thyroid gland, next step is to identify the middle superior and inferior thyroid vessels, which should be ligated
- Inferior thyroid artery is not ligated because of supply to parathyroid gland, which must be saved
- Special care is taken for recurrent laryngeal and external laryngeal nerves by identifying recurrent laryngeal nerve (RLN) lower down below inferior thyroid artery when it passes obliquely upwards and forwards
- Remember superior thyroid vessel is ligated, as far away from thyroid gland and inferior thyroid as close to the gland to avoid injury to RLN and superior laryngeal nerve respectively
- Higher up nerve lies between branches of inferior thyroid artery before passing into larynx just behind inferior cornu of thyroid cartilage
- Parathyroid glands should be identified close to the hilum of gland and preserved
- Subtotal resection of thyroid is done by leaving a remnant of thyroid tissue nearly 4 to 6 g
- After achieving complete hemostasis, a drain may be given and a firm dressing is done (**Figures 52.6 to 52.12**).

Postoperative Complications

1. Hemorrhage
2. Injury to RLN (1–10%)
3. Injury to external laryngeal nerve
4. Hypocalcemia (10%), which may manifest as tetany. Hypocalcemia is treated with IV calcium gluconate and oral calcium.
5. Hypothyroidism is treated with thyroxine.
6. Complications of anesthesia and scar.

MALIGNANCIES OF THYROID GLAND

Solitary nodule of thyroid gland may be malignant in 10 percent of cases. Histopathologically, malignancies are classified as:

- Papillary
- Follicular
- Medullary (parafollicular)
- Anaplastic
- Malignant lymphoma.

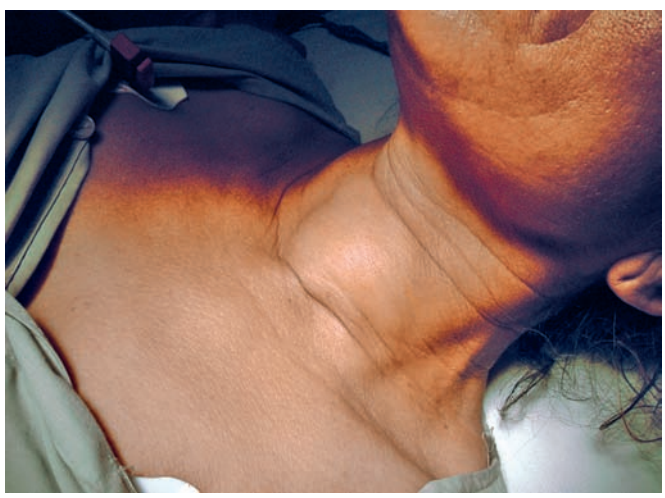


Figure 52.6 Incision line in thyroidectomy

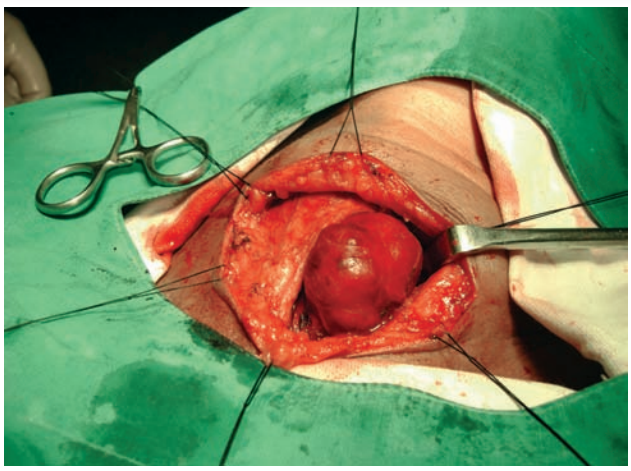


Figure 52.7 Exposure of adenoma mass

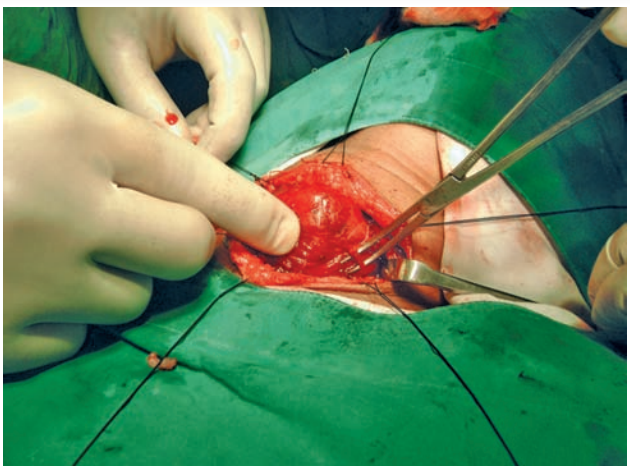


Figure 52.8 Identification and ligation of middle thyroid vein

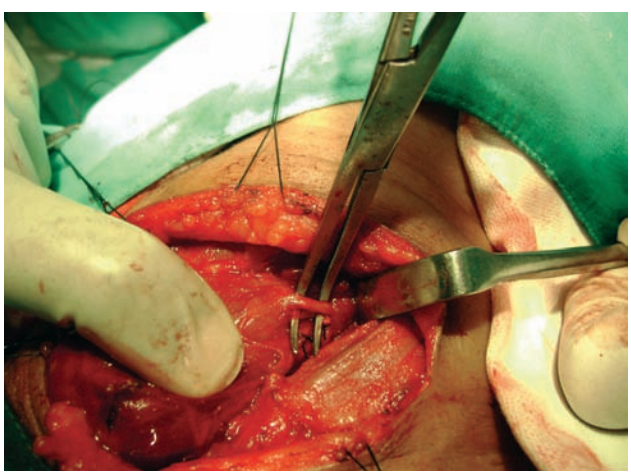


Figure 52.9 Identification and ligation of superior thyroid vein

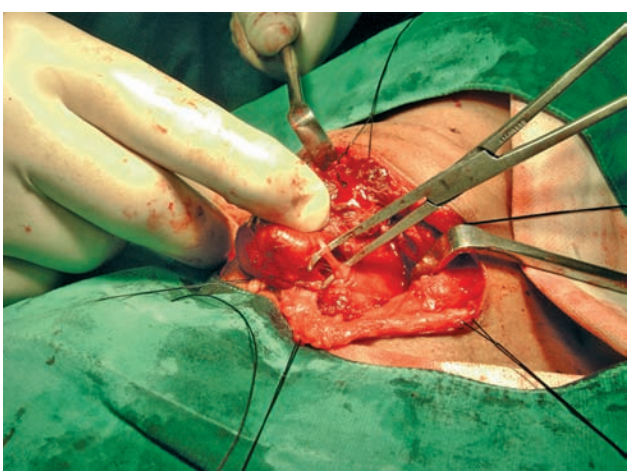


Figure 52.10 Identification and ligation of inferior thyroid vein

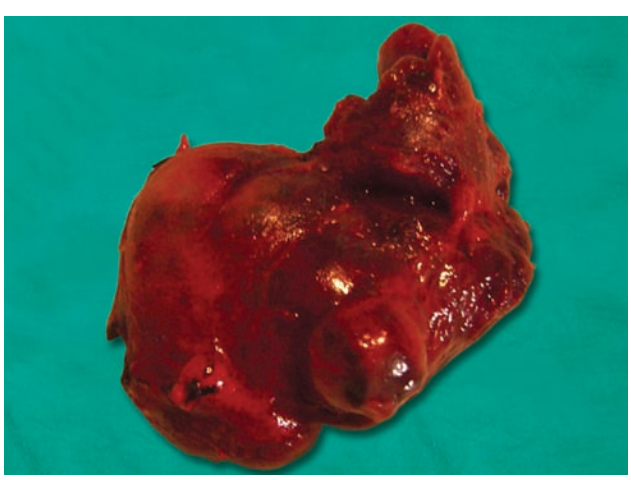


Figure 52.11 Adenoma thyroid removed

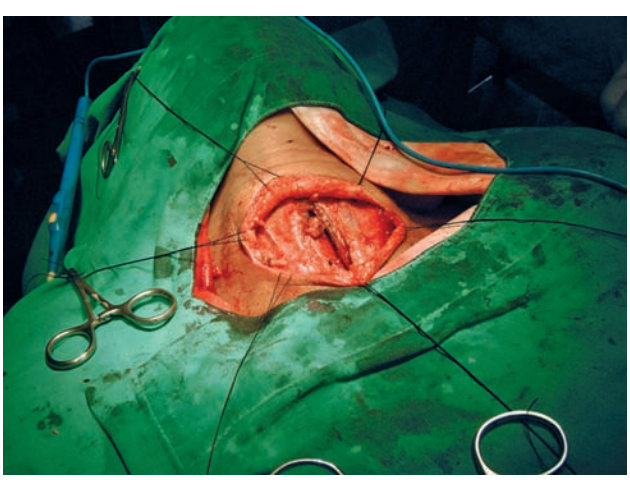


Figure 52.12 Wound after removal of thyroid adenoma

The most common type is papillary carcinoma (50–60%) followed by follicular (15–20%), medullary (5%) and anaplastic (5%). Anaplastic carcinoma carries poor prognosis.

Clinical Features

The most common presentation is a solitary nodule. A long-standing thyroid swelling, which shows sudden increase in size and with symptoms of dyspnea, pain should arise suspicion of malignancy. The patient may present with:

- Dyspnea
- Dysphagia
- Hoarseness of voice
- Lymphadenopathy (Delphian node or cricothyroid node is a common site for carcinoma thyroid metastasis)
- With metastasis.

Investigations

- T_3, T_4 and TSH
- Serum calcium
- Fine-needle aspiration cytology
- Isotope scan
- X-ray, CT scan and MRI.

Treatment

Surgical

Total thyroidectomy along with lymphadenectomy is done. In cases of anaplastic carcinoma thyroidectomy should be followed by radiotherapy. In case of lymphoma, isthmusectomy + anticancer drugs.

Key Points

1. Each lobe of **thyroid gland measures** 4 × 2 × 0.2 cm and whole of the gland weighs 24 g.
2. **Right recurrent laryngeal nerve** has more inconsistent course than left. It may be present in front of gland (33%), behind the gland (33%) or in the branches of inferior thyroid artery.
3. **Parafollicular cells** of thyroid gland secrete calcitonin, which plays important part in calcium metabolism.
4. Availability of **iodized salt** has markedly decreased incidence of cretinism. Table salt should be added, only after the dish has been finally made and not during preparation.
5. **Graves' disease** is characterized by diffuse toxic swelling with eye signs and bruit on auscultation.
6. Toxic nodular and toxic multinodular goiter are also called **Plummer's disease**.
7. **Atrial fibrillation** is the common arrhythmia manifested in thyrotoxicosis.
8. The most dreaded complication of **carbimazole therapy** is agranulocytosis; therefore, repeated TLC should be done.
9. **Medullary carcinoma** can never be found in lingual thyroid because parafollicular cells join the gland only on its descent. Postoperative hemorrhage is a serious complication and requires immediate re-exploration of the wound.
10. **Retrosternal goiter** is the one, which has grown more than 50 percent inferior to the level of suprasternal notch.
11. **Chvostek's sign** is indicative of hypoparathyroidism. In this tapping over facial nerve causes momentary twitch of corner of mouth due to irritable facial muscles.
12. **Trousseau's sign** is inflating sphygmomanometer cuff above systolic pressure level causes carpopedal spasm of the hand in hypoparathyroidism
13. The most common thyroid cancer is **papillary adenocarcinoma**.

Chapter 53 Cervical Swellings

What Students Must Know!

- **Surgical Anatomy**
- **Lymph Nodes of Neck**
- **Neck Masses**
  - Branchial Cyst
  - Thyroglossal Cyst
  - Ludwig's Angina
  - Pharyngeal Pouch
  - Carotid Body Tumor
  - Thyroid Gland Swelling
  - Lymph Node Swellings
  - Laryngocele
- **Neck Dissection**
  - Radical Neck Dissection
  - Modified Neck Dissection

SURGICAL ANATOMY

1. Side of neck is bounded above by base of mandible and a line drawn from its angle to the mastoid process. Below is the clavicle, in front by median line and posteriorly by anterior border of trapezius.
2. Sternocleidomastoid muscle divides this space into anterior triangle in front and posterior triangle behind.
3. Anterior triangle is further divided by digastric and omohyoid muscles into muscular triangle, carotid triangle, digastric and submental triangle.
4. Posterior triangle is divided by omohyoid into occipital and supraclavicular triangle.
5. Common carotid lies in carotid triangle and divides into external and internal carotid close to upper border of thyroid cartilage opposite 3rd and 4th cervical vertebra.
6. External carotid artery gives following branches (**Figure 53.1**):
   - Superior thyroid
   - Ascending pharyngeal
   - Lingual
   - Facial
   - Occipital
   - Posterior auricular
   - Terminal branches—superficial temporal and maxillary artery.
7. Internal carotid does not give any branch in the neck; while petrous part gives caroticotympanic and pterygoid branches, cavernous portion and cerebral part gives branches to cavernous sinus, eyes and brain.
8. Venous drainage is through internal jugular vein.

LYMPH NODES OF NECK

Classification

They may be classified into:

- Pericervical chain consisting of occipital, mastoid, parotid, submandibular, submental and retropharyngeal lymph nodes (2–3 nodes).
- Cervical chain has superficial cervical nodes (**Figure 53.2**) along the anterior and external jugular veins and a deep group of nodes (**Figure 53.3**) along the internal jugular vein (IJV). Anterior cervical nodes have prelaryngeal, pretracheal and paratracheal lymph nodes.

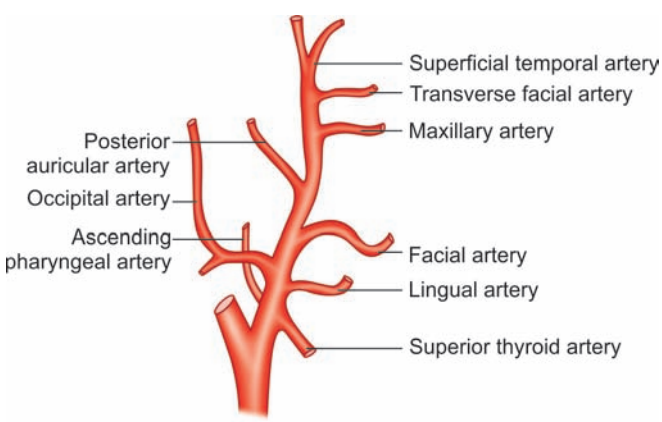


Figure 53.1 Branches of external carotid artery

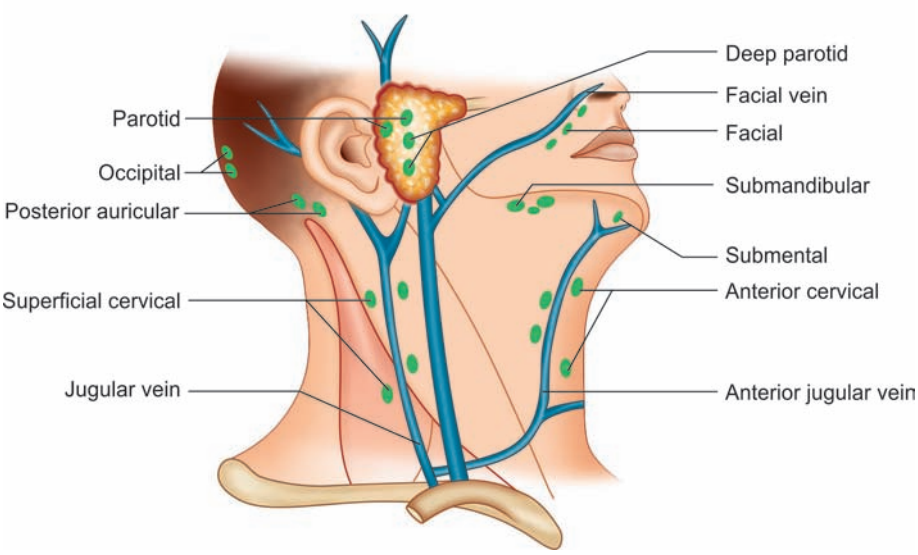


Figure 53.2 Superficial cervical lymph nodes

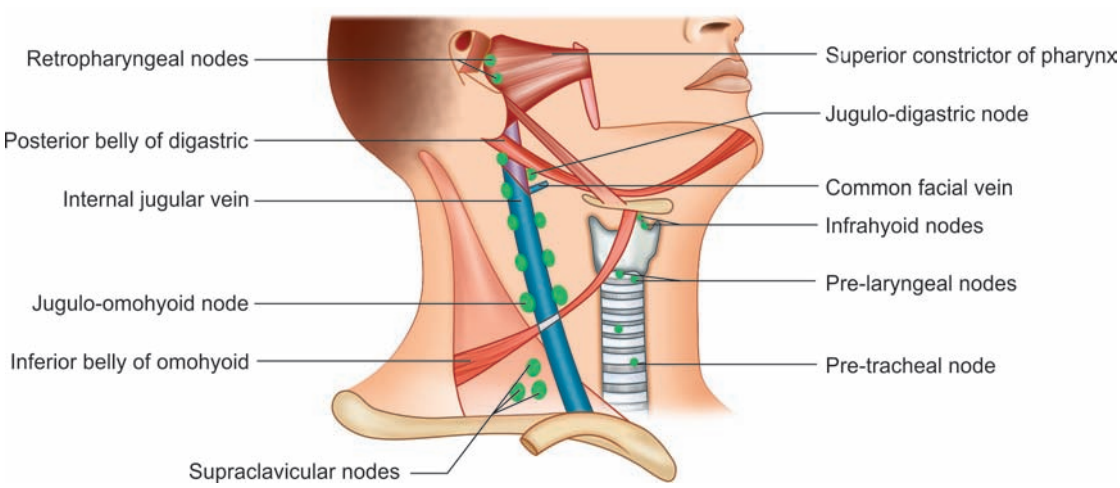


Figure 53.3 Deep cervical lymph nodes

Sloan-Kettering Classification

Levels of lymph nodes (**Figures 53.4A and B**) as per this classification are as follows:

Level 1: A includes submental and 1-B submandibular lymph nodes.

Level 2: Nodes lie along the upper one-third of internal jugular vein (IJV) between base of skull and hyoid bone (upper Jugular).

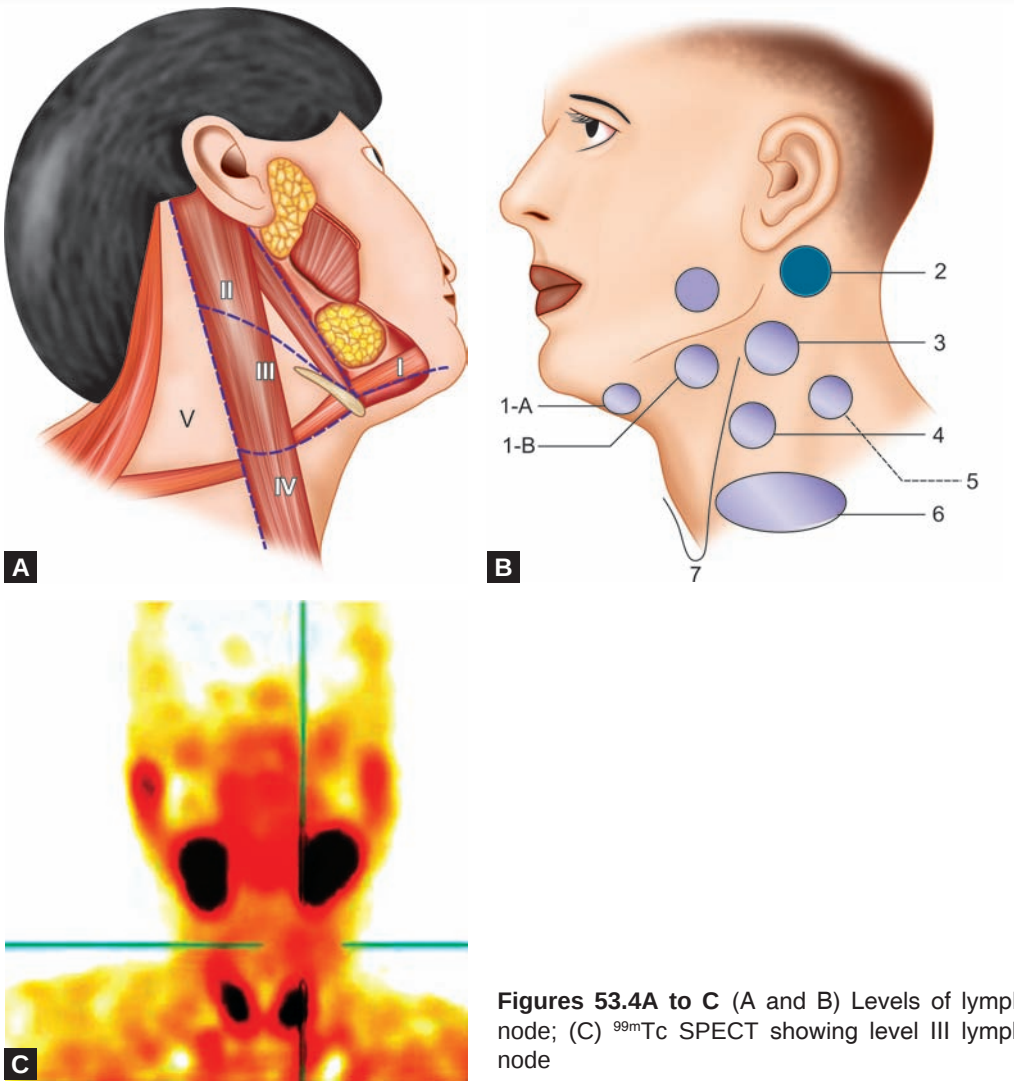
Level 3: Nodes along the middle third of IJV or between hyoid bone and upper border of cricoid cartilage or omohyoid muscle (mid Jugular).

Level 4: Nodes along the lower third of IJV between cricoid cartilage or omohyoid and clavicle (lower Jugular).

Level 5: These nodes lie in posterior triangle of neck including transverse cervical and supraclavicular nodes.

Level 6: These are nodes in anterior compartment including prelaryngeal, pretracheal and paratracheal groups extending from hyoid to suprasternal notch.

Level 7: Includes nodes of upper mediastinum below suprasternal notch (**Figure 53.4B**).



Figures 53.4A to C (A and B) Levels of lymph node; (C) ^{99m}Tc SPECT showing level III lymph node

These lymph nodes can be assessed more accurately by doing ^{99m}Tc single-photon emission computed tomography (SPECT) study of lymph nodes (**Figure 53.4C**).

NECK MASSES

Classification

These may be classified into the following (**Figure 53.5**):

Congenital Neck Masses

- Thyroglossal cyst
- Branchial cyst
- Laryngocele
- Cystic hygroma
- Congenital dermoids.

Neck masses may be as follows (**Figures 53.6A to D**).

Lateral swellings: Anterior triangle may have lymph nodes, enlarged salivary glands, ranula, branchial cyst, carotid body tumor, aneurysm of carotid, bronchogenic carcinoma or thyroid swellings, pharyngeal pouch, laryngocele and parapharyngeal swellings.

Posterior triangle may have cold abscess, lymph nodes, cystic hygroma, lipoma and cervical rib. Sebaceous cyst and neurofibroma can also occur in this region.

Midline swelling: May be goiter, lymph nodes, pharyngeal pouch, subhyoid bursa, plunging ranula, Ludwig's

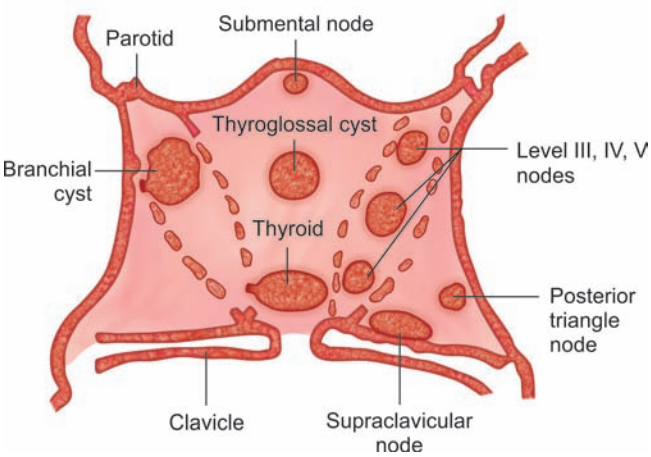
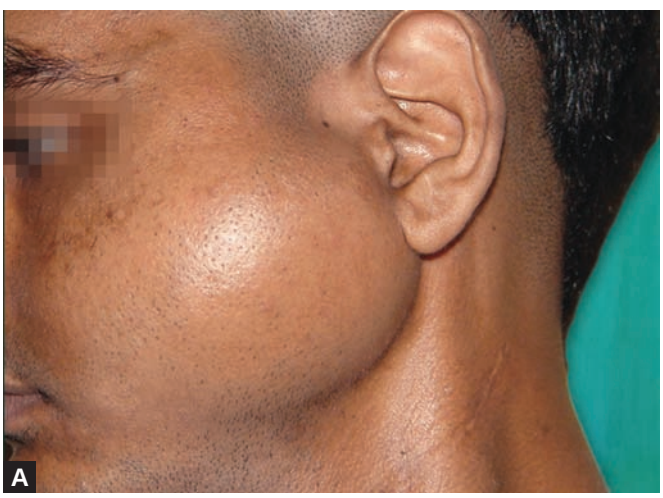
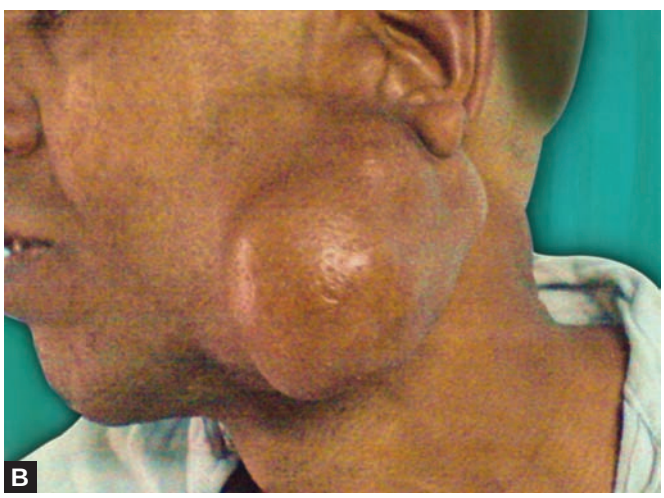
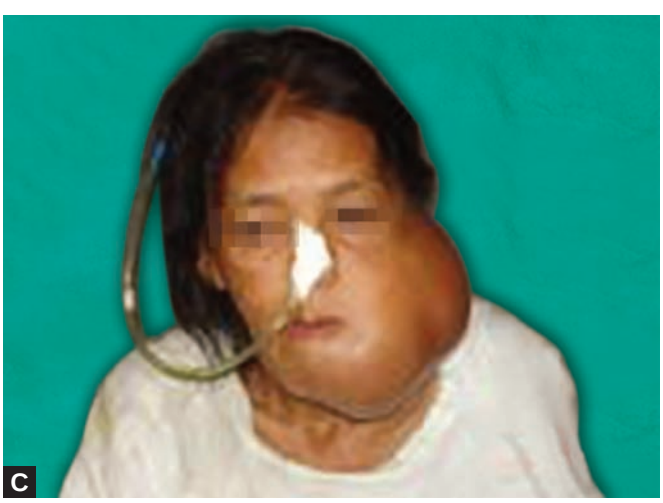
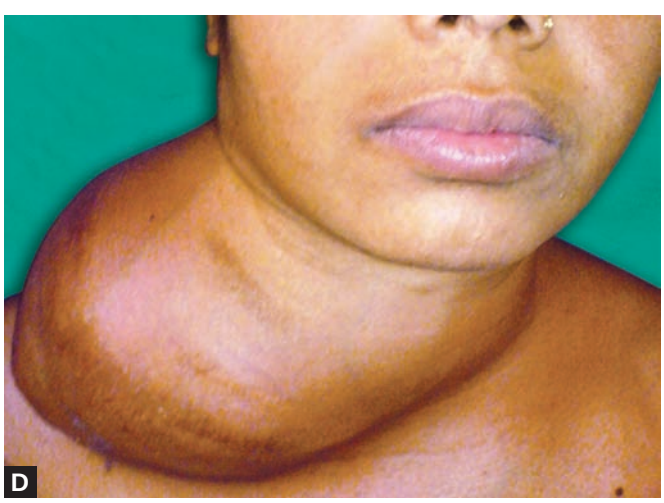


Figure 53.5 Various common masses in the neck









Figures 53.6A to D Lateral swelling of neck

angina, lipoma, laryngocele, thyroglossal cyst or sublingual dermoid.

IMPORTANT SWELLINGS

Branchial Cyst

How is it Formed?

1. A small depression deep to 2nd branchial arch forms, which lies superficial to 3rd and 4th arch—it is precervical sinus, which usually disappears.
2. A brancial cyst normally develops from vestigial remnants of second branchial cleft, which if it persists, it forms a cystic swelling in upper part of neck, which is called branchial cyst.
3. If 2nd arch fails to fuse with 5th arch, a fistula develops and it connects the precervical sinus (branchial sinus) or fistula and it passes between external and internal carotid artery.
4. **Branchial cyst although congenital, manifests at puberty** in upper lateral part of neck deep to upper one-third of sternocleidomastoid muscle. It is painless, smooth, cystic swelling. Its tract may be outlined by injecting a radiopaque dye.
5. Presence of cholesterol crystals in aspirate is diagnostic.

Treatment

Cyst or fistulous tract must be excised completely, when it is quiscent.

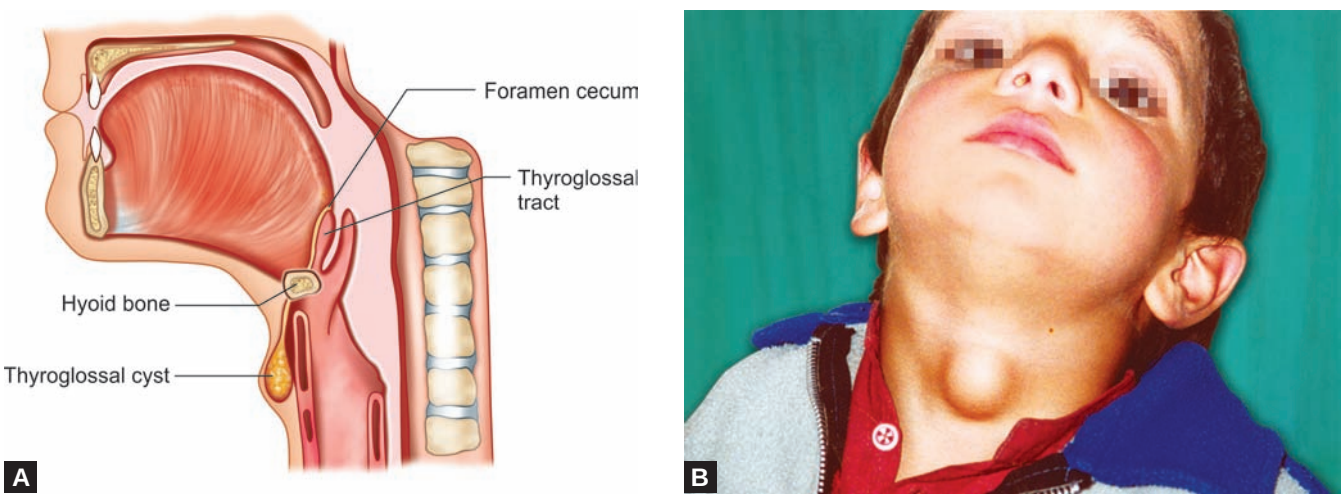
Thyroglossal Cyst

How it Forms?

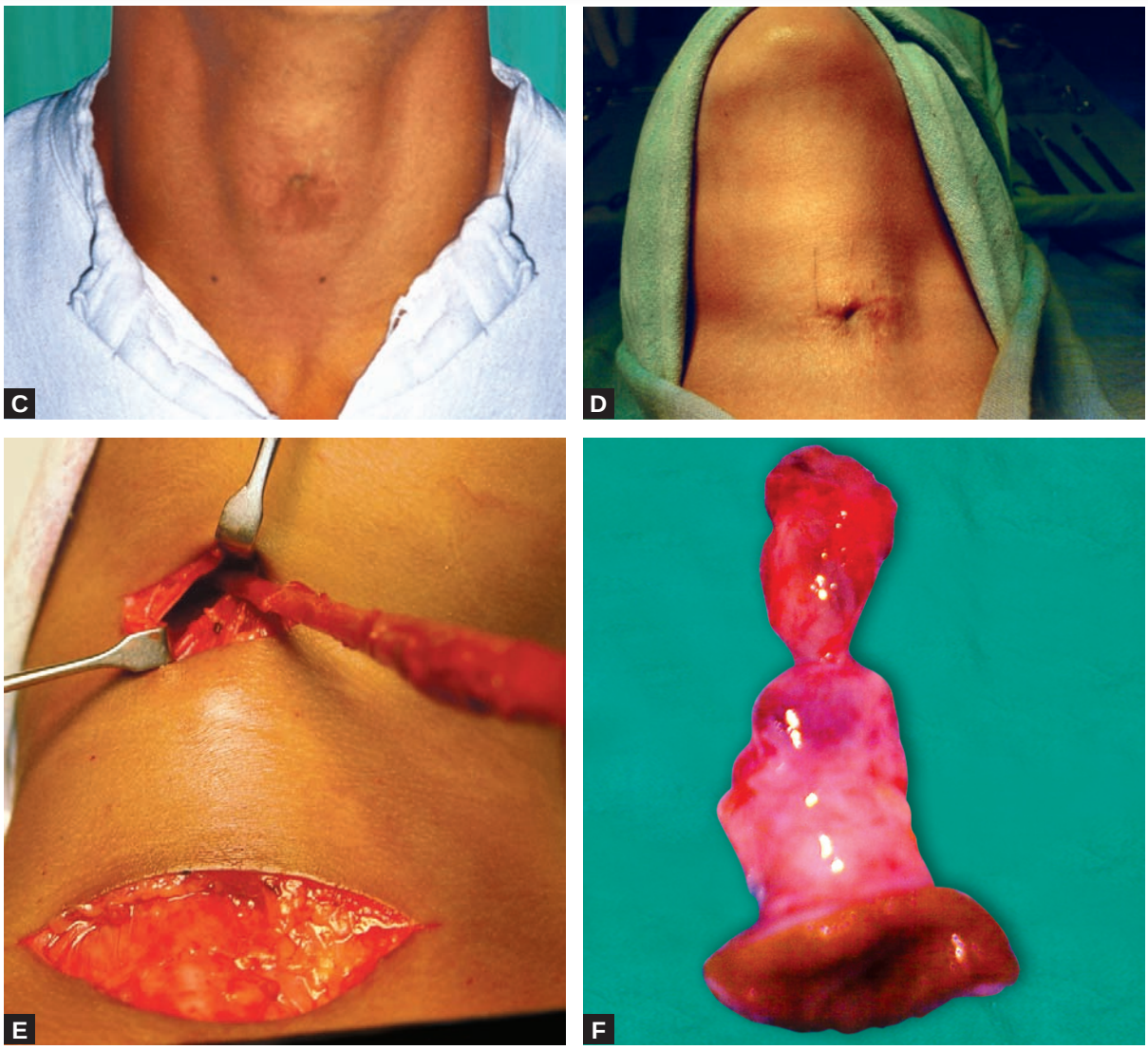
- Thyroid gland descends early in fetal life from base of tongue to its position in the neck.
- The track of descent passes variably in relation to the hyoid bone.
- Thyroglossal cyst represents a persistence of this track and may be found anywhere in the midline.
- Thyroglossal tract passes down from foramen cecum of the tongue between genioglossi muscle in front, passing behind the hyoid bone to the upper border of thyroid cartilage ultimately ending in pyramidal lobe of thyroid gland.
- Normally, this tract disappears except in lower part forming isthmus of thyroid or a portion of duct remains patent giving rise to a cystic swelling due to retention of secretions resulting in thyroglossal cyst.
- Thyroglossal fistula may result from bursting of infected cyst, incision or incomplete removal of cyst (**Figures 53.7A to C**).

Clinical Features

Thyroglossal cyst presents as a midline swelling at the thyrohyoid level. Although congenital in origin, but is usually seen in later age. The swelling can be moved sideways only and it also moves upward on protruding the tongue or on deglutition. Carcinomatous changes may occur. When infected, may rupture onto skin of neck, presenting as a discharging sinus (**Figure 53.7D**).



Figures 53.7A and B (A) Thyroglossal cyst and its relations with hyoid bone and foramen cecum; (B) Thyroglossal cyst



Figures 53.7C to F (C) Thyroglossal fistula; (D) Sinus neck; (E) Sistrunk operation; (F) Excised track of the sinus

Treatment

Sistrunk's operation in which complete excision of the tract along with middle of hyoid bone is done (**Figures 53.7 E and F**)

Cystic Hygroma

Cystic hygroma is also a congenital cystic swelling containing multiple locules of lymph, which develops due to sequestration of portion of jugular sac, which fails to join the regular lymphatic system.

It is usually seen in posterior triangle of neck in its lower part and is seen in infants only. It is partly compressible and translucent. Sudden increase in size may occur due to secondary infection.

Treatment

Complete excision of mass at an early age or repeated aspiration and injection of sclerosing agents.

Ludwig's Angina

It is an infection of submandibular space with cellulitis going onto formation of an abscess. It is usually due to dental infection caused by anaerobic streptococci or infection of oral cavity may also cause the problem.

Symptoms are fever, pain, dysphagia and excessive salivation and a submental swelling affecting the floor of mouth causing edema. Stridor may also occur.

Treatment

- I and D of the abscess through neck with division of myelohyoid muscle.
- Broad-spectrum antibiotics.
- Anti-inflammatory drugs.
- Treatment of the cause such as that of dental caries.

Carotid Body Tumor

- Carotid body tumor may be called chemodectoma or potato tumor or non-chromaffin paraganglioma.
- Carotid body is a chemoreceptor organ situated at the bifurcation of carotid artery and these receptors are stimulated by rise in partial pressures of oxygen (PO_2) or H^+ concentration or a decline in partial pressure of carbon dioxide (PCO_2).
- Carotid body is supplied by glossopharyngeal nerve.
- Both acetylcholine and catecholamine are present in carotid body.
- Various sites of chemoreceptors are brain, pulmonary and coronary vessels, bulb of jugular vein, vagus ganglion and also along the tympanic branch of glossopharyngeal nerves.
- Although benign, in 20 percent cases regional metastasis may occur. It is mobile from side-to-side and not vertically.
- Arteriography shows splayed carotid fork. Open biopsy is risky because of injury to carotid.
- Treatment is surgical excision as the tumor is radio resistant.

Subhyoid Bursa or Cyst

Subhyoid bursa presents, as a midline swelling below the hyoid bone in front of thyrohyoid membrane and moves with deglutition. Its long axis is parallel to hyoid bone.

Treatment is by excision.

Sternomastoid Tumor

- Sternomastoid tumor is also called congenital torticollis or fibromatosis colli.
- It occurs due to infarction of central part of sterno-cleidomastoid muscle at birth, which is replaced by fibrous tissue causing contraction.
- Infarction results from venous obstruction during labor or formation of hematoma may be another factor.
- Treatment is done by regular head movements to avoid contraction.
- Braces or harness may be given to correct torticollis.
- Sternocleidomastoid may be divided at its lower end.
- Subcutaneous tenotomy is not done as it may injure blood vessel or XIth nerve.

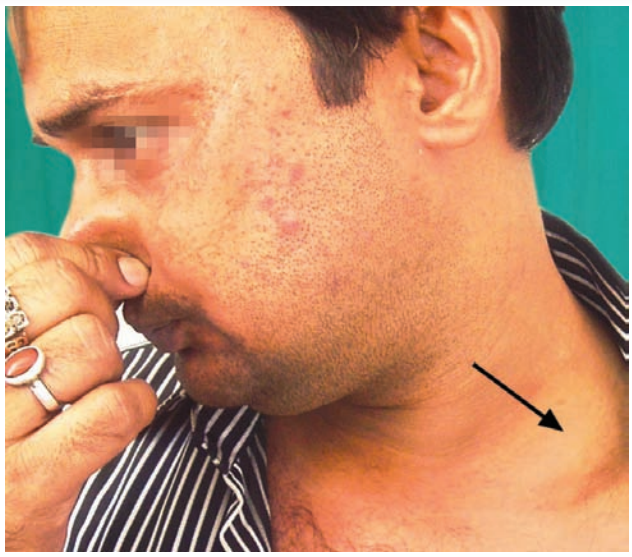


Figure 53.8 Pharyngocele, which increases on Valsalva

Pharyngeal Pouch

- Pharyngeal pouch is also called Zenker's diverticulum, which lies between oblique and transverse fibers of inferior constrictor muscle.
- Sac lies in posterior triangle of neck posterior to sternocleidomastoid muscle and in front of trapezius (**Figure 53.8**).
- Treatment is excision of the sac with cricopharyngeal myotomy, in which, circular fibers are divided vertically till the submucosa is reached.

Laryngocele

Laryngocele is herniation of laryngeal mucosa, which may be internal or external. External passes through thyrohyoid membrane presenting in the neck over the thyrohyoid membrane and the swelling moves with deglutition.

Treatment is excision of the sac by laryngofissure or endoscopic techniques.

Cervical Rib

Swelling presents in subclavian triangle Adson's test is positive, i.e. pulse becomes weak on turning the neck on same side.

Treatment is surgical if causing symptoms.

Cold Abscess

- Cold abscess is due to cervical tubercular nodes, which may present in anterior triangle or in posterior triangle, which may be due to caries spine.
- The nodes are usually multiple and matted and caseation is seen.

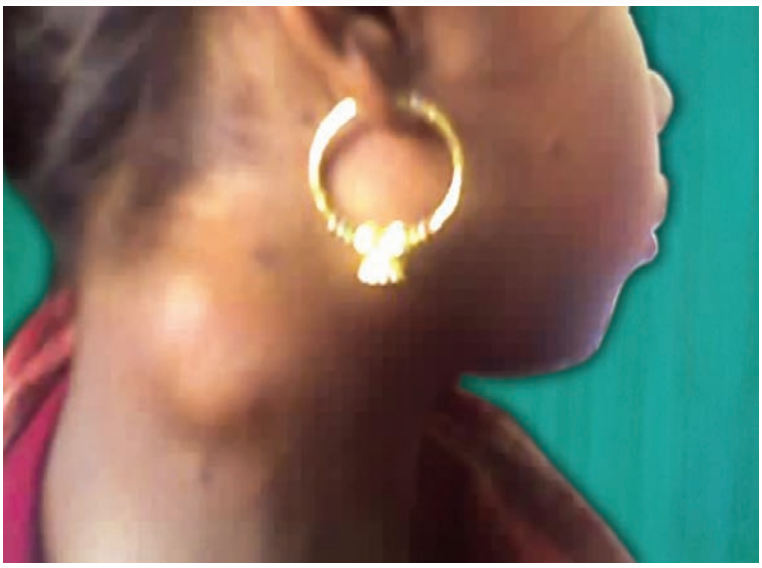


Figure 53.9 A patient showing matted lymph nodes in neck

- Fine-needle aspiration cytology (FNAC) and biopsy are confirmatory.
- When abscess forms a subcutaneous collection, it is called collar stud abscess.
- Treatment is by antitubercular therapy.

Thyroid Gland Swelling

They have been described separately.

Lymph Node Swellings

It may be inflammatory or neoplastic.

Lymphadenitis

Deep cervical nodes are usually involved due to infection of pharynx and oral cavity and it is treated by antibiotics and treatment of the cause.

Specific Infections

Specific infections like syphilis and tubercular lymphadenitis. In syphilis these are involved in secondary stage and treatment is penicillin.

Tubercular lymph nodes (**Figure 53.9**) are commonly seen in the posterior triangle.

Lymphomas

It may be Hodgkin's or non-Hodgkin's type.

1. In Hodgkin's usually men 45 to 75 glass or early adulthood age group is usually affected.

   One group of lymph nodes is involved. These are painless, discrete and rubbery, no matting. Clinical features are weakness, malaise, fever of Pel-Ebstein type, night sweats, pruritus and discomfort after taking alcohol (**Figure 53.10**).

   Further types may be:
   - Nodular sclerosing (Type I)
   - Mixed cellularity (Type II)
   - Lymphocyte predominant (Type III)
   - Lymphocyte depletion (Type IV), which is least common.

   Staging
   - *Stage I:* Single group of lymph nodes involved.
   - *Stage II:* Two or more groups of lymph nodes are affected.
   - *Stage III:* Lymph nodes on both sides above and below diaphragm are involved.
   - *Stage IV:* Diffuse involvement of extra lymphoid tissue such as liver and bone marrow.

   Diagnosis is confirmed by examination and biopsy.

   Treatment is by radiotherapy for stage I and early II, while stage II (late), III and IV are treated by chemotherapy.

   MOPP regimen in which chlorambucil 6 mg/meter^2 or 10 mg total, vinblastine 10 mg, procarbazine 100 mg/meter^2 or 150 mg and prednisolone 40 mg/meter^2 or 60 mg is given.

   Prognosis: Five years survival in stage I is 90 percent and it becomes worse as the stage progresses.
2. Non-Hodgkin's type characteristics are:
   - Males in all age groups are involved (**Figure 53.11**).

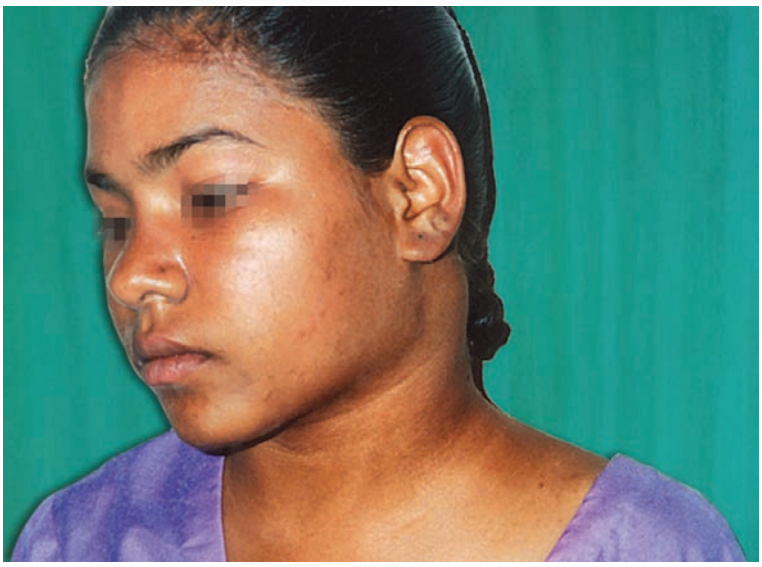


Figure 53.10 Cervical lymph node swelling on left side of neck. On biopsy, it was found to be a case of Hodgkin's lymphoma

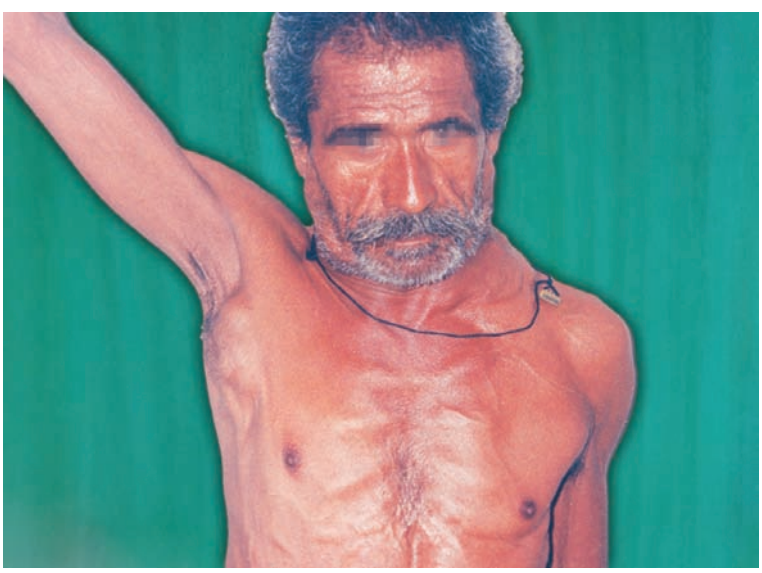


Figure 53.11 Patient having massive lymphadenopathy (cervical and axillary). On biopsy it was non-Hodgkin lymphoma

- Three percent acquired immuno deficiency syndrome (AIDS) cases may present as non-Hodgkin's lymphoma (NHL).
- Nodes are discrete and firm.
- It may be lymphoblastic lymphoma (highly malignant T cell type) or Burkitt's lymphoma (B cell due to EB virus), which involves mandible or maxillary sinus.
- Histologically, it may be small cell type or large cell type of NHL.
- Lymph node biopsy and computed tomography (CT) scan for extranodal spread is helpful along with human immunodeficiency virus (HIV) testing.
- Treatment is by radiotherapy (RT) and chemotherapy.

Neoplasms of Lymphoid Tissue

- It may be of primary type, which includes giant cell lymphoma, lymphosarcoma or reticulum cell sarcoma. These are not very common and treatment of choice is RT; but if multiple areas are involved multidrug chemotherapy is given.
- *Metastatic nodes:* They are very commonly seen in ear, nose and throat (ENT) practice and the secondaries,

usually come from head and neck malignant tumors. Rarely, there may be occult primary, but it may be found if nasopharynx; tonsils, base of tongue, hypopharynx, thyroid or bronchus are thoroughly scanned. Supraclavicular node may be from primary in the stomach or testes.

- In such cases, a careful history and examination is very important to find out the primary site such as with IDL, DL examination, panendoscopy, fine-needle aspiration cytology (FNAC), biopsy and CT scan.
- Treatment depends upon the primary site, which includes the lymph nodes in RT or surgical neck dissection of lymph nodes.

NECK DISSECTION

It may be as follows:

Radical Neck Dissection

Dissection in which total lymph node clearance is done from mandible to clavicle and midline to trapezius muscle on one or both sides (**Figure 53.12A**) with 3 to 6 weeks gap between two dissections, because removal of both IJV results in increased cerebrospinal fluid (CSF) pressure.

Incision given is Macfee's or Crile's (modified Y incision) and structures removed

- Total lymph nodes, fascia and fatty tissue
- Sternomastoid muscle, omohyoid muscle
- External and internal jugular veins
- Accessory nerve
- Submandibular salivary gland along with tail of parotid.

Structures Preserved

- Carotid
- Brachial plexus
- Hypoglossal nerve, phrenic nerve
- Lingual nerve, vagus nerve, cervical and mandibular branches of facial and sympathetic trunk are not removed.

Contraindications reflex neurovascular dystrophy (RND) is not done if distant metastasis has occurred or nodes are fixed to underlying structures or if primary is not treatable (**Figure 53.12B**).

Modified Neck Dissection or Functional Neck Dissection

In this one tries to preserve spinal accessory, IJV and sternomastoid muscle (**Figure 53.12C**)

Type I: Spinal accessory is saved.

Type II: Spinal accessory and IJV is spared.

Type III: Spinal accessory, IJV and sternocleidomastoid are saved.

Elective Neck Dissection

- In this the selective neck nodes are removed
- Accessory spinal, IJV and SC mastoid muscle are preserved along with one or more groups of lymph nodes.
- Types are supraomohyoid neck dissection in which level I, II, III are removed.
- Lateral neck dissection in which level II, III and IV are removed.
- Posterolateral neck dissection in which level II, III, IV and V are removed.

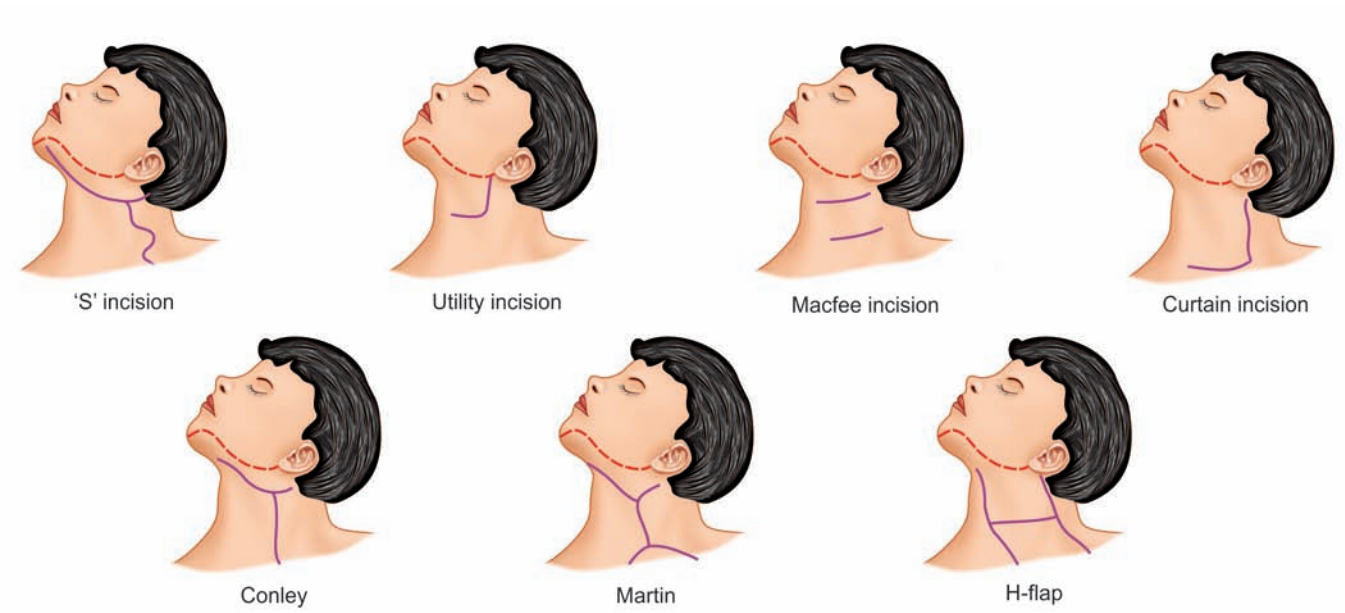
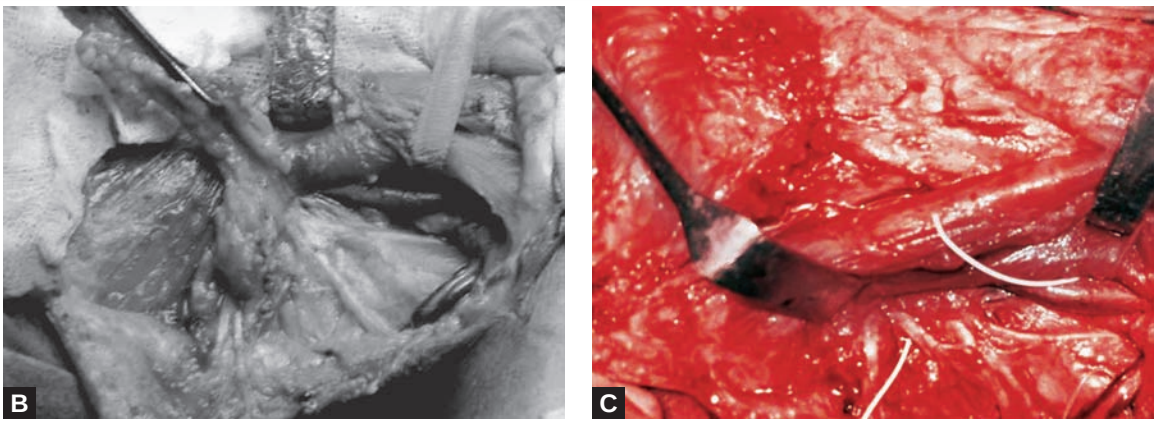


Figure 53.12A Various incisions for radical neck dissection



Figures 53.12B and C (B) Radical neck dissection; (C) Neck dissection showing spinal accessory nerve, internal jugular vein and sternocleidomastoid muscle

Extended Neck Dissection

In this all structures as in RND are removed, which may further include other lymph node groups such as retropharyngeal, parotid and external carotid, hypoglossal nerve and parotid gland.

Key Points

1. **Nodes of level II, III and IV** in the neck are related respectively to upper, middle and lower third of the internal jugular vein (IJV).
2. **Branchial cyst,** which results due to the persistence of precervical sinus, although congenital, manifests usually at puberty.
3. **Sistrunk operation** is treatment of choice for thyroglossal cyst.
4. **Heller's operation or Ramstedt's operation** also called cricopharyngeal myotomy is the treatment of choice for Zenker's (or pharyngeal) diverticulum.
5. Three percent AIDS cases may present as non-**Hodgkin's lymphoma**.
6. **For occult primary,** it is mandatory to thoroughly scan nasopharynx, tonsil, base of tongue and hypopharynx.
7. In **radical neck dissection** structures removed are sternocleidomastoid and omohyoid muscles, total lymph nodes with fascia, external and IJV, accessory nerve and submandibular salivary gland. But in modified or functional neck dissection, spinal accessory, internal jugular vein and sternocleidomastoid muscles are preserved.
8. Most common carcinoma arising in thyroglossal cyst is **papillary adenocarcinoma**
9. Neck incision after radiotherapy are **Macfee and Hetter's incision**.
10. **Unilateral RND** causes 3 times increase of intracranial pressure, while bilateral causes 5 times rise.
11. After RND **ptosis of ipsilateral eyelid** is due to dissection deep to common carotid artery.
12. In RND if **ligature of IJV slips** best option is cortical mastoidectomy and packing.
13. In **bilateral neck dissection** first neck dissection is done on uninvolved side or less involved side.

Section 8 Recent Advances

Chapter 54 Radiology and Imaging in ENT

What Students Must Know!

- **Introduction**
- **Plain Skiagrams**
  - Nose and Paranasal Sinuses
  - Temporal Bone
  - Oropharynx, Hypopharynx and Larynx
  - Nasopharynx
- **Barium Swallow Study**
- **CT Scan**
  - HRCT (High Resolution CT)
  - MRI
  - MRI in Temporal Bone
  - MRI in Nose and PNS
  - MRI in Larynx
- **CT Scan v/s MRI**

INTRODUCTION

- Radiological investigations are a vital supplement to the medical history and physical examination in the diagnosis of otorhinolaryngological disorders.
- Although computed tomography (CT) and magnetic resonance imaging (MRI) are now the best imaging modalities for ENT, but cost factor necessitate a continuing reliance on the plain films.

PLAIN SKIAGRAMS

Nose and Paranasal Sinuses

The normal paranasal sinuses (PNS) are air filled and so appear transradiant on plain films. The presence of pathology results in opacity of the sinuses.

Salient Features

The following are the salient features on plain radiography:

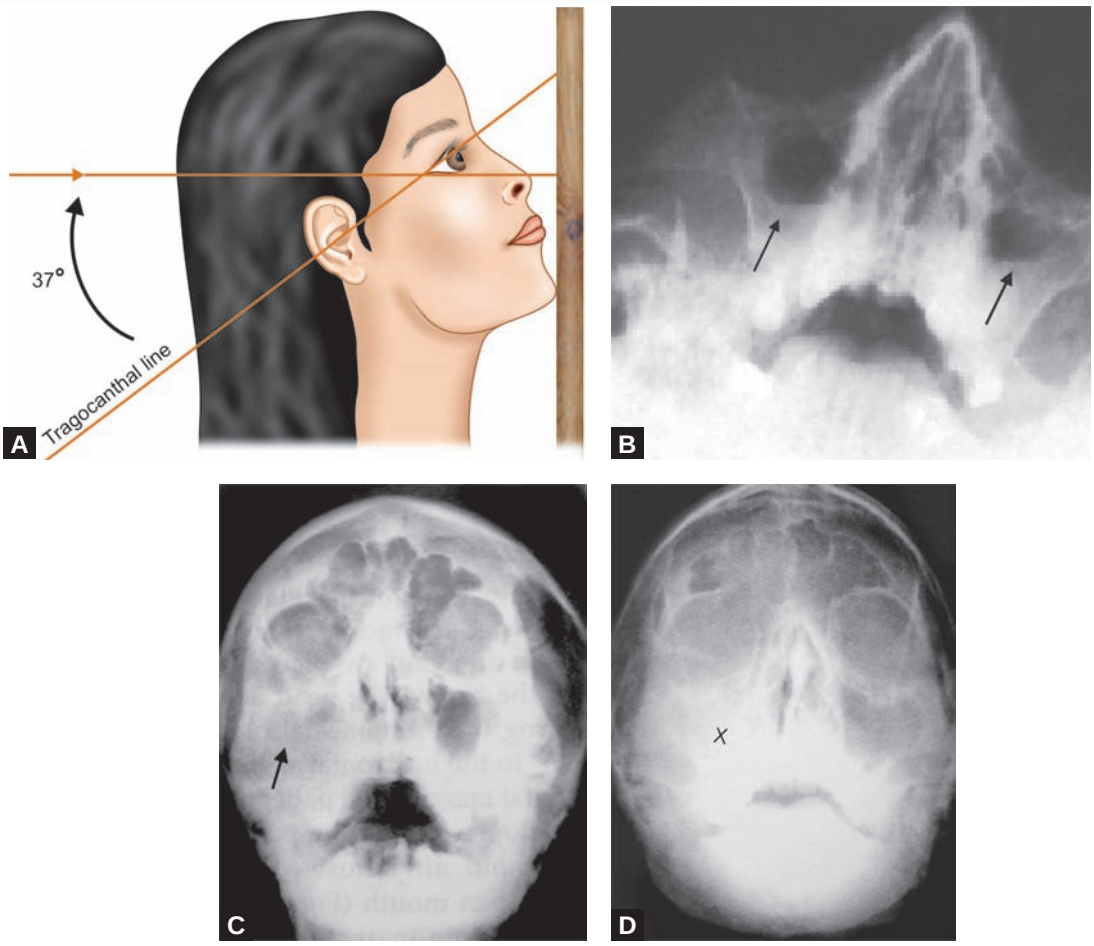
- Bony walls of the sinuses usually are seen as white lines, and therefore, indicate the size of the sinus
- Fluid level in the sinuses indicates sinusitis
- Malignancy destroys the bone
- Opaque sinus is unusual in patient with sinusitis and tumor should be ruled out.

Occipitomental or Water's View

- This is the best view for maxillary sinuses
- The patient is seated facing an erect bucky and the nose and chin are placed with the midline of the bucky
- The head is adjusted so as to bring the orbitomeatal plane at an angle of 45° to the horizontal at the level of inferior orbital margin
- The patient keeps his/her mouth wide open so that the posterior part of the sphenoid air sinuses is projected through the open mouth (**Figures 54.1A to D**)
- Structures demonstrated are:
  - Maxillary antrum (best view) frontal sinuses, sphenoid sinuses (open mouth), nasal bones, nasal septum, middle and inferior turbinates
  - Foramen ovale, foramen rotundum, infraorbital foramina
  - Zygoma, superior orbital fissures, innominate line
  - Lamina papyracea of ethmoids, frontozygomatic sutures, ethmoid cells and orbits.

Occipitofrontal or Caldwell View

This view is for frontal (which are best seen in this view), ethmoid, maxillary and sphenoid sinuses (**Figure 54.2**). The tube is angled at 15°.



Figures 54.1A to D (A) Water's view for paranasal sinuses; (B) X-ray PNS Water's view showing fluid levels in maxilary antrum; (C) X-ray PNS Water's view showing total opacity in right maxillary antrum, mucosal hypertrophy in left antrum and mild DNS; (D) X-ray PNS Water's view showing total opacity right maxillary antrum, mild mucosal hypertrophy of left maxillary antrum and opacity of right frontal sinus

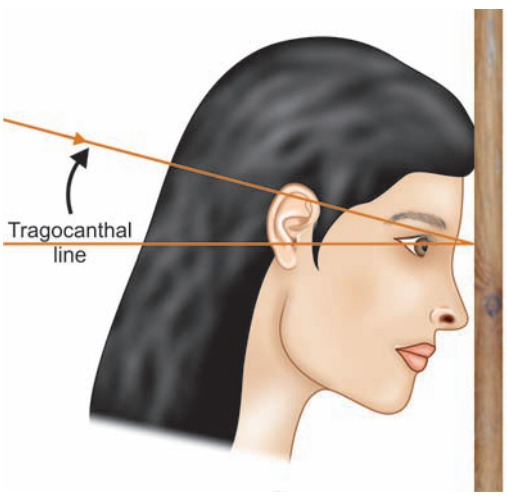


Figure 54.2 Caldwell view for PNS

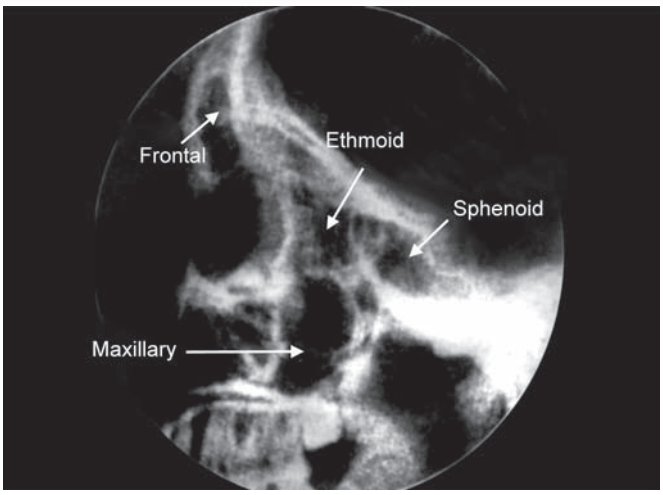


Figure 54.3 Lateral view of sinuses showing frontal, ethmoid, sphenoid and maxillary sinuses

Lateral View

This view is useful for:

- Anteroposterior extent of frontal, maxillary and sphenoid sinuses
- Ethmoid sinuses (**Figure 54.3**)
- Sella turcica
- Condyle and neck of mandible.

Submentovertical or Basal View

This view is used to visualize posterior wall of frontal sinus, maxillary and sphenoid sinuses.

Decubitus Water's and Supine (Brow Up) View

Used to visualize and confirm fluid level.

Bucket Handle View

Done to visualize the fracture of zygomatic arch.

Nasal Bones

Lateral View

Used to visualize nasal bones and spinous process of maxilla. Both the right and left lateral views should be taken. Fracture line should be differentiated from the groove of the ethmoidal nerve and vessels, which run downwards and forwards (**Figures 54.4A and B**).

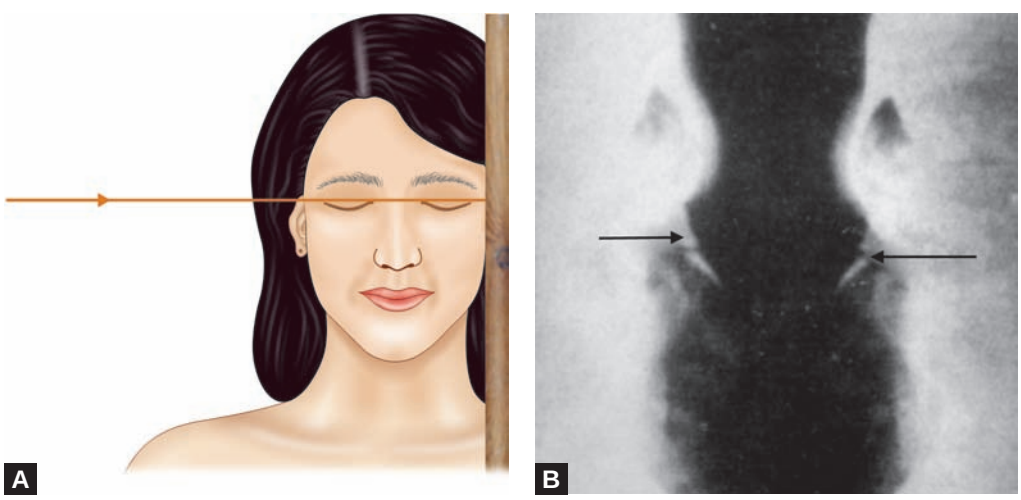
Temporal Bone

Law's Lateral Oblique View

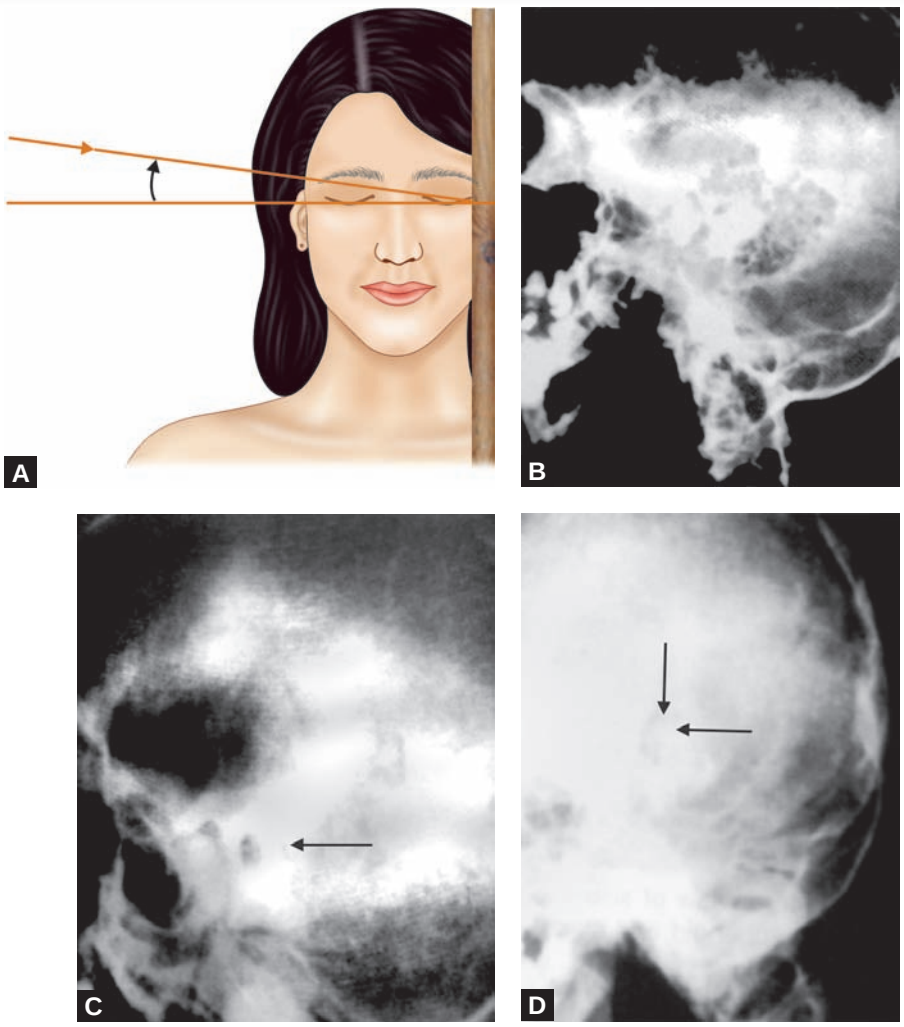
- The patient lies on his/her lateral side so that sagittal plane of the skull is parallel to the film and X-ray beam is centered 15° cephalocaudal (**Figures 54.5A to D**)
- Surgical importance of this view is that external auditory canal, mastoid air cells, tegmen tympani and position of sigmoid sinus can be visualized. Attic, aditus and antrum are not well seen.

Lateral (Schüller's) View

- Schüller's view is similar to Law's view but cephalocaudal beam makes an angle of 30° with the sagittal plane.
- Structures seen in addition to Law's view are sinodural



Figures 54.4A and B (A) Projection for nasal bones—lateral view; (B) X-ray nasal bones, lateral view, showing fracture of nasal bones



Figures 54.5A to D (A) Projection for Law's lateral oblique view; (B) X-ray mastoid, lateral oblique view, showing normal pneumatized mastoid; (C) X-ray mastoid, Law's view, showing sclerotic mastoid; (D) X-ray mastoid, Law's view, showing sclerotic mastoid with erosion due to cholesteatoma

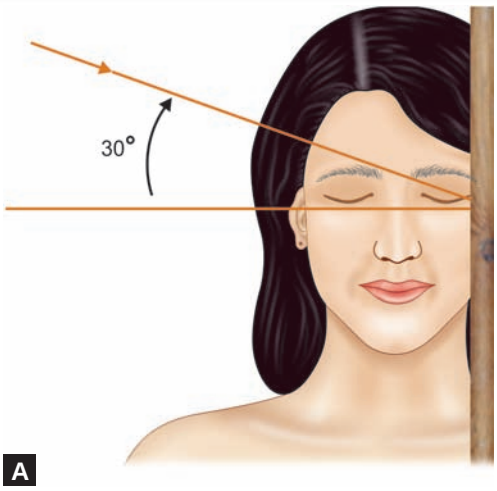
angle, antrum and upper part of attic (**Figures 54.6A and B**)
- Surgical importance of this view is that extensive erosion of the atticoantral region, and of the bony bridge formed by the outer attic wall can be well-appreciated
- Therefore, the surgeon can assess how much space there is between the external auditory meatus and the middle fossa dura above and the lateral sinus behind, when he makes an approach to the mastoid antrum.

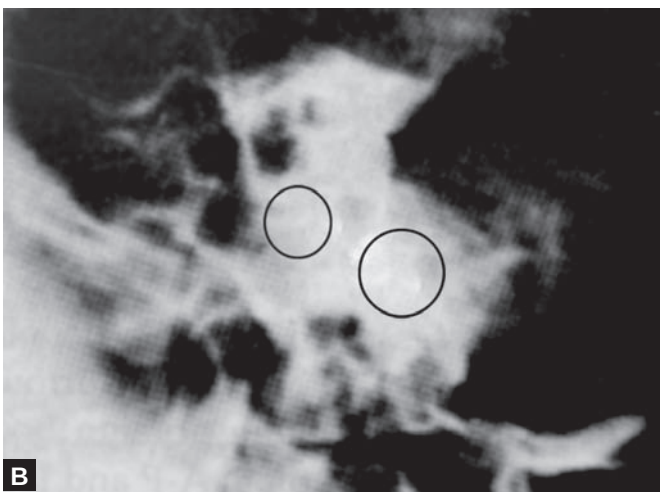
Stenver's View (Oblique posteroanterior view)

- The petrous tip, internal auditory meatus and canal, the bony labyrinth comprising of the semicircular canals, vestibule and cochlea and middle ear cleft are well demonstrated on this view (**Figure 54.6C**)
- Surgical importance is that the presence of erosion of petrous tip and widening of the internal auditory meatus is looked for in this view. If cholesteatoma is present, bony erosion is most often seen.

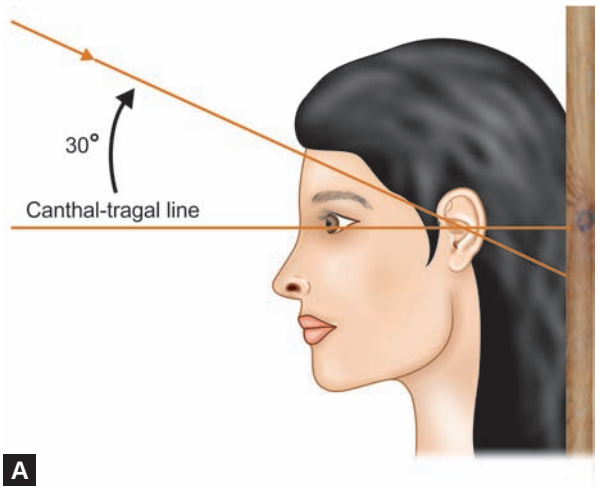
Half Axial (Towne's) View

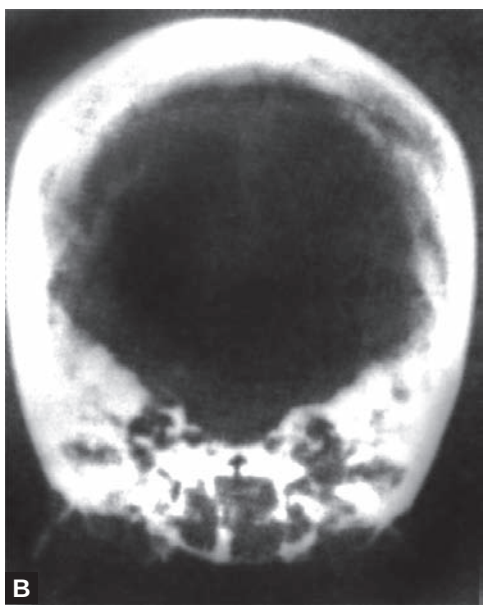
- In this view, both petrous ridges, occipital bone, foramen magnum and dorsum sellae are well-demonstrated (**Figures 54.7A and B**)
- An enlarged attic and antrum can be well identified on this view. Erosion of the lateral spur or scutum by a cholesteatoma is also well seen.

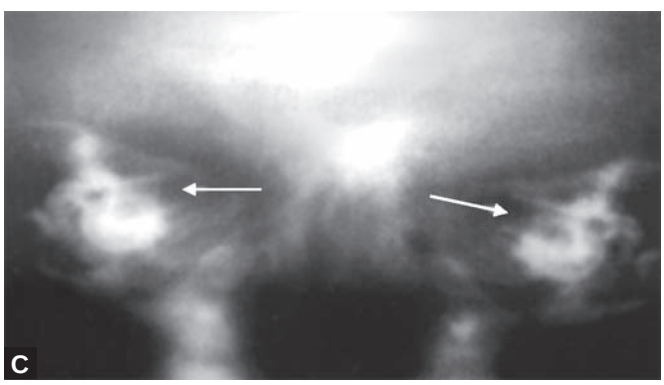




Figures 54.6A to C (A) Projection for Schüller's view; (B) X-ray mastoid, Schüller's view, showing sclerotic mastoid; (C) Stenver's view







Figures 54.7A to C (A) Projection for Towne's view; (B) X-ray mastoid, Towne's view, showing both the petrous ridges and dorsum sellae; (C) X-ray mastoid, perorbital view, showing internal auditory meatus

Chaussé III View

Chaussé III view is an oblique view to evaluate the scutum and lateral wall of attic.

Perorbital or Transorbital View

Transorbital view is the best view for internal acoustic meatus if CT is unavailable (**Figure 54.7C**).

Axial or Submentovertical View

The air-containing cavity of the middle ear is well assessed on this view. Air forms a very good contrast, which enables clear visualization of the head of the malleus, body of the incus and the cartilage space of the incudomalleolar joint. Any abnormality affecting the ossicles is thereby evaluated.

Oropharynx, Hypopharynx and Larynx

Lateral View—Soft Tissue Neck

- On quiet breathing or rest, to best visualize the nasopharynx, retropharyngeal airway, laryngeal surface of epiglottis and trachea, the laryngeal cartilages, hyoid bone, prevertebral space and the cervical spine (**Figure 54.8A**)
- On phonation, it is indicated to distend the ventricle of larynx and hypopharynx.

Anteroposterior View

1. It allows the assessment of tissue details of hypopharynx, larynx, trachea and surrounding soft tissue. Radiopaque foreign bodies can best be seen in the plain anteroposterior and lateral views of neck and chest (**Figures 54.8B to G**).
2. A coin when swallowed lies in coronal plane and is visible as a vertical linear structure in lateral view, which will show the position of coin in relation to tracheobronchial tree and bodies of vertebrae.

Nasopharynx

Lateral Soft Tissue View

With high kilovolt technique (00–120 kV) to evaluate the bone as well as soft tissue (**Figure 54.9**).

Anteroposterior View

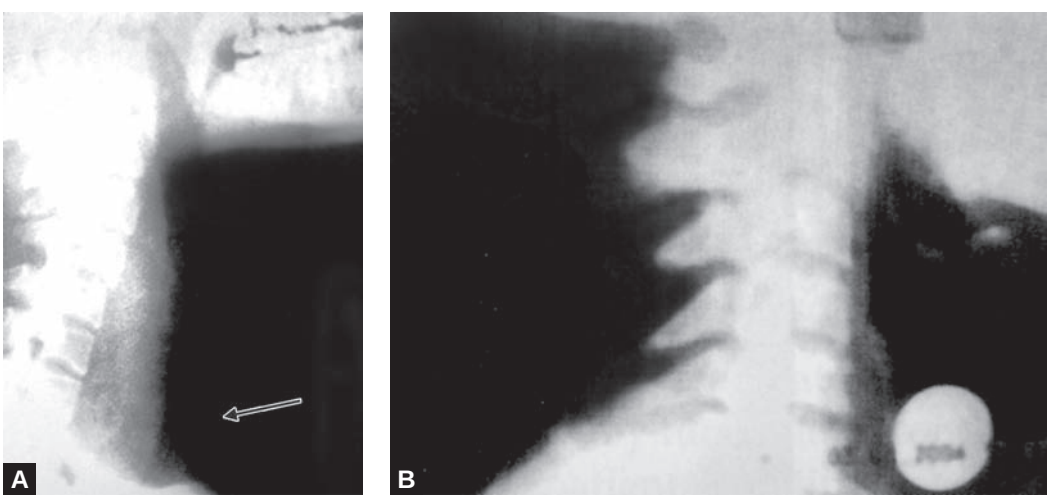
Anteroposterior view is used to view any foreign body or mass or any bony erosion in the nasopharynx.

Base of Skull View

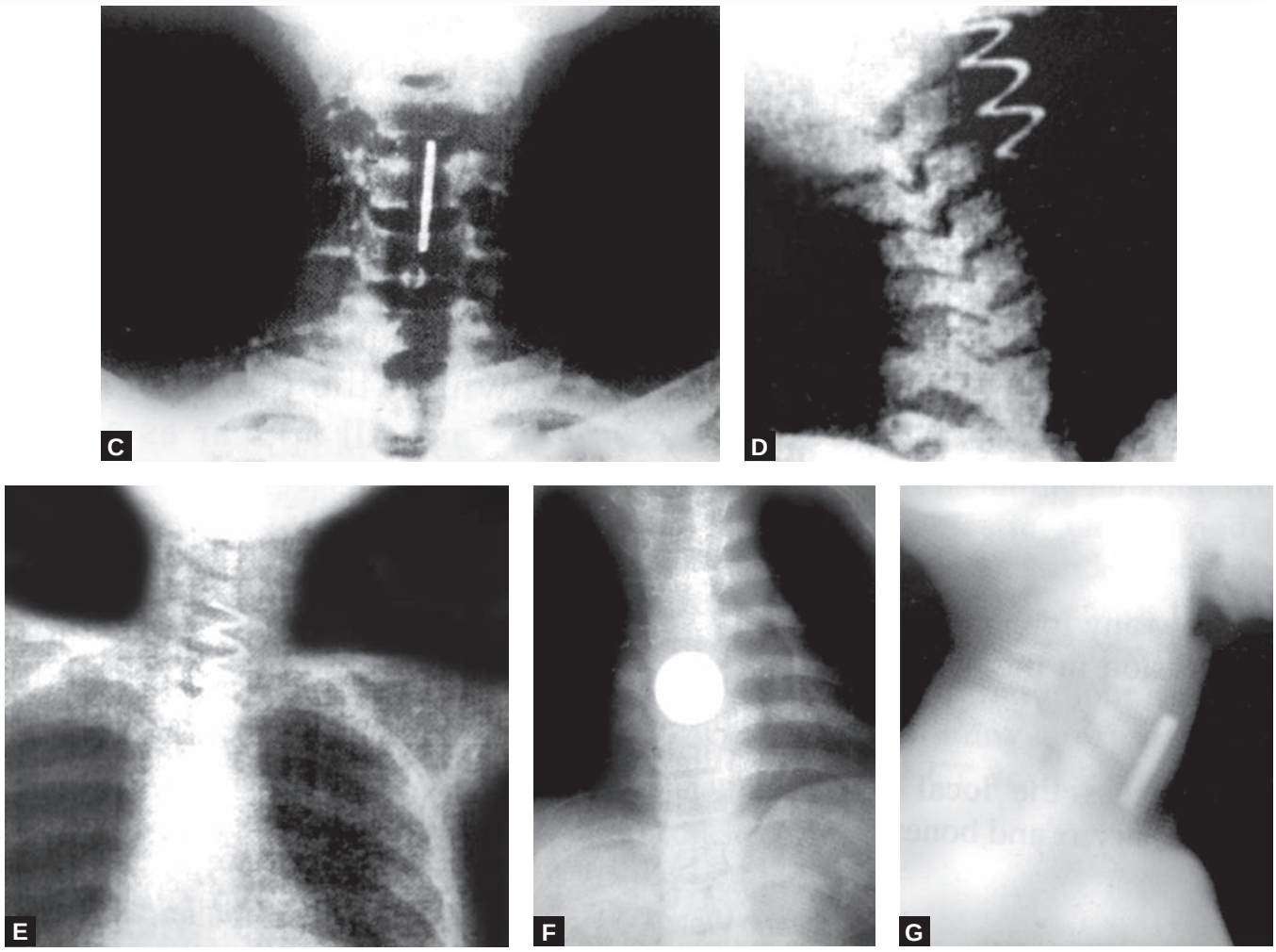
Base of skull view is used to assess the local spread of carcinoma; nasopharynx and bones are found demine ralized.

BARIUM SWALLOW STUDY

This is a simple and easy means of examination for lesions below the cricopharyngeus, which cannot be assessed with a laryngeal mirror. Tumors of pharynx are well outlined by a coating of barium and masses can be demonstrated within the pyriform sinuses. The normal larynx will appear as a 'filling defect' in the frontal projections with contrast in pyriform sinuses on both sides (**Figures 54.10A and B**).



Figures 54.8A and B (A) X-ray soft tissue neck, lateral view, showing increased prevertebral space; (B) X-ray soft tissue neck, lateral view, showing radiopaque FB in the airway



Figures 54.8C to G (C) X-ray of the same patient, anteroposterior view; (D) X-ray soft tissue neck, lateral view, showing a coiled radiopaque FB; (E) X-ray of the same patient, anteroposterior view; (F) FB esophagus—coin, anteroposterior view; (G) FB esophagus—coin, lateral view

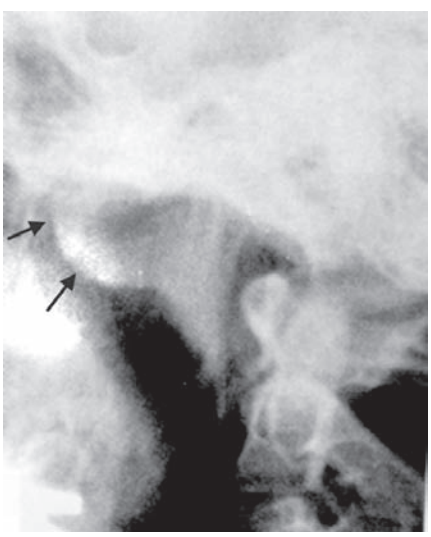
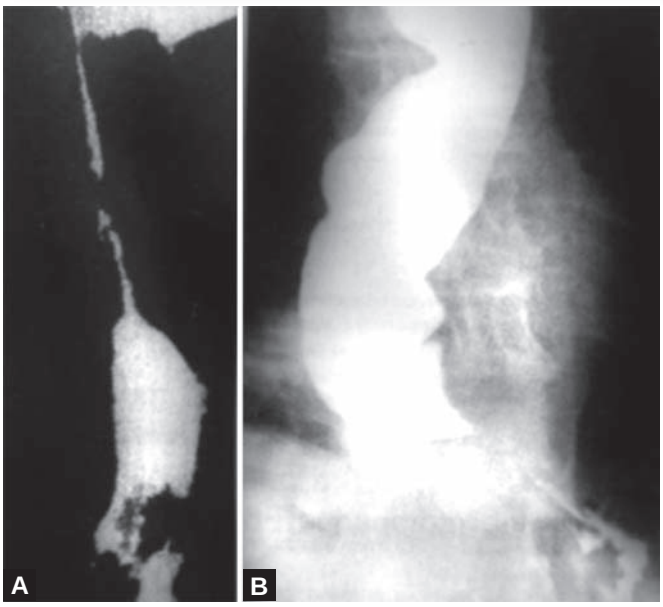


Figure 54.9 X-ray soft tissue nasopharynx, lateral view, showing hypertrophied adenoids



Figures 54.10A and B (A) Carcinoma Barrium Swallow Study esophagus, lower 1/3rd showing apple core defect; (B) Achalasia cardia

COMPUTED TOMOGRAPHY SCAN

- CT scan is an accurate and non-invasive two-dimensional method in radiology, which was used by a British scientist Hounsfield
- In this technique X-ray tube rotates around the immobilized patient's head
- Attenuated X-rays are picked up by detectors, converted into signals, which are amplified and transmitted to a computer, which analyzes the data and calculates the total radiation absorbed by different tissues
- The computer reconstructs the image for display.

High Resolution CT or Thin Section CT

High resolution CT combines the use of thinly collimated CT slices that are 1 to 1.5 to 2 mm in thickness, with a high-spatial-frequency algorithm that enhances edge detection. It is very valuable for fracture of temporal bone or to see facial nerve in its course through temporal bone.

Spiral CT

Spiral CT is a new addition to CT modality. In this, the patient table translates through the quantry and X-ray tube rotates continuously around the patient, creating a volume of data. Advantages over conventional CT include decreased motion artifacts, reduced patient dose and faster scan time.

Advantages of CT Scan

- Accuracy
- Minimum exposure to radiation
- Better visualization of bony details.

Disadvantages

- High cost
- It is not available at all center.

Role of CT in Temporal Bone

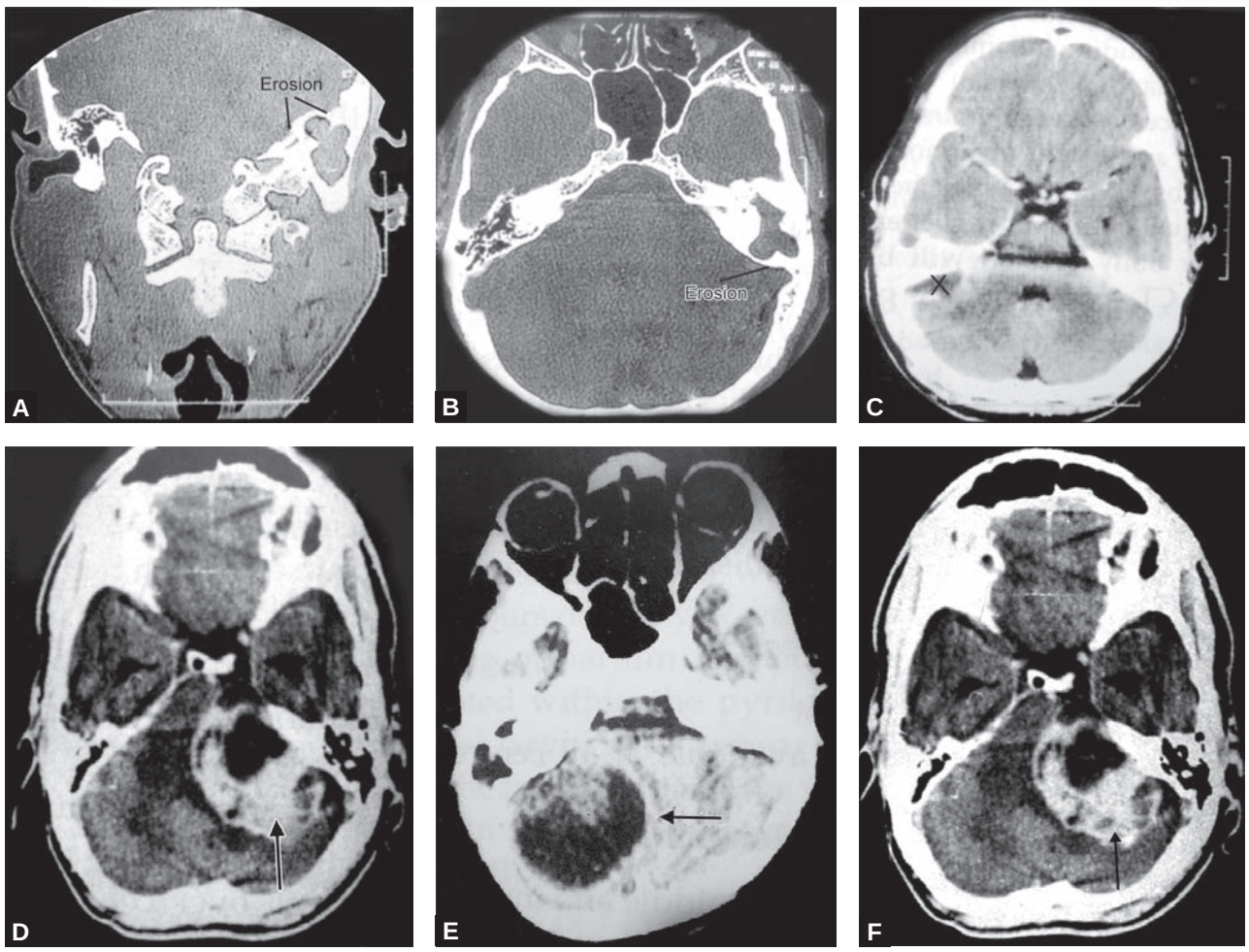
1. For the study of middle and inner ear, HRCT is very good. Both axial and coronal sections are taken. In presence of cholesteatoma CT will show a soft tissue homogeneous mass with surrounding bone destruction. Extension of cholesteatoma soft tissue may be seen extending into the sinus tympani, hypotympanum, aditus ad antrum and various mastoid air cells (**Figures 54.11A to F**).
2. Destruction or dislocation of the ossicles may also be seen usually of the long process of the incus followed by body of incus and head of malleus and this may show loss of normal icecream cone appearance.
3. Relationship of the cholesteatoma with facial canal will be defined. Labyrinthine fistula may be visible.
4. Destruction of the tegmen tympani and petrous pyramid may be seen usually caused by pressure necrosis or enzymatic osteolysis.
5. Evidence of intracerebral or epidural abscess, lateral sinus thrombosis will also be seen on CT.
6. The greatest advantage of HRCT is early diagnosis of cholesteatoma in the attic or posterior tympanum, which is not visible on otoscopy.
7. It also helps in diagnosing residual cholesteatoma in the mastoid cavity. It is also very useful in traumatic fractures of temporal bone, facial nerve palsy, tumors of middle and inner ear.

Role of CT Scan in Nose and PNS

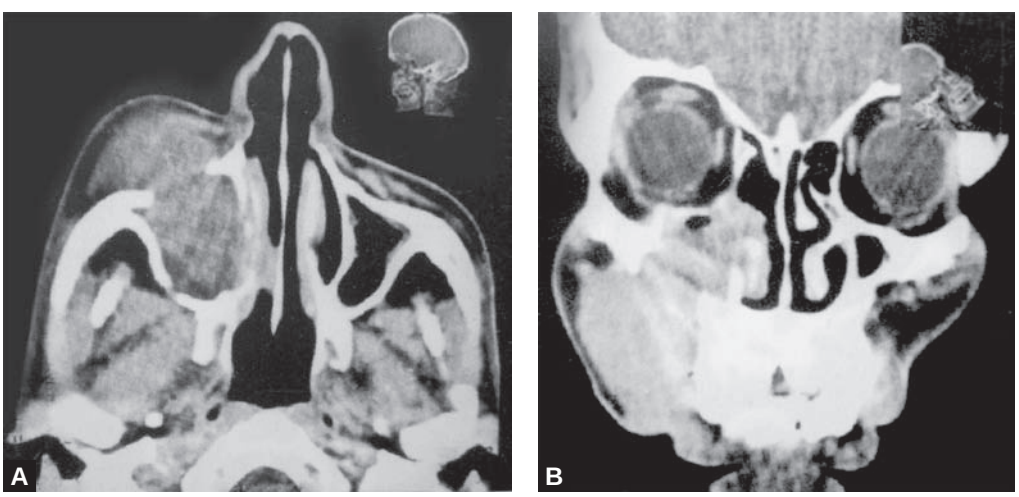
Computed tomography scan is now used to evaluate the nose and PNS prior to endoscopic sinus surgery (**Figures 54.12A and B**). It is also used to evaluate rhinosinusitis and tumors where it demonstrates bony erosion (**Figures 54.12C and D**). It is also used to see the abnormalities in osteomeatal complex like concha bullosa, Hellar's cells, Onodi's cells and abnormalities of uncinate process causing chronic sinusitis (**Figures 54.13 to 54.16**).

Role of CT Scan in Pharynx and Larynx

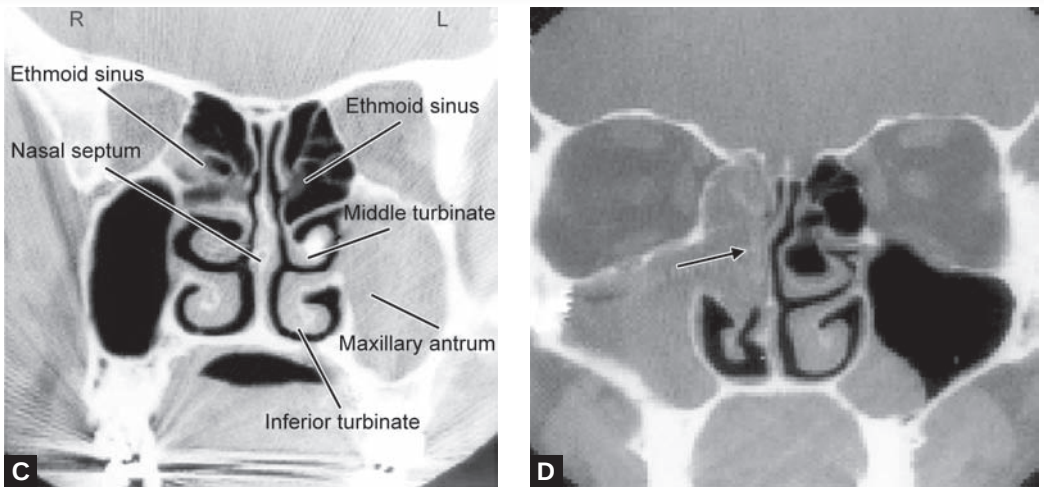
CT scan is of considerable value in swellings of pharynx including inflammatory, traumatic or neoplastic. One can differentiate between abscesses and tumors by CT scan.



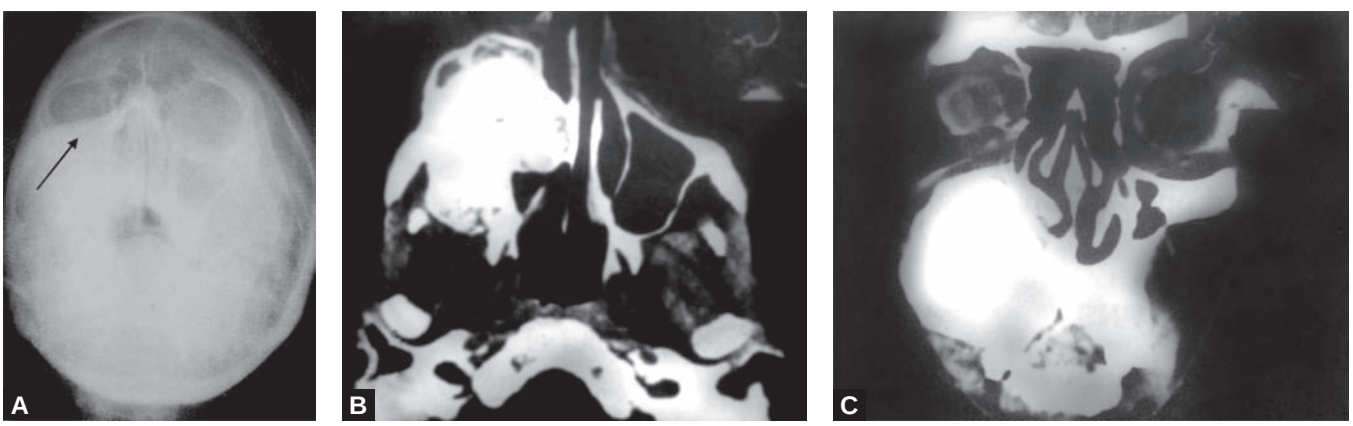
Figures 54.11A to F (A) CT scan, coronal section, showing cholesteatoma and erosion in the left mastoid; (B) CT scan of the same patient, axial view; (C) CT scan, axial view, showing cerebellar abscess on right side; (D) CT scan, axial view, showing mass at petrous apex; (E) CT scan, axial view, showing large right cerebellar abscess; (F) CT scan showing acoustic neuroma at CP angle



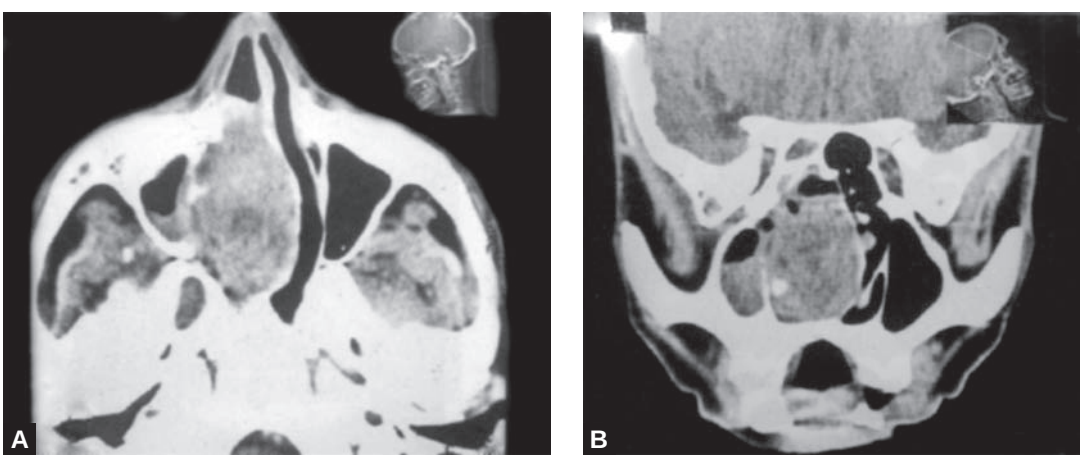
Figures 54.12A and B (A) CT scan PNS, axial view, showing carcinoma maxillary antrum eroding the anterior wall; (B) CT scan of the same patient, coronal section



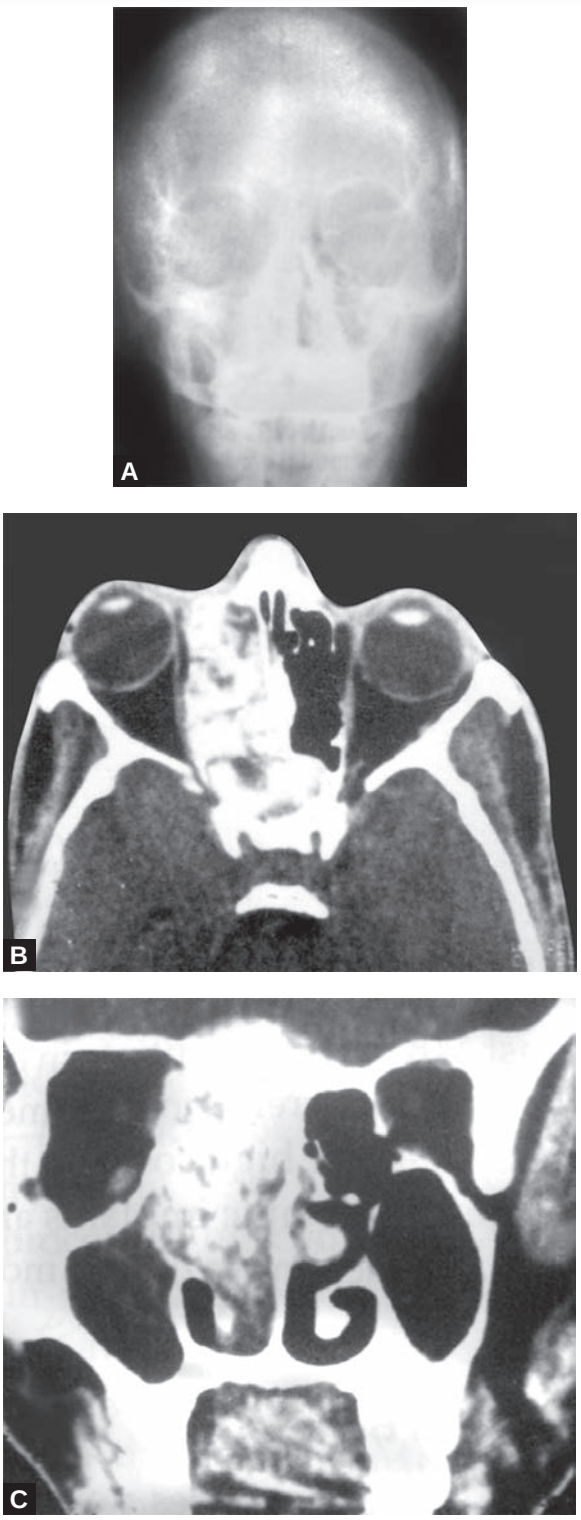
Figures 54.12C and D (C) CT scan PNS showing maxillary sinusitis; (D) CT scan showing ethmoidomaxillary sinusitis



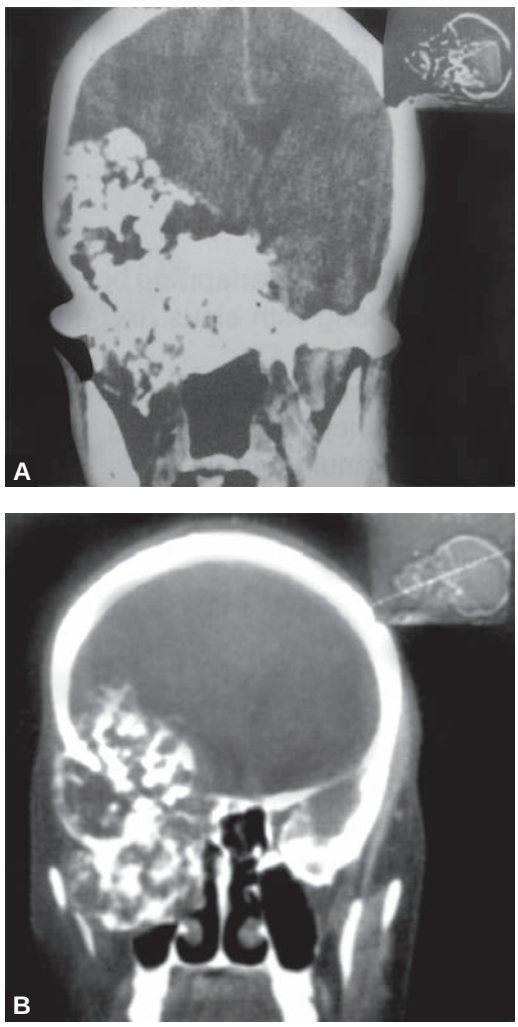
Figures 54.13A to C (A) X-ray PNS, Water's view, showing features of ossifying fibroma; (B) CT scan of the same patient, axial view; (C) CT scan of the same patient, coronal view



Figures 54.14A and B (A) CT scan, axial section, showing inverted papilloma; (B) CT scan of the same patient, coronal section



Figures 54.15A to C (A) X-ray PNS, Water's view, showing mucin impaction tumor on right side; (B) CT scan of the same patient, axial section; (C) CT scan of the same patient, coronal section



Figures 54.16A and B (A) CT scan, coronal section, showing chondrosarcoma; (B) CT scan, coronal section, of the same patient at a different cut, showing calcification in the tumor

Site, nature and extent of tumor can also be judged by CT scan, which helps in the correct staging of tumor for better management. Any bony erosion will be clearly shown by CT scan indicating possibly a neoplasm.

MAGNETIC RESONANCE IMAGING

Magnetic resonance imaging is an imaging modality, which gives cross section images of the body in any plane without exposing the body to ionizing radiation. The MRI uses radiowaves directed at protons—the nuclei of hydrogen atoms in a strong magnetic field and the radiosignals can be processed by computers to form an image. In the body, protons are present in hydrogen atom of water and MRI can

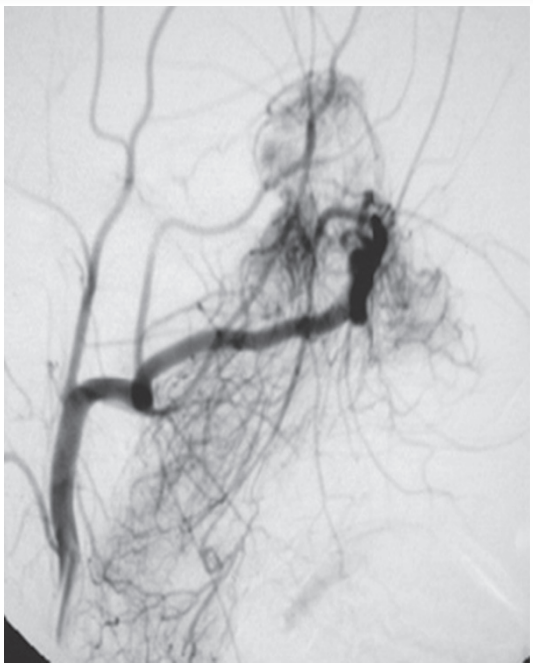


Figure 54.17 MRI angiography in nasopharyngeal fibroma

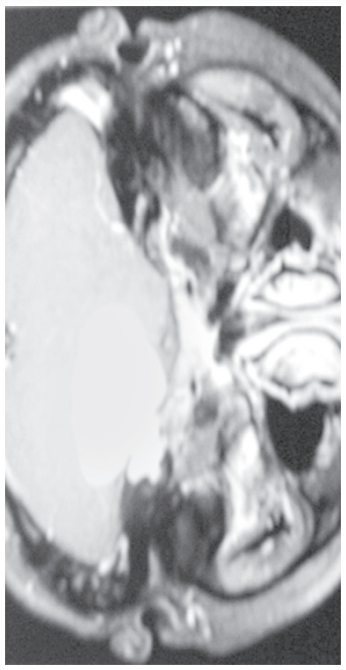


Figure 54.18 MRI showing acoustic neuroma with contrast

differentiate water content in different tissues in the body.

Advantages

Advantages of MRI are: Three-dimensional image, non-invasive, greater potential for soft tissue, white and gray matter of brain and blood vessels (**Figure 54.17**) can be differentiated. Postcontrast MRI can differentiate in between scar tissue and recurrence of a tumor.

Disadvantages

Disadvantages are high cost and that they cannot be done if metallic implants are worn on the body, also scanning time is more than CT.

MRI in Temporal Bone

Since cortical bone produces no signal and only soft tissues are visualized, this fact is utilized to visualize the cranial nerves passing through the skull base. In contrast to absence of signal from cortical bone, the yellow bone marrow of diploeic bone gives bright signal on T1W1 and bright signals on T2W1.

MRI in Nose and PNS

The MRI can help in accurate staging of malignancy and also to differentiate tumors from secretions. The MRI is superior to CT in evaluation of soft tissues. Disadvantage is its inability to differentiate between air and bone as both give no signals on MRI.

Gadolinium-enhanced MRI scan (**Figure 54.18**) helps to differentiate tumor from secretions because tumor tissue is enhanced whereas retained secretions do not.

MRI in Pharynx

In many cases of suprahyoid neck masses, MRI offers benefits over CT because of its higher soft tissue contrast resolution, multiplanar capability and superiority in detecting perineural tumor spread and intracranial invasion. In general, T1-weighted images provide the best fat-muscle and fat-tumor contrast, whereas T2-weighted images provide the best muscle-lymphoid tissue contrast.

MRI in Larynx

At present, MRI is better at differentiating various soft tissues compared with CT. The MRI may allow better analysis of potential cartilage invasion or improved definition of the tumor-muscle interface. In MRI studies, the coronal images are perpendicular to the ventricle. Even if the ventricle is not actually visible, its position can be predicted by the transition from fat to muscle in the paraglottic space.

The comparison between the CT scan and MRI are shown in **Table 54.1.**

Table 54.1: Comparison between CT scan and MRI

CT Scan	*Magnetic resonance imaging*
• It is the best modality for bone lesions	• It is best for soft tissue shadows
• It is faster and economical	• Costly and time consuming. The patient may have claustrophobia
• Air, bone and calcification are well differentiated on CT	• No signal from cortical bone and calcification
• Most valuable for lesions of external, middle and inner ear	• Most valuable for cerebral/cerebellar and other brain lesions and inner ear lesions
• It gives 2D image	• It gives 3D image in any plane
• Not possible to demonstrate arteries and veins without contrast	• Demonstration of arteries and veins without contrast can be done
• No problem with metallic implants	• Cannot be done with cochlear implants, aneurysm clips or pacemaker

Key Points

1. **Lateral view of mastoid** shows external and internal auditory canals overlapping each other, key areas of the mastoid, i.e. atticoantral region, sinodural angle along with sinus and dural plates, various mastoid air cells and TM joint of the same side.
2. Important causes of **cavitation in the mastoid** are cholesteatoma (irregular edges), operated mastoid cavity (regular and smooth edges), big air cell, malignancy of the mastoid, secondaries and metastasis, multiple myeloma, tuberculoma, eosinophilic granulomas.
3. Reduced air shadow along the free margin of a polyp or a mass into the nasopharynx is called **crescent sign**.
4. **Prevertebral space** if more than three-fourth the size of body of vertebra indicates either retropharyngeal abscess or a post-cricoid growth.
5. **Anteroposterior and lateral view** of neck are important to see if the foreign body is in the foodpipe or in the tracheobronchial tree.
6. **HRCT** is very useful in temporal bone fractures and fallopian canal lesions.
7. **Coronal CT** cuts are taken from anterior to posterior parallel to coronal sutures of skull.
8. **Axial cuts** are from inferior to superior or parallel to sagital sutures.
9. **Icecream cone in CT middle ear** is represented by head of malleus and incus.
10. **MRI is better** for facial nerve palsy as it provides better enhancement of nerve.
11. Ultrasound has waves of more than 20,000 cps frequency. The probe used transmits sound and also receives echoes.
12. **Piezoelectric crystals** produce ultrasound waves.
13. **Ultrasound of thyroid gland** differentiates between solid and cystic lesions.
14. **Advantages of USG** are, noninvasive, no radiations, painless, low cost and portable
15. **Doppler effect** measures sound by a moving source and hence measures blood flow, so may be used to study vascularity of tumors and is a good substitute for angiograms/venograms.
16. **Kero's classification** to find the height of cribriform plate
    Type I: 1–3 mm
    Type II: 4–7 mm
    Type III: 8–16 mm
    Type IV: Asymmetry.
17. **D/D of opaque maxillary sinus:** Trauma - due to blood collection/fungal disease and Wegener's granulomatosis/Neoplasms/Fibrous dysplasia/Dentigerous cyst
18. **D/D of bony erosion** Malignancy/Aggressive bacterial infections-/diabetics/Aggressive fungal infection/Osteomyelitis Rhinitis caseosa or cholesteatoma of nose
19. To differentiate mass from A/C polyp in maxillary antrum radiologically, opacity in nasal cavity goes in favour of A/C polyp.
20. Difference in Barium meal and Barium swallow study is that stomach is seen in the former.
21. TOWNE'S view is used to demonstrate—**remember mneumonic: SIMLA:** S: **S**uperior semicircular canal; I: **I**nternal auditory meatus; M: **M**astoid air cells; L: **L**ateral semicircular canal; A: **A**ntrum

Chapter 55

Radiotherapy in Head and Neck Cancers

What Students Must Know!

- **Introduction**
  - Radiotherapy
- **Modalities of Treatment**
  - Tele Therapy or External Beam Therapy
  - Brachytherapy
- **Various Sources of Radiation**
- **Mode of Action**
- **Management of Head and Neck Cancers**
  - Curative Radiotherapy
  - Combination of Surgery and Radiotherapy
- **Complications of Radiotherapy**
  - Care of Patient during Radiotherapy

INTRODUCTION

1. Radiotherapy (RT) over the years has become an important modality in the management of head and neck cancers.
2. In early stages, it is used as a curative modality with organ function preservation, especially in carcinoma larynx; while it is combined with surgery or chemotherapy as a palliative modality in recurrent and advanced head and neck cancers.
3. It may be used as an adjuvant to surgery or chemotherapy to increase the survival rate in advanced cases.

RADIOTHERAPY

1. Radiotherapy is a treatment with electromagnetic radiations, X-rays or gamma rays (photon beams) and particles which produce ionization in the body.
2. **Cellular deoxyribonucleic acid (DNA) is the prime target for mechanism of action of RT.** Malignant cells are incapable of repair of damaged DNA and so die faster than normal cells.
3. Radiation also acts indirectly by reducing the vascularity of tumor.
4. X-rays are produced when highly accelerated electrons strike an anode.
5. Gamma rays are emitted from radioactive isotopes, which exist in natural and artificial forms.
6. Radium 226 (Ra-226) is a natural radioisotope, while cobalt 60 (Co-60), cesium 137 (Cs-137), iridium 192 (Ir-192), gold 198 (Au-198), phosphorus 32 (P-32), and iodine 125 (I-125) are all artificial radioisotopes
7. High-energy particles like electrons are produced in linear accelerators (**Figure 55.1**). Electron beams are produced by linear accelerator or microtron.

MODALITIES OF TREATMENT

Tele Therapy or External Beam Therapy

1. When radiotherapy is delivered to the patient from a distance, it is called teletherapy. Earlier, 50–150 kV radiation was used in the treatment of superficial cancers of skin and lip (also called superficial therapy).

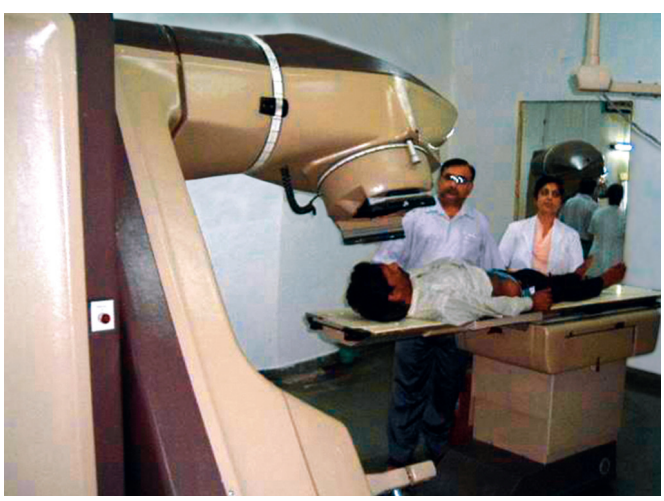


Figure 55.1 Patient being prepared for radiotherapy

2. It was followed by kilovoltage or orthovoltage radiations in the range of 250 kV (also called deep therapy).
3. It was followed by an era of supervoltage therapy (megavoltage therapy). Co-60 produces gamma rays in the range of 1.17 to 1.33 MeV. The source has natural decay time and needs replacement every 5 years.
4. Co-60 has a half-life of 5.23 years. It has skin sparing and bone sparing effect. As the energy increases, their penetration power increases.
5. Radiations in megavoltage range (linear accelerator) have a very high penetrating power and better percentage depth dose.
6. Linear accelerators, betatrons and cyclotrons produce radiations in the range of 4 to 35 MeV. They produce both protons and electron beam.
7. Electron beam is very useful in the treatment of deep-seated tumors as they have very high percentage depth dose at the target and sharp fall off beyond it thus, it spares the normal tissues around the tumor.

Brachytherapy

1. Brachytherapy is a modality where radioactive source is kept over the surface of tumor called surface mould treatment.
2. When source is placed in the cavity, it is called intracavitary brachytherapy.
3. When the source is placed in the tissues, it is called interstitial therapy.
4. Earlier, Ra-226 was used in the form of needles. Since it has a very long half-life of 1622 years, it was replaced by Ca-137 and Co-60 needles.
5. It has now been replaced by iridium 192 used in the form of wires. These are used in high dose rate remote control after loading brachytherapy. Au-198 and I-125 are used in the form of seeds or grains.

INTENSITY MODULATED RADIATION THERAPY

Intensity modulated radiation therapy (IMRT) is a recent addition to the method of delivery of radiotherapy and has been due to better understanding of extent of tumor due to computed tomography (CT) and computer controlled delivery of dose of radiation. It is good for carcinoma maxillary antrum and nasopharynx.

UNIT OF RADIATIONS

The absorption of energy in the biological material produces biological effect. The unit of energy absorbed per unit material is gray (Gy)/Gy corresponds to an energy absorption of 1 joule per kilogram. Previous unit was rad.

1 Gy = 100 rads or 100 cGy (centigray)
or 1 rad is equal to 1 cGy.

Various Sources of Radiation

1. X-ray machines, which deliver superficial (5-150 kV) or orthovoltage (200 to 400 kV)
2. Cobalt machine 60, which produces gamma rays and is good for head and neck tumors. Source needs to be replaced after 5 years.
3. Linear accelerator (betatron or microtron)—a mega-voltage machine producing radiation of 4 to 25 MV.
4. Radioactive material like Ra-226, Cs-137, Ir-192, I-125 and Au-198 are used.

MODE OF ACTION

Deoxyribonucleic acid is the principal target of ionizing radiation. The value of radiation or indeed the whole basis of radiotherapy rests on its capacity to destroy malignant growth *in situ* without producing destruction of normal tissues in which tumor is growing and which necessarily receives an equal amount of radiations. Radiation is thus a selective destructive agent. The selectivity depends on:

1. Lethal dose to the tumor
2. Normal tissue tolerance.

The ratio between these two is called therapeutic ratio. On the basis of therapeutic ratio, the tumors are categorized into:

1. Very sensitive tumors.
2. Moderately sensitive tumors.
3. Resistant tumors.

The other factors which are important to achieve maximum cell killing are:

1. Dose to the tumors.
2. Volume of the tumor.
3. Wavelength of radiation.
4. Dose time fractionation.

Conventionally, 200 cGy is delivered over 5 days in a week (Monday to Friday). Total dose of 4,000 to 6,000 cGy is delivered in 4 to 6 weeks. The four R's explain the biological rationale of dose time fractionation:

1. Repair of sublethal damage.
2. Repopulation between fractions.
3. Restribution of cells in cell cycle.
4. Reoxygenation of tumor.

MANAGEMENT OF HEAD AND NECK CANCERS

Curative Radiotherapy/Palliative RT

Before planning radiotherapy, it has to be decided whether RT being given is curative or palliative, site and extent of

tumor must be known, histology of tumor and dose of radiation. Early lesions, both local and regional, are taken care of simultaneously with radiotherapy. Interstitial implants with iridium 192 are used in early T1-T2 lesions. It gives high control rate with organ preservation, e.g. in oral cavity, oropharynx and nasopharynx. It gives safety to the personnel using after loading techniques, but the patient gets side effects like xerostomia.

The (IMRT) is a 3D radiotherapy with CT planning, also called high precision radiotherapy, which has been recently introduced. It spares the normal tissue, while delivering higher doses to the target. When lymph nodes are irradiated on both sides of neck, IMRT has been shown to preserve salivary gland function without compromising dose to the target tissue.

Combination of Surgery and Radiotherapy

Surgical salvage in radiation failed cases is far better than radiotherapy salvage in surgically failed cases. In large tumors T3-T4 there is poor control with either of the treatments.

Combination is advised in cases where there is:

1. Lymph node metastasis
2. Gross residual disease after surgery or radiotherapy
3. Unclear surgical margins.

Radiotherapy can be preoperative or postoperative. Surgery takes care of bulk of disease, while radiotherapy takes care of microscopic disease.

The goal is to obtain maximum number of patients free of disease with minimal morbidity and with functional and cosmetic acceptability. In planning patient, one must balance risk of treatment failure against discomfort and complications.

Advantages of Preoperative Irradiation

1. Conversion of nonresectable cancer to resectable one.
2. Prevention of distant metastasis.
3. Good control of primary cancer with occult local extension or uncertain extent is achieved.

Interval between radiotherapy and surgery should not be more than 3 to 6 weeks so that cancer cells are not able to repopulate. Dose given has to be cancericidal (45 to 50 Gy in 4 to 5 weeks), but not of curative level.

Disadvantages

1. Decreased wound healing; but with megavoltage irradiation, there is no disturbance in wound healing as it has skin sparing effect.
2. Gross shrinkage of tumor tempts the surgeon to perform less extensive surgery, which may lead to high recurrence rate.
3. Gross shrinkage provokes the patient to delay or even refuse curative resection.

Aims of Postoperative Radiotherapy

1. When surgical margins at primary site are positive and there is microscopic residual disease in advanced primary tumor.
2. Soft tissue, skin, cartilage or bone is infiltrated by tumor or there is perineural disease, i.e. extent of disease is known.
3. Lymph nodes are positive histologically.
4. Higher dose can be delivered.
5. Healing is superior.

Timing of Postoperative Radiotherapy

Postoperative radiotherapy should be given as soon as surgical wound heals because transected cells, if not treated early, get encased inside connective tissue scar. If scar gets older, cells become more and more resistant due to progressive hypoxia.

It should be given within 4 to 6 weeks. After surgery, dose should be in the range of 55 to 65 Gy.

Disadvantages

1. Distant metastasis is likely to be greater.
2. Decreased vascularly at the time of radiotherapy due to surgical tampering.

Palliative Radiotherapy

Palliative radiotherapy is used in very advanced cases, which have distant metastasis, general condition is too poor due to heart, lung or kidney diseases, in bleeding, pain or obstruction to air or food channels.

COMPLICATIONS OF RADIOTHERAPY

General Complications

1. Poor nutrition due to dysphagia.
2. Dyspnea due to laryngeal edema.
3. Recurrent infection due to decreased immunity.
4. Depression of bone marrow.

Local Complications

1. Alopecia
2. Erythema of skin
3. Excoriation of skin
4. Fungal infections
5. Mucosal stomatitis
6. Cataract and retinopathy
7. Xerostomia
8. Radionecrosis of mandible or maxilla and teeth
9. Perichondritis
10. Carcinogenic effect

11. Trismus (due to fibrosis of temporomandibular [TM] joint).

Focal Complications

1. Dysfunction of salivary and lacrimal glands and thyroid gland.
2. Transverse myelitis of spinal cord.

Care of Patient during Radiotherapy

1. General nutritional care includes diet rich in proteins, vitamins and iron.
2. If hemoglobin is low, fresh blood transfusion should be given.
3. Nasogastric tube is put for feeding.
4. Due care should be given to skin under irradiation.
   i. Exposure to sunlight should be avoided.
   ii. Area should be kept dry and it should not be washed with soap and water.
   iii. Avoid wet shaving, only clipping is advisable.
   iv. No adhesive plaster for dressing should be used.
   v. Area should be covered with soft cloth or silk for proper aeration.
   vi. Alcohol, spicy food and tobacco should not be used to avoid further trauma.
   vii. If acute mucositis persists, for 8 to 12 weeks local anesthetic can be applied.
   viii. If *Candida* infection occurs, clotrimazole or nystatin should be applied locally along with antifungal therapy.
5. Teeth need special care.

Radiation affects underlying bones, oral mucosa and salivary glands leading to dental caries.

If oral hygiene is poor, then suffering increases. These changes occur due to decrease in vascularity, decreased saliva formation and mucosal changes and decreased osteoblasts and osteoclasts formation.

To avoid these changes, the patient should be instructed to have proper hydration, regular mouthwashing, cleaning teeth after each meal, no artifical dentures, soft tooth brush, fluoride toothpaste, carious teeth should be extracted before irradiation, and impacted teeth should be removed. Radiotherapy is started 2 to 3 weeks after teeth extraction. Postoperative extraction is carried 18 to 24 months after radical radiotherapy.

Chemoprevention

Chemoprevention is an attempt to inhibit tumor formation from premalignant conditions or effectively block the process of development of second malignant neoplasm after the treatment of primary cancer.

Beta carotene, tocopherol, selenium, retinoids and vitamin A are used for reversal of oral leukoplakia in 25 to 50 percent.

Key Points

1. **X-rays were discovered by Roentgen in** 1895, while Radium by Marie Curie in 1899.
2. **Radiotherapy** acts by acting on the DNA of the nucleus of tumor cells and by inducing chemical changes due to ionizing radiation.
3. **Linear accelerator** has the advantage over cobalt 60 due to its higher percentage depth dose and no decay.
4. **Optimum dose of radiotherapy** is 4,000 to 6,000/7,000 cGy in 4 to 6 weeks [200 rads (cGy) for 5 days a week].
5. **More a tumor is anaplastic, more it is sensitive to radiotherapy,** besides it also depends upon the size of tumor, tissue of origins of tumor and oxygenation of tumor and degree of anaplasia. Lymphoid tissue tumors are very sensitive.
6. In **brachytherapy** radioactive material is placed in close contact with tumor tissue (tongue, maxilla and nasopharynx) in the form of needles, wires, seeds or moulds.
7. Important **side effects of radiotherapy** are skin reaction, dryness, local edema, mucosal reactions and malignancy.
8. **Xerostomia** is the most common long-term side effect of radiotherapy.
9. **Indication of RT** in benign lesions where risks of surgery are more such as—angiofibroma and glomus tumors.
10. **Indications for palliative RT** includes—advanced cancer with distant metastasis, poor general condition of the patient say due to heart, lungs, kidney or liver disease
11. 100 rad = 100 cent iGray = 1 Gray
12. Lymphomas, anaplastic tumors and embryonal tumors are **most sensitive to radiotherapy**.
13. Sarcomas and bone and soft tissue tumors are **radioresistant**.
14. **Source of brachytherapy** are Radium, Gold, Tantalum, Iridium and Cesium.
15. **Surgery after RT** should be done after 6 to 8 weeks so that edema subsides by that time.
16. Potential sites for **occult primary** are tonsil thyroid, base of tongue, nasopharynx, pyriform sinus and retromolar trigone.

Chapter 56

Chemotherapy of Head and Neck Cancers

What Students Must Know!

- ❖ **Introduction**
- ❖ **Cell Kinetic Concept**
- ❖ **Cell Cycle**
- ❖ **Chemotherapeutic Drugs**
  - Neoadjuvants Chemotherapy
  - Adjuvant Chemotherapy
  - Concomitant Chemotherapy
- ❖ **Workup of the Patient**

INTRODUCTION

- In advanced cancers (Stage III, IV) combined surgery and radiotherapy gives poor survival due to chances of recurrence and distant spread
- Surgery and radiotherapy combined with chemotherapy has improved the curability in advanced cancers.

CELL KINETIC CONCEPT

Both normal and tumorous cells have a certain growth capacity and are influenced and regulated by various internal and external forces. The differential growth and regulatory influences occurring in both normal and tumorous tissues form the basis of effective cancer treatment.

All normal tissues are capable of cellular division and growth. It is in three general forms:

1. Static cells do not grow after embryonic or neonatal period
2. Expanding cells proliferate under special stimuli (tissue injury)
3. Regenerating cells are constantly proliferating, e.g. bone marrow, epidermis and gastrointestinal mucosa.

This understanding explains most of the common type of toxicities with cancer treatments. Normal tissues with static pattern of growth are rarely injured by drugs, while renewing cell population is usually injured, e.g. bone marrow, gastrointestinal mucosa and spermatozoa.

CELL CYCLE

Cell cycle is in four distinct phases. G_1, S_1, G_2 and M phase. Duration is almost of 24 hours.

G_1 : It is a phase of deoxyribonucleic acid (DNA) synthesis
S : Nuclear DNA content of the cell is copied
G_2 : Ribonucleic acid (RNA) and protein synthesis.

$$S \rightarrow G_2 \rightarrow M \rightarrow G_0 \text{ or } G_1 \rightarrow S$$

There is repair of errors of DNA replication in this phase. Defects in this repair mechanism lead to increased incidence of cancer.

M : Mitosis—nuclear division
: DNA is equally distributed to daughter cells.

Dividing cancer cells that are actively traversing cell cycle (M phase) are very sensitive to chemotherapeutic agents. Cells in resting phase (G_0) are insensitive to chemotherapeutic agents although they occupy space and add to the bulk of tumor.

CHEMOTHERAPEUTIC DRUGS

Various chemotherapeutic drugs (**Table 56.1**) are used either single or in combination with radiotherapy or surgery as follows.

Neoadjuvants/Anterior/Induction Chemotherapy

It is delivered prior to surgery or radiotherapy in two to three cycles. This form of therapy converts an unresectable tumour

Table 56.1: Chemotherapeutic agents used in head and neck cancer

Drug	*Type of neoplasm*	*Common treatment schedule*	*Common toxicities*
Antimetabolites			
5-fluorouracil	Squamous cell carcinoma	10–15 mg/kg IV daily not more than 1 g in single dose for 4–5 days. Repeated every 21 days	Myelosuppression Mucositis (nausea, vomiting, stomatitis, diarrhea) Skin—alopecia, hyperpigmentation, maculopapular rash, hand and feet syndrome.
Methotrexate	Squamous cell carcinoma, lymphoma	40 mg/m^2/weekly high dose in leucovorin rescue	Bone marrow insufficiency Mucositis of oral cavity, GI* mucosa Renal, hepatic toxicity Maculopapular rash.
Alkylating agents			
Cisplatin	Squamous cell carcinoma	80–120 mg/m^2 IV every 3 week 10–20 mg/m^2 × 5 day every 3 week	GIT† (nausea, vomiting) Renal toxicity, neurologic (peripheral neuropathy), ototoxicity, hematologic (anemia, leukopenias, thrombocytopenias).
Carboplatin	Squamous cell carcinoma	300–400 mg/m^2 × 6 every 3-4 week	Neuropathy, ototoxicity, nephrotoxicity. It is more hematotoxic than Cisplatin.
Dacarbazine	Melanoma, sarcoma	250 mg/m^2 × 5 days every 3 week	Severe nausea, vomiting, myelosuppression, flu-like syndrome, alopecia.
Cyclophosphamide	Squamous cell carcinoma, lymphoma, neuroblastoma	60-120 mg/m^2 IV daily × 5 day every 3 week	Hemorrhagic cystitis, alopecia, nausea, vomiting, neutropenia, cessation of menses, permanent infertility.
Iforsfamide	Squamous cell carcinoma lymphoma, neuroblastoma	1.0-1.2 g/m^2/day × 5 day	Myelosuppression Bladder toxicity CNS‡ and renal toxicity.
Antitumor antibiotics			
Bleomycin	Squamous cell carcinoma, lymphoma	10-20 mg/m^2 once or twice weekly IM or IV	Pneumonitis (dry cough with rales), pulmonary fibrosis, fever and chills in first 24 hours alopecia, erythema, hyperpigmentation.
Adriamycin (Doxorubicin)	Lymphoma, sarcoma, esthesioneuroblastoma, salivary gland tumors	60-90 mg/m^2 every 3 week (total dose 500 mg/m2)	Cardiotoxicity, alopecia, stomatitis, nausea, vomiting, diarrhea, neutropenia, local vesication.
Plant alkaloids			
Vincristine (Oncovin)	Lymphoma, squamous cell carcinoma, rhabdomyosarcoma	1.5 mg/m^2 once or twice monthly	Neurotoxicity, alopecia, myelosuppression, constipation.
Paclitaxel (Taxol)	Squamous cell carcinoma	175 mg/m^2 (3 hour infusion)	Myelosuppression, alopecia, cardiotoxicity, arrhythmias, allergic reaction.

*GI: Gastrointestinal
†GIT: Gastrointestinal tract
‡CNS: Central nervous system

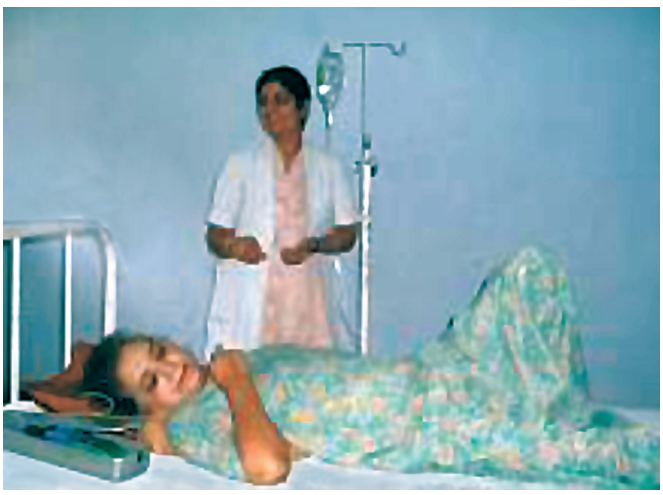


Figure 56.1 Patient being given chemotherapy

to a resectable one and reduces the chances of seeding and micrometastasis intraoperatively.

Adjuvant Chemotherapy

It is delivered after surgery or is sandwiched between surgery and radiotherapy in two to three courses. It is delivered when surgical margins are positive and there is extracapsular lymph node invasion.

Concomitant Chemotherapy

1. It is delivered during radiotherapy at 2 weeks interval or weekly interval for 3 to 4 cycles. It gives high toxicity.
2. Drugs used are either single or in combination, e.g. Methotrexate, bleomycin, carboplatin, cisplatin, 5-fluorouracil, vinblastine and doxorubicin.
3. Newer drugs are paclitaxel, docetaxel, topotecan and vinorelbine.
4. Methotrexate is the first single drug used in squamous cell carcinoma. Combination of two or more drugs improves the response rate.
5. From the knowledge of cellular kinetics, different chemotherapeutic regimens are designed, which act in different phases of tumor cell cycle.
6. Use of multiple drugs with different kinetic characteristics reduce the tumor mass more completely than any single chemotherapeutic agent while minimizing the impact of single drug resistance.
7. By using combination or sequences of cell cycle specific and cell cycle nonspecific agents, there is log kill in tumor thus achieving a cure.
8. Log kill means a constant fraction is killed rather than a constant number. Where there is big burden, a single exposure of antineoplastic drug first gives 2 to 5 log of cell kill with a burden of 1012 cells.
9. Intermittent courses achieve the maximum cell kill required for tumor regression and cure. If tumor mass is less, cure rate is better.
10. Chemoprevention drugs are given to suppress carcinogenesis and prevent the development of invasive secondary cancer.

WORKUP OF THE PATIENT

Before the patient is put on treatment (**Figure 56.1**), an assessment is done by taking:

- History and clinical examination
- Hematological tests [Hemoglobin (Hb), total leukocute count (TLC), differential leukocyte count (DLC), platelet count]
- Urine examination
- Blood urea
- Blood creatinine
- Liver function tests
- X-ray chest
- Computed tomography (CT) and magnetic resonance imaging (MRI)
- Ultrasonography
- Pulmonary function tests
- Electrocardiography (ECG)
- Audiogram
- Nutritional status of patient.

Key Points

1. **Chemotherapy** may be adjuvant when used with, before or after surgery or radiotherapy and palliative chemotherapy when used only as a palliative measure in advanced cases to relieve pain, etc.
2. **Chemotherapeutic agents** may be cytotoxic such as alkylating agents (cyclophosphamide), anticancer antibiotics (bleomycin), antimetabolites (Methotrexate), alkaloids (vincristine) or miscellaneous (Cisplatin).
3. Most common **side effects of chemotherapy** are alopecia, stomatitis, depression of bone marrow, nephrotoxicity, neurotoxicity, ototoxicity and pulmonary fibrosis.
4. **Chemotherapeutic agents are most useful in lymphomas**.
5. **Gene therapy** is capable of treating the basic disease by **altering the genetic make up of the patient's cell**. Two types are germ cell therapy (insertion of a gene into an egg) and somatic cell therapy (manipulation of the gene).

Chapter 57 Cryosurgery

What Students Must Know!

- **Introduction**
  - What is Cryosurgery?
  - Mechanism of Action
- **Pathophysiology**
- **Indications of Cryosurgery**
  - Nose
  - Oral Cavity and Pharynx
  - Ears
  - Tumours of Head and Neck
- **Advantages of Cryosurgery**
- **Disadvantages**

INTRODUCTION

1. Cryosurgery is the process of destruction of the tissues by rapid cooling and freezing to a very low temperature and then thawing.
2. It literally means surgery by freezing.
3. It is **based upon the Joule-Thomson effect** of the cooling of gases where there is sudden rapid expansion of the compressed gas from high to low pressure through a narrow orifice leading thereby to extremely low temperature.
4. The temperature ranges between **–20°C and –170°C**. The cooling agents used are liquid nitrous oxide, carbon dioxide snow or liquid nitrogen spray.
5. The operative procedure of cryosurgery is very simple and safe. Generally, no anesthesia is given, but a local anesthetic can be used.
6. A cryoprobe is applied to the site of lesion for 2 to 5 minutes.
7. The working pressure of the instrument is kept at 600 to 1,000 psi or 40 to 70 kg/cm^2.
8. Ice is formed at the cryotip which is allowed to thaw.
9. The slough is removed or falls itself after 1 to 3 weeks.
10. If needed, the procedure can be repeated a number of times (**Figures 57.1 and 57.2**).

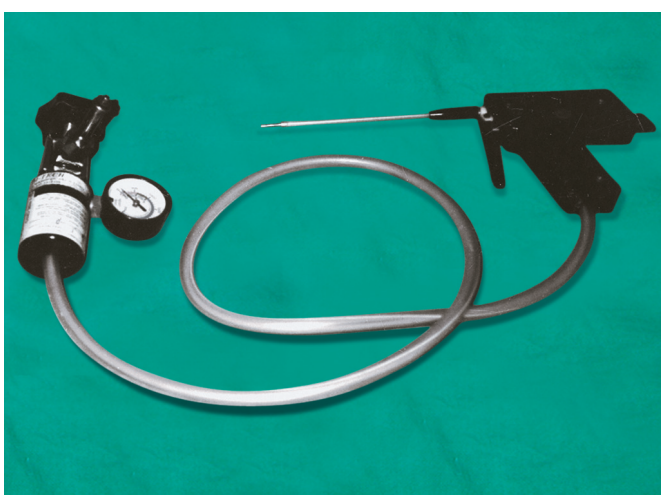


Figure 57.1 Cryoprobe

MECHANISM OF ACTION

Freezing causes cell death by following mechanism:

- Dehydration of cells
- Denaturation of cellular proteins
- Occlusion of blood supply by microthrombosis
- Thermal shock
- By alteration of cellular pH
- By cryoimmunization due to development of autoimmune response.

PATHOPHYSIOLOGY

The lethal effect of freezing may occur in many ways:

1. Rupture of cell membranes.
2. Intracellular dehydration.

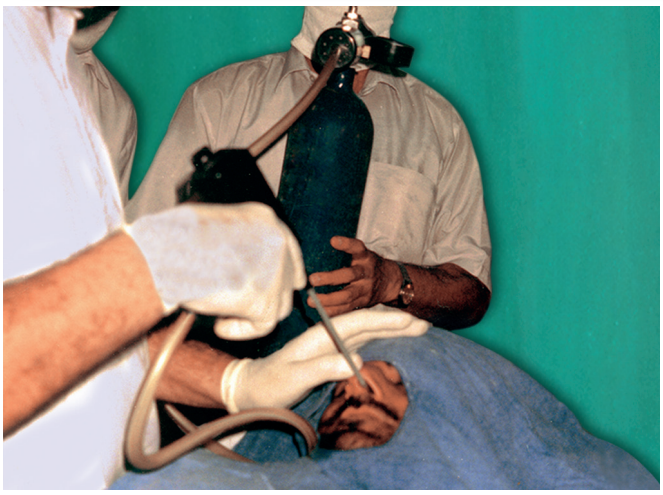


Figure 57.2 Cryosurgical procedure

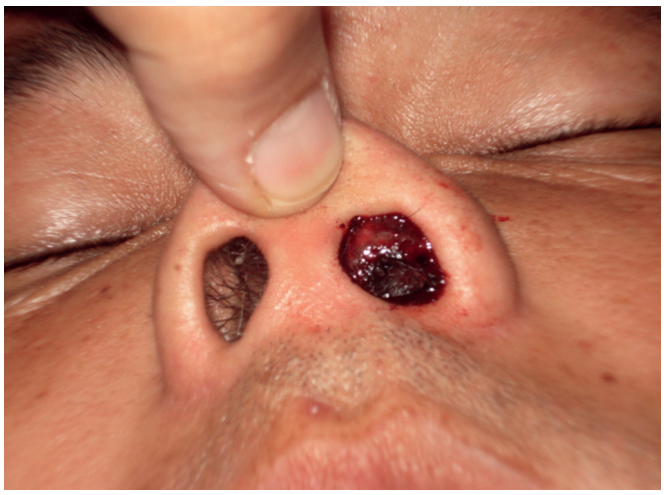


Figure 57.3A A bleeding polypus nasal cavity

3. Protein denaturation.
4. Local ischemia or microthrombosis.
5. Formation of antibodies against the frozen tissues.
6. Mechanical destruction of cellular structure by intracellular ice.

It has been established that effectiveness of freezing to kill the cells depends upon the rate of cooling, the temperature obtained during the procedure, the duration of the cooling, the rate of thawing, the size of the cryoprobe and lastly, the cellular response.

INDICATIONS

1. Cryosurgery has been widely used in various diseases of the ear, nose and throat, because there is no scar formation and no excision is required.
2. It is used as a curative as well as a palliative procedure, especially in some advanced malignant lesions. Diseases where cryosurgery is beneficial are as follows.

Nose

- Allergic rhinitis and vasomotor rhinitis
- To reduce the size of inferior turbinates in chronic rhinitis
- Nasal epistaxis
- Nasal polypi
- Some benign vascular lesions like hemangiomas or inverted papillomas (**Figure 57.3A**)
- Granulomatous lesions.

Oral Cavity and Pharynx

- Leukoplakia of oral cavity and vocal cords (**Figure 57.3B**)
- Dentin hyperplasia
- Papillary hyperplasia of palate
- Fibrous eputis
- Mucous cysts
- Granular pharyngitis
- Tonsil remnants or tonsillectomy and adenoidectomy, especially in blood dyscrasias
- Glossopharyngeal neuralgias
- Lingual thyroid
- Erythroplakia
- Ulcerative lesions.

Ears

- Ménière disease
- Glomus jugulare
- Malignancy of ear.

Tumors of Head and Neck

- Skin cancers over the nasal and ear cartilages
- Malignant melanoma
- Epidermoid cysts
- Capillary hemangioma
- Basal cell carcinoma
- Lymphangiomas
- Inverted papilloma
- Laryngeal papilloma (**Figure 57.3C**)
- Laryngeal hemangiomas
- Carcinoma tongue.

Miscellaneous Indications

Hypophysectomy or Pituitary Ablation

In malignancies, cryosurgery is used for palliation or to reduce the size of the tumor, especially to make the airway wide.

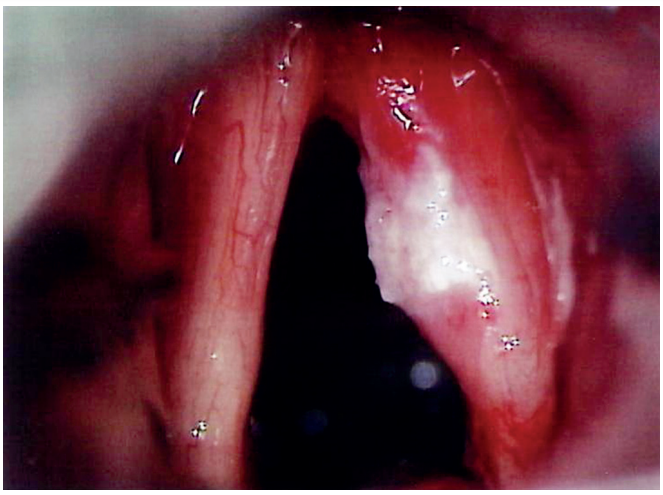


Figure. 57.3B Leukoplakia of vocal cords

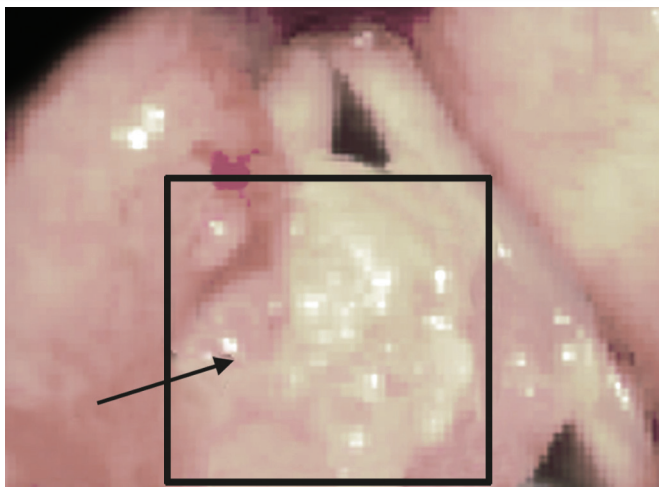


Figure 57.3C Multiple papillomas of larynx

ADVANTAGES

Cryosurgery has the following advantages over other surgical procedures:

- It is an outpatient procedure (Day care surgery)
- Usually no anesthesia is required
- Postoperatively, there is very little pain or discomfort
- No hemorrhage or very little hemorrhage, so it can be used in patients with blood disorders
- It is safe and portable
- It can be tolerated by elderly people
- No complaint of keloid formation
- It is very effective as an adjunct with other therapies for the treatment of malignancies
- It also induces immune response in cancer patients.

DISADVANTAGES

- Biopsy cannot be obtained
- Limited efficacy
- Needs many sittings
- Depigmented scar
- No control on depth of freezing.

Key Points

1. **Advantages of cryosurgery** are minimal discomfort, no scarring, hardly any bleeding, no anesthesia and it is an outpatient department (OPD) procedure.
2. **Joule-Thomson effect** states that sudden rapid expansion of compressed gas through a narrow orifice produces cooling.
3. **Cryosurgery** causes cell death by dehydration, thermal shock, vascular occlusion, denaturation or cryoimmunization.
4. Some important **indications for cryosurgery** are chronic hypertrophic rhinitis, hemangiomas, leukoplakia, skin cancer, palliation of recurrent tumors.
5. Minimum temperature achieved is **–20°C to –170°C and agents used are N_2O, CO_2 or liquid nitrogen**. N_2O achieves – 70°C, while liquid nitrogen gives cooling up to –196°C.
6. Cryosurgery is of **no use in angiofibroma** because tumor is very vascular and it is difficult to form an ice ball.

Chapter 58 LASER in ENT

What Students Must Know!

- **Introduction**
  - Advantages of LASER
  - Disadvantages
- **Types of LASER**
  - Carbon Dioxide (LASER)
  - Nd-YAG LASER
  - Argon
  - Potassium Titanyl Phosphate
- **Indications of LASER**
  - Anesthesia in LASER
- **Safety Measures in LASER**
  - Hyperbaric Oxygen in ENT

INTRODUCTION

1. LASER is an abbreviation for Light Amplification by Stimulated Emission of Radiation.
2. Albert Einstein was the first to invent the essential physics of stimulated emission in 1917 in his quantum theory of radiation. From an elementary knowledge of the atom, it is clear that when an atom is excited by an external source (e.g. electricity, heat or light energy), the electrons in the atom get stimulated and move away from the proton. These stimulated atoms absorb energy. When the external source is removed, the electrons come to their original resting state and the atoms will release the gained energy, which is called spontaneous emission of radiation.
3. These emissions are untimed, erratic in direction and have different frequencies. For a LASER, these radiations are reflected by a mirror and made unidirectional with same frequency. There will be an enormous energy focussed on to a small beam, which is called a 'LASER beam' (an electromagnetic radiation).
4. The energy released by LASER system depends upon the type of the medium or substance (e.g. CO_2, argon, etc.) which is capable of producing stimulated emissions of energy.
5. Low-energy beams are generally used for coagulation, prevention of scars, etc.
6. High-energy LASERs are used for cutting, vaporization, etc.
7. The LASER beam is generally invisible; but when red helium light is added to this beam, it helps the surgeon in visualization and to focus it on the tissue (**Figure 58.1**). So LASERs are electromagnetic radiations with specific wave length depending upon the type of lasing media, i.e. CO_2, argon or Nd:YAG.
8. The LASER system consists of a compact tube (**Figure 58.2**) in which the medium (i.e. CO_2, argon, etc.) can be filled. The source of energy is attached to this compact tube. This tube is having two concave mirrors—one having 100 percent reflectivity is fitted on the rear side of this tube and the second has partial reflectivity. This second mirror allows some of the beam to pass through it. This beam is transported through either an articulated arm of mirrors and prisms or fiberoptic cable to its final destination (**Figure 58.3**).

ADVANTAGES OF LASER

1. There is an instant vaporization of the tissues at a great speed and there is very little conduction of heat to the adjacent structures or tissues.
2. The LASERs help in coagulation of small vessels and the surgical field is kept bloodless.
3. The LASERs prevent the metastasis of the malignant tumors by blocking the lymphatics.
4. The LASERs cause very little tissue trauma.
5. The LASERs help to decrease the postoperative neuralgia by sealing the peripheral nerves.
6. Surgical precision and hemostasis with minimum post-operative edema and no scarring.

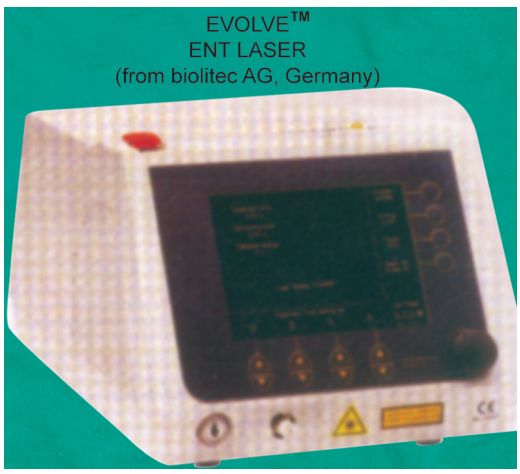


Figure 58.1 LASER apparatus

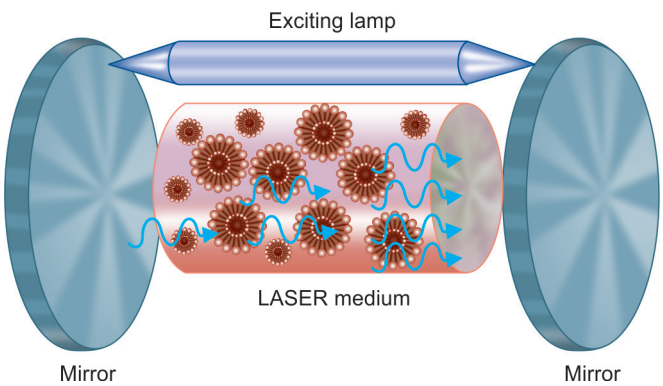


Figure 58.2 Mechanism of LASER

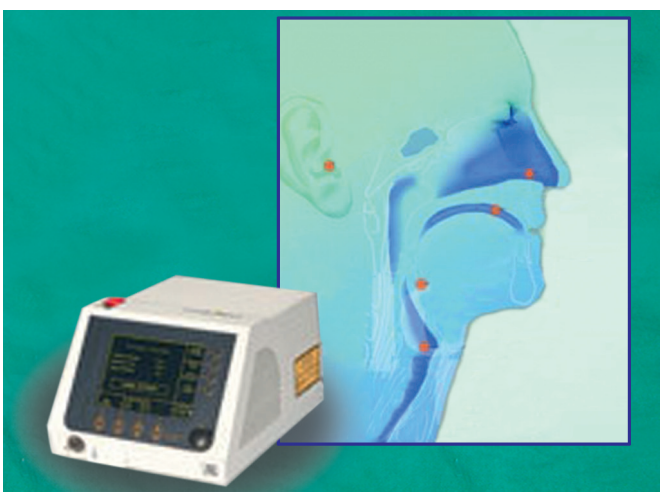


Figure 58.3 LASER and its sites of use in ENT

DISADVANTAGES

- High cost
- Biopsy cannot be taken
- Hazards to the patient and OT staff.

TYPES OF LASERS

Commonly used LASERs are as follows.

Carbon Dioxide (CO_2) LASER

1. Carbon dioxide is very commonly used in ENT.
2. It is an invisible LASER beam emitted at a wavelength of 10,600 nm.
3. The medium is a mixture of carbon dioxide, nitrogen and helium gases.
4. The invisibility of CO_2 LASER is covered by a red beam produced by helium-neon.
5. The CO_2 LASER is used for cutting and vaporization. It also helps to coagulate the small blood vessels and creates a bloodless field.

Nd:YAG LASER

1. The medium is in crystal form.
2. It is Neodymium-doped with Yttrium-Aluminum-garnet (Nd:YAG).
3. The LASER can be easily passed through fiberoptic flexible endoscopes.
4. Its wavelength is 1,060 nm. It has coagulative and cutting properties.

Argon

1. A high power electric current is passed through the argon gas (medium), which excites the atoms and a bluish-green LASER beam is produced.
2. Its wavelength is 488 to 512 nm. It is generally used to destroy the vascular lesions because it has the property of affinity towards hemoglobin.

Potassium Titanyl Phosphate

1. Potasium titanyl phosphate (KTP) is a blue green colored LASER beam with a wavelength of 532 nm.
2. It is used for cutting and coagulating.
3. It can be transmitted through flexible endoscope.
4. This beam is also absorbed by hemoglobin (**Figure 60.2**).

INDICATIONS OF LASERS

Oral Cavity (CO_2 and Nd:YAG LASERs)

1. For excising mucosal lesions like leukoplakia, erythroplakia.

2. To excise small tongue carcinomas.
3. For debulking of large oral tumors.
4. For reducing trismus in oral submucosal fibrosis.
5. Tonsillectomy can be done with LASER.
6. For uvulopalatopharyngoplasty in snoring.

Laryngeal Surgery (CO_2 LASER)

1. Recurrent laryngeal papillomas, vocal polypi and nodules, laryngotracheal stenosis, benign laryngeal cysts, subglottic granulomas, hemangiomas, etc.
2. In bilateral vocal cords palsy, LASER is used in arytenoidectomy or vocal cord excision.
3. In laryngeal malignancies to excise the small primary tumors or to reduce the size of the tumors.

Nose and Sinus Surgery (CO_2 LASER)

1. To excise small tumors and polypi.
2. For treatment of vasomotor rhinitis for excising the vidian nerve.
3. KTP LASER is used in partial turbinectomy.

Ear Surgery (KTP, Nd:YAG and CO_2 LASERs)

1. For removal of granulomas and polypi in the middle ear.
2. In ossicular reconstruction and stapedectomy operations.
3. For removing small intracanalicular acoustic neuromas.

Miscellaneous (Argon and CO_2 LASERs)

1. Lesions of skin, e.g. telengiectasias, naevi, condylomata, rhinophymas, tattoos, etc.
2. Benign and malignant skin tumors.

ANESTHESIA IN LASER

1. The anesthetist usually suffers a problem in keeping the airway safe in the presence of high-energy LASER beam along with the oxygen, nitrous oxide and endotracheal tube which can catch fire.
2. So a LASER-resistant tube, usually a red rubber tube, is used. Sometimes the endotracheal tube can be wrapped in a metallic tape above and below the metallic cuff. Such tubes are only for a single use. Commercially available LASER-resistant tubes have their own advantages and disadvantages.
3. Alternatives to the endotracheal tubes are jet ventilation, Sander's venturi ventilation techniques or apneic techniques.

SAFETY MEASURES IN LASERS

LASER beams are high-energy ignition source and every care must be taken to protect the various persons handling it in surgery.

1. Wear protective, LASER resistant eye glasses to protect cornea and retina.
2. Cover the patient's eyes and exposed parts with moist gauze.
3. Use dull finished instruments in LASER.
4. Use measures to remove smoke so as to avoid chemical injury to larynx.
5. Use only non-inflammable gases like halothane (ether is strictly contraindicated).
6. Wrap rubber tube with reflective metallic foil.
7. Cuff of the tube should be protected with saline-soaked cottonoids.

USES OF HYPERBARIC OXYGEN IN DISEASES OF ENT

1. It is being commonly used modality of treatment in ENT.
2. It means inhalation of 100 percent oxygen for 1 hour at 2.4 atmospheric pressure after placing the patient in a hyperbaric oxygen chamber.
3. Usually 15 to 20 sittings are required.
4. It is very costly at present.
5. During this therapy, pressure of oxygen rises in body fluids and supply of oxygen to vital parts increases and viscosity of blood decreases improving flow of oxygen to ischemic cells.

Various Indications

- Sudden sensorineural hearing loss (SNHL)
- Noise-induced hearing loss
- Tinnitis
- Malignant otitis externa
- Fungal infection of sinuses
- Non-healing ulcers
- Air embolism
- Burn cases
- Osteomyelitis
- Skin grafts.

Key Points

1. **LASER** stands for light amplification by stimulated emission of radiation.
2. **Argon and potassium titanyl phosphate (KTP)** LASER is best for middle ear surgery and **CO_2 LASER** for laryngeal and nose surgery.
3. **Safest tube** with Nd:YAG LASER is colorless or poly vinyl endotracheal tube with no dark letters or lead lining.
4. Main **advantages of LASER** are precision surgery, minimum bleeding and minimal tissue reaction with rapid healing, while disadvantages are high cost, biopsy may not be possible and trauma to the patient.
5. **CO_2 LASER** is most commonly used LASER for ENT and general surgery.
6. **Characters of LASER beam** are:
   - Same direction
   - Same wavelength
   - No diversion
   - Fine focus
   - Monochromatic light.

Section 9 Miscellaneous Disorders

Chapter 59 Proptosis

What Students Must Know!

- **Introduction**
  - Proptosis
  - Exophthalmos
- **ENT Causes of Unilateral Proptosis**
  - Infective
  - Traumatic
  - Neoplastic
  - Miscellaneous
  - Clinical Features
  - Diagnosis
  - Treatment of Proptosis

INTRODUCTION

- Proptosis means forward displacement of eyeball beyond orbital margins and it is also an important symptom of ear, nose and throat (ENT) lesions.
- Exophthalmos is same as proptosis, but it is more used with displacement associated with thyroid diseases. Lagophthalmos is inability to completely close the eyes.
- It may be unilateral, bilateral, acute, intermittent or pulsating proptosis.
- Axial proptosis is a term used when proptosis is straight forward.
- Orbit is in close relation to frontal sinus above, ethmoidal sinus medially and maxillary sinus inferiorly.
- Nasopharyngeal lesions may affect the orbit through pterygopalatine fossa.

ENT CAUSES OF UNILATERAL PROPTOSIS

Infective

- Sinusitis
- Orbital cellulitis
- Subperiosteal cellulitis.

Traumatic

- Maxillofacial injuries
- Iatrogenic trauma
- Orbital hemorrhage
- Retained foreign bodies.

Neoplastic

- Nasopharyngeal fibroma
- Carcinoma maxilla
- Carcinoma ethmoids
- Carcinoma nasopharynx
- Olfactory neuroblastoma.

Miscellaneous

- Fibro-osseous dysplasia
- Mucocele of fronto ethmoidal sinus
- Granulomas
- Cavernous sinus thrombosis
- Congenital dermoid cyst
- Aneurysms.

CLINICAL FEATURES

- Features of causative disease
- Protrusion of eyeball
- Double vision
- Examination shows restricted movements of eyeball.

Pseudoproptosis is seen in

- Buphthalmos
- High myopia
- Enophthalmos of the opposite eye (**Figure 59.1**).

DIAGNOSIS

- Clinical features and ENT examination including anterior and posterior rhinoscopy

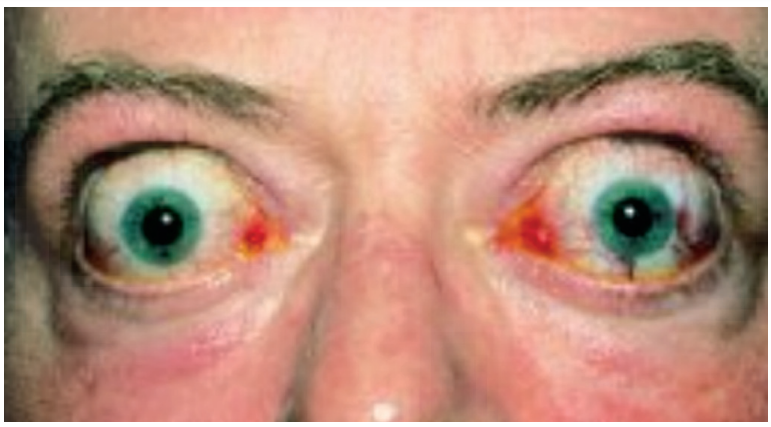


Figure 59.1 A patient with proptosis

- X-rays of orbit/paranasal sinuses/nasopharynx
- CT scan paranasal sinuses/orbit/nasopharynx
- Biopsy of suspected growth.

TREATMENT

- Treatment of the cause is most important and the proptosis slowly reverts back to normal.
- When noninvasive methods fail, surgical decom-pression may be done by using a nasal endoscope after the primary cause has been treated. Transnasal endoscopic approach targets the medial wall of the orbit.
- Surgical decompression involves removal of floor and the posterior part of medial wall of maxillary antrum.
- Malignant tumors may require combination of surgery and radiotherapy.

Key Points

1. **Proptosis** usually indicates forward displacement of eyeball beyond the margins of orbit. The word exophthalmos means the same as proptosis, but is used when associated with thyroid disorders.
2. **Five most important ENT causes of proptosis** are complication of chronic sinusitis, maxillofacial injuries, iatrogenic trauma, tumors of nasopharynx and paranasal sinuses (PNS) and cavernous sinus thrombosis.
3. **Pseudoproptosis**, which in fact is not a true bulging out of the eyeball and is seen in high myopics, enophthalmos of the opposite eye and buphthalmos.
4. Important part of treatment is **surgical decompression** after the primary cause has been treated.
5. Most important cause of **proptosis in children** is orbital cellulitis; while in adults, it is thyroid disease.
6. **Unilateral pulsating** proptosis is due to:
   - Arteriovenous (AV) fistula
   - Ophthalmic artery aneurysm or
   - Sarcoma

Chapter 60

Cavernous Sinus Thrombosis

What Students Must Know!

- ❖ **Introduction**
- ❖ **Communications of Cavernous Sinus**
- ❖ **Cavernous Sinus Thrombosis**
  - Causes
  - Clinical Features
  - Diagnosis
  - Investigations
  - Treatment
  - Differential Diagnosis

INTRODUCTION

Cavernous sinus thrombosis is a serious complication resulting from spread of infection and thrombophlebitis of ethmoid, sphenoid and frontal sinuses.

COMMUNICATIONS OF CAVERNOUS SINUS

1. **Anteriorly:** With superior and inferior ophthalmic veins. Superior ophthalmic vein gets blood from angular and frontal vein, while inferior ophthalmic vein is connected with pterygoid venous plexus.
2. **Posteriorly:** Superior and inferior petrosal sinus leave it to join lateral sinus. Labyrinthine veins open into inferior petrosal sinus bringing infection from middle ear. Mastoid emissary vein connected to lateral sinus spreads infection from mastoid air cells.
3. **Superiorly:** Vein of cerebrum brings blood from meninges and cerebrum (**Figures 60.1A to C**).
4. **Inferiorly:** Communicates with pterygoid venous plexus.
5. **Medially:** Two cavernous sinuses are connected with each other by transverse sinuses, which accounts for spread of infection from one side to the other.

Causes

- Spread of infection from frontal, sphenoid and ethmoidal sinuses through ophthalmic veins
- Infection from dangerous area of face and nose and upper lip via pharyngeal plexus
- Orbital cellulitis and abscess through ophthalmic veins
- Lateral sinus thrombosis due to ear disease such as petrositis through petrosal venus sinuses
- Quinsy via pharyngeal plexus.

CLINICAL FEATURES

- Starts as unilateral disease but soon becomes bilateral
- High-grade fever with rigors
- Vomiting, headache
- Severe pain in eye
- Conjunctiva is swollen and congested (**Figure 60.2**)
- Dilated and fixed pupil
- Proptosis directly forward and ptosis
- IIIrd, IVth and VIth cranial nerve palsy
- Edema of mastoid region
- Papilledema is a late feature
- Engorged retinal veins and ophthalmoplegia
- Cerebrospinal fluid (CSF) is usually normal

DIFFERENTIAL DIAGNOSIS

- Orbital cellulitis.
- Panophthalmitis.

In these conditions proptosis is moderate to marked degree with painful and restricted mobility of eyeball with mild fever and prostration.

Investigations

- Blood culture
- Fundoscopy
- Computed tomography (CT) scan.

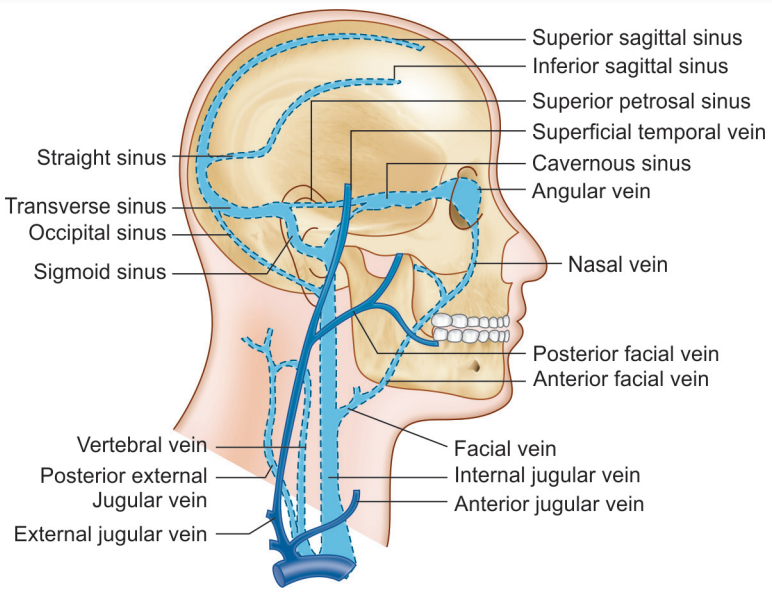


Figure 60.1A Venous drainage of head

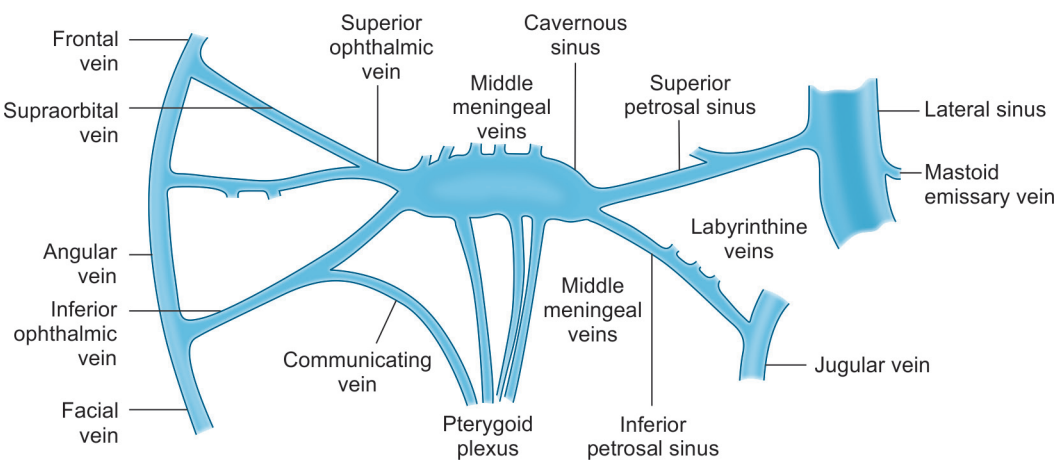


Figure 60.1B Cavernous sinus and its drainage

Treatment

1. **Antibiotics:** IV broad-spectrum pareneteral antibiotics such as injection gentamicin 80 mg. BD with injection ampicillin 500 mg to 1 gm, 6 to 8 hourly.
2. **Anti-inflammatory drugs** for control of pain and fever.
3. **Anticoagulants** are considered in case of thrombosis.
4. Treatment of the **underlying cause** is also important.

COMPLICATIONS

1. Hyperpyrexia.
2. Meningitis.
3. Extradural, subdural and frontal lobe abscess.
4. Pulmonary infarction.
5. Death.

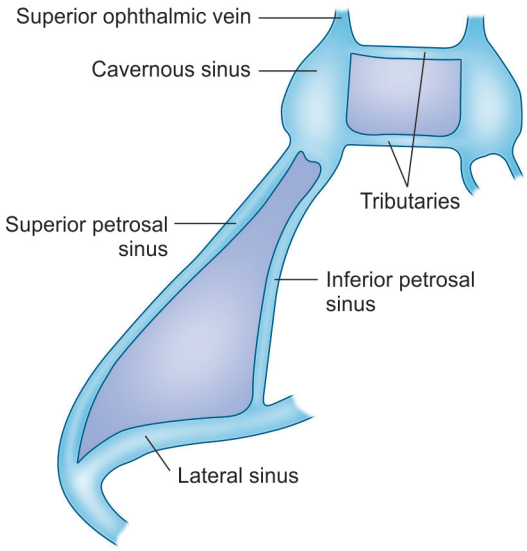


Figure 60.1C Cavernous sinus and its drainage

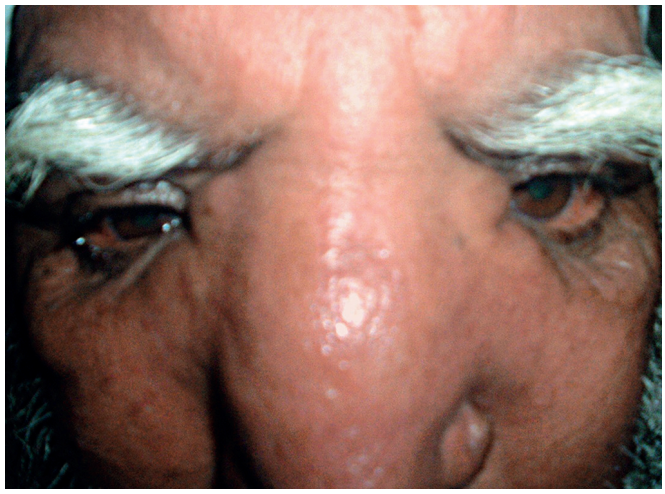


Figure 60.2 A patient of cavernous sinus thrombosis

Key Points

1. Most important **causes of cavernous sinus thrombosis** are spread of infections from ethmoidal or sphenoidal sinuses; from dangerous areas of face and nose and from orbital cellulitis.
2. **Cavernous sinus thrombosis** is suspected, when the patient presents with high-grade fever with rigors, pain, chemosis, proptosis, 4th, 5th and 6th nerve palsy.
3. Squeezing in nasal furuncles is avoided unless it is pointing for the fear of spread of infection to cavernous sinus through ophthalmic vein via valveless facial veins.
4. **Sinus thrombophlebitis** in quinsy is accompanied by pipe stem neck due to thrombophlebitis of internal jugular vein.
5. **Orbital cellulitis differs** from cavernous sinus thrombosis by the presence of moderate to marked degree of proptosis (downward and outward) and painful and restricted mobility of eyeball.
6. **Important investigations** include blood culture (showing Staphylococcus and Streptococcus), fundoscopy and CT scan.
7. **Complications of cavernous sinus thrombosis** are meningitis, pulmonary infarctions and death.
8. **Constricted pupil** in response to light is **not a feature** of cavernous sinus thrombosis.
9. **Petrositis** can also lead to lateral sinus thrombosis
10. Cavernous sinus is **connected to sigmoid sinus** through superior and inferior petrosal sinus besides its connection to ophthalmic vein, frontal vein, emissary veins, sphenoparietal sinus and opposite cavernous sinus.

Chapter 61

Cerebrospinal Fluid Rhinorrhea

What Students Must Know!

- **CSF Rhinorrhea**
- **Etiology**
  - Congenital
  - Traumatic
  - Clinical Features
  - Diagnosis
  - Treatment
  - Complications of CSF Leak

INTRODUCTION

1. Cerebrospinal fluid (CSF) is produced by choroid plexus of 3rd, 4th and lateral ventricles of brain and average CSF volume is 100 to 150 mL in an adult.
2. Normal CSF pressure varies between 5 and 15 cm of water.
3. CSF rhinorrhea is the flow of CSF from the nose, which can occur spontaneously or because of varied etiological factors.
4. It results from a breakdown of dura of skull base giving rise to a communication between subarachnoid space and nose.
5. Usually, the sites of CSF leak are cribriform plate of ethmoid, frontoethmoid and sphenoid sinuses, which have an intimate relationship with the nasal cavity.
6. Galen was the first to describe CSF rhinorrhea in second century AD.

ETIOLOGY

Congenital

- Congenital dehiscences of the nasal roof
- Meningoencephalocele or
- Congenital hydrocephalus.

Traumatic

- Fracture in anterior cranial fossa in head injury cases (most common cause) Iatrogenic trauma
- Transnasal hypophysectomy
- Intranasal ethmoidectomy
- Frontoethmoid mucocele operation
- Functional endoscopic sinus surgery (FESS) following polypectomy, mucocele and after fungal sinusitis.

Spontaneous

- Raised intracranial tension
- Hydrocephalus
- Destructive bony lesions like granulomas
- Tumors.
- CSF leaks may also be classified as High flow and Low flow leaks

Clinical Features

- Unilateral, clear, sweet in taste and beta-2 transferrin is always present due to the presence of glucose, watery dripping suddenly as drops on looking downwards which increases on coughing, sneezing or exertion (**Figure 61.1**)
- History of meningitis in the past
- History of trauma or operation on the nose/paranasal sinuses (PNS) or nasopharynx for any mass

It differs from nasal secretions by the following:

- No aggravation on bending forward
- Slimy nature, salty in taste
- Beta-2 transferrin is absent in nasal secretions and tears
- Nasal secretions stiffen the handkerchief due to presence of mucus
- Nasal symptoms like sneezing or nasal stuffiness are absent in CSF rhinorrhea.

Diagnosis

- Biochemical examination of collected fluid for presence of glucose and chlorides indicating CSF and not mucus

Figure 61.1 Cerebrospinal fluid rhinorrhea: on bending forwards, clear, watery fluid comes out of the nose

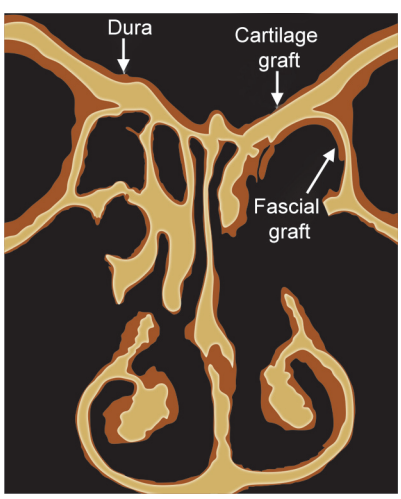


Figure 61.2A HRCT(Corona) showing leakage site

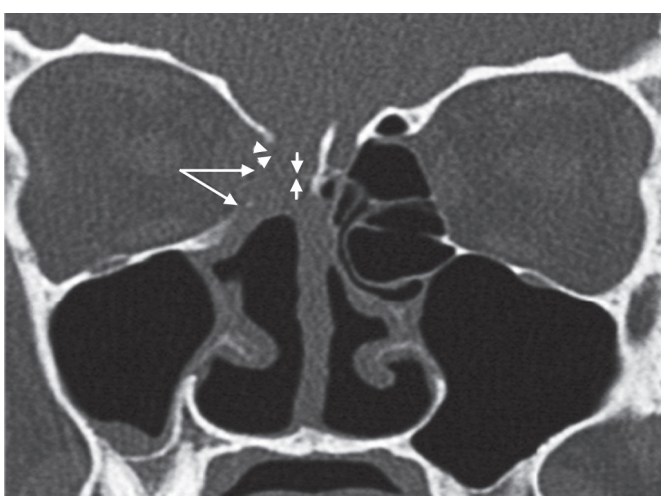


Figure 61.2B Repair of leak

- *Handkerchief test:* If soaked with CSF secretions, it does not get stiffened due to absence of mucin on drying. Double ring sign on a piece of filter paper (or Halo sign) or target sign is typical of traumatic CSF leak and is due to blood mixed with CSF
- X-ray of skull bones
- High resolution computerized tomography (HRCT) scan with thin section coronal cuts and contrast (metrizamide) of skull and PNS to see the site and extent of fracture (**Figure 61.2A**). T2-weighted Magnetic resonance imaging (MRI) is also helpful
- Fluorescein (5%) dye test is done by introducing a dye 0.25 mL of 5 percent mixed with 10 mL of CSF via lumbar puncture and putting cotton pledgets in middle and superior meatus in olfactory region to detect the site in the nose after putting the patient in Trendlenberg position for nearly one hour
- Nasoendoscopic examination has also been used to detect the leak and to repair it as well
- Investigation of choice is beta-2 transferrin, which is specific for CSF as it is not present in tears and nasal secretions.
- Nowadays, beta-2 transferrin test is considered corroborative, whilst beta-2 trace is considered con-firmatory. The drawback of this test is that a good amount of sample is needed.

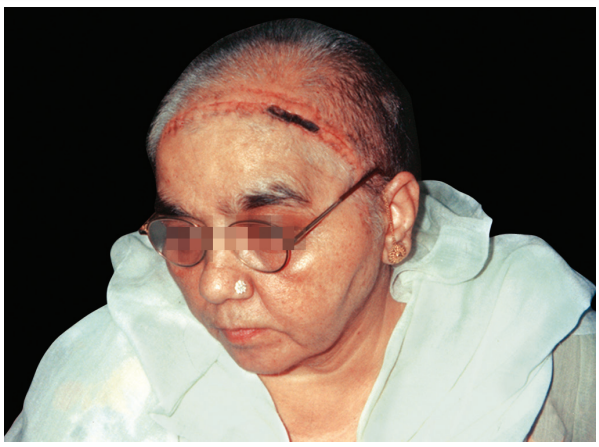


Figure 61.3 Anterior craniotomy approach for cerebrospinal fluid rhinorrhea

Treatment

Conservative Treatment

- Complete bed rest with raised head end
- Avoid straining, sneezing, coughing or forceful blowing of nose
- Avoid nose drops and nasal packing to prevent secondary infection and meningitis
- Early cases treated with prophylactic antibiotics, which cross blood-brain barrier
- Mannitol and acetazolamide to reduce intracranial pressure
- Treatment of the cause.
- Majority of traumatic leaks heal with conservative treatment, however those not responding by 2-3 weeks must be operated.

Surgical Treatment

- Functional endoscopic sinus surgery (FESS) is used to diagnose and repair the defect by closing it with fascial flaps or cartilage strips and mucoperiosteal flaps (**Figure 61.2B**).
- Persistent cases treated with repair of the defect by neurosurgeon via anterior cranial fossa approach by using fascia lata or synthetic mesh, if spontaneous healing does not occur (**Figure 61.3**) or if conservative treatment does not help even after 2 weeks.

Complications of Cerebrospinal Fluid Leak

- Persistent leak (5 to 10%)
- Meningitis (0.3%)
- Pneumocephalus
- Frontal lobe abscess
- Anosmia
- Chronic headache.

Key Points

1. **CSF is formed by choroid plexus of ventricles** and may be by capillaries on the surface of brain and fills the subarachnoid space. Total volume is 150 mL and rate of production of CSF is 0.2 to 0.4 mL/minute.
2. **Main constituents of CSF** are water, NaCl (720 to 750 mg/100 cc), glucose (50 to 75 mg/100 cc), proteins (20 to 40 mg/100 cc) and cells (0 to 5/cmm).
3. **The commonest sites of CSF leak** are cribriform plate, followed by posterior wall of frontal sinus and floor of anterior cranial fossa.
4. Diagnosis of CSF is made by **'halo effect'** seen on the white handkerchief and by biochemical examination of the collected fluid.
5. **Fluorescein dye test** is done by injecting it into the CSF via lumbar puncture and then looking for the dye in the pledgets placed at various sites in the nasal cavity. High resolution CT is confirmatory to find out the site of the leak.
6. **Meningitis** is the most feared complication of CSF rhinorrhea.
7. **Treatment requires a craniotomy** with repair of dura with fascia lata. FESS has lately been used extensively for repair of the CSF leak.
8. To show the presence of glucose in the fluid, **oxidase-peroxidase paper strip test** can be carried out.
9. Injuries of temporal bone can result in leakage of CSF into middle ear and hence into nose through eustachian tube (otorhinorrhea).
10. **Most common cause of CSF rhinorrhea** is head injury and nasal blowing is not done in cases of CSF rhinorrhea.
11. **Beta-2 transferrin** on electrophoresis is pathognomic of CSF rhinorrhea
12. **Hyrtl's fissure** may be a pathway for CSF otorrhea.
13. CSF leak may be localized by **intrathecal injection of metrizamide** followed by screening.
14. Other methods of localization are **fluorescin dye** and intra thecal radionucleides
15. **Site of leak** can be localized by MRI with T2-weighted image or MRI cisternography
16. CSF leak does not occur in **LeFort- I fracture of maxilla**.

Chapter 62 Cleft Lip and Cleft Palate

What Students Must Know!

- **Introduction**
- **Types of Clefts**
  - Clinical Features
  - Management
  - Repair of Cleft Lip
  - Repair of Cleft Palate
  - Postoperative Complications

INTRODUCTION

1. Cleft lip and cleft palate are is the most common congenital deformities after the club foot deformity.
2. It occurs once in 700 births approximately.
3. These occur together in male infants more than females.
4. It is because of failure of fusion of median nasal process, maxillary process and alveolar process which takes place in 8th to 9th week of intrauterine life.
5. Palate anterior to incisive foramen is primary palate, while posterior to it is secondary palate.
6. Ultrasound scan can make an antenatal diagnosis after 18 weeks of gestation.

TYPES OF CLEFTS

- Cleft lip may be of median, para median, oblique or of transverse type
- Unilateral or bilateral cleft palate and lip
- Cleft palate only
- Submucous cleft palate in which musculature of the palate is absent.

CLINICAL FEATURES

- Infant has feeding difficulty due to inability to suck (**Figure 62.1A**)
- Eustachain tube dysfunction due to hypoplasia of levator and tensor palati muscles
- Chronic suppurative otitis media (CSOM) with conductive hearing loss
- Velopharyngeal dysfunction causing hypernasality and nasal regurgitation of food.

MANAGEMENT

1. Initial priority should be feeding assistance and counselling of the family. Use of special nipples, soft bottles or use of bulb syringe can eliminate the need for suckling.
2. **Palatal prosthesis** can occlude the cleft for the time being.
3. **Surgical management**.

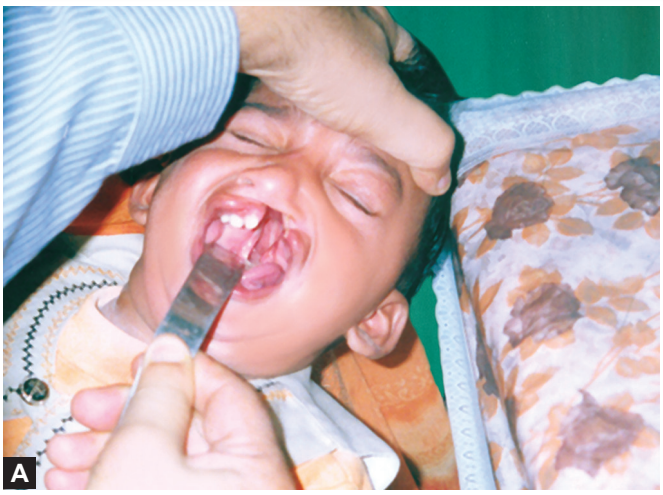
   Timing for palate repair should be such so as to establish speech development and minimise adverse effects on growing palate and occlusal relationships.

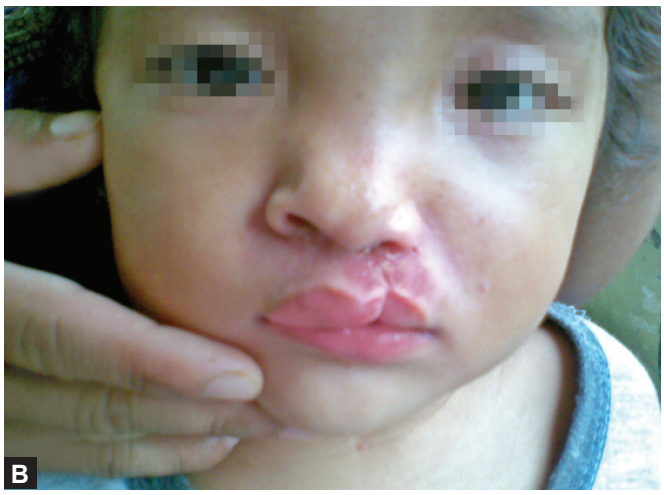
   It is **preferred in the age of 10 to 18 months** so that proper speech articulation starts. At some centers, 18 to 24 months of age is preferred after the eruption of 1st molar tooth.

Repair of Cleft Lip

Rule of 10 in repair of cleft lip, which implies that infant should be 10 months old, 10 pounds in weight and hemoglobin level of more than 10 gram. Ideal lip repair must achieve accurate approximation of skin, muscle and mucosa, minimal scar mark, properly aligned cupid bow, symmetrical nostrils and columella.

Various techniques are as follows:





Figures 62.1A and B (A) Cleft lip with cleft palate; (B) Cleft lip repaired (Millard's repair)

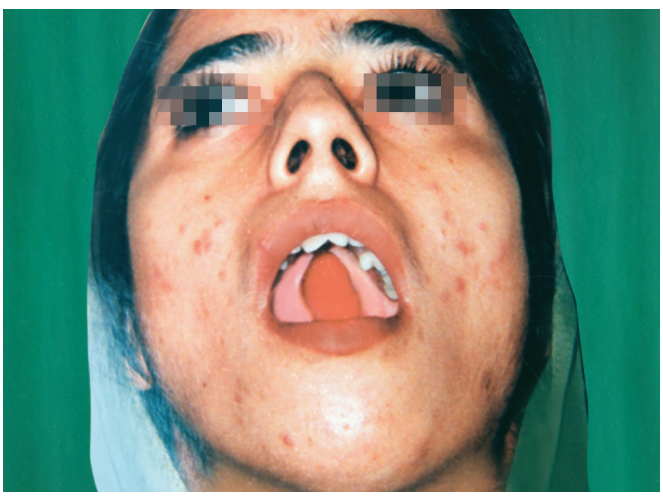


Figure 62.2 Cleft palate

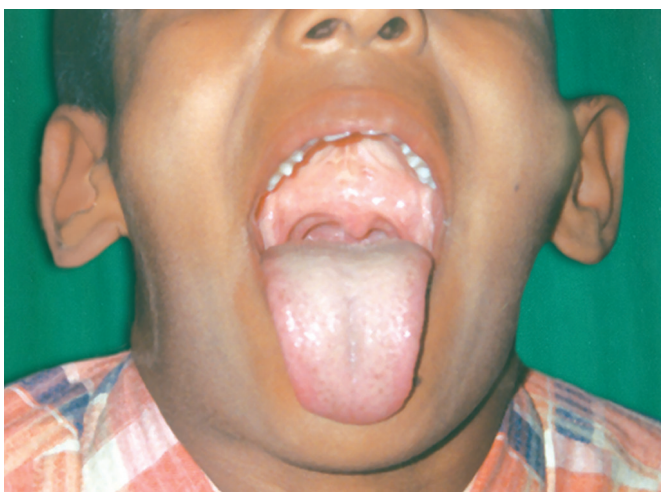


Figure 62.3 Repaired cleft palate

Millard's Repair

Millard repair is the most popular method involving rotation advancement technique (**Figure 62.1B**).

Philtrum of lip is rotated downward as a flap and lateral lip segment is advanced across the cleft.

Other Methods

- Z-plasty technique (triangular flap) and its variations
- Rectangular or triangular flap repair.

Repair of Cleft Palate

Ideal cleft palate repair should achieve:

- One stage closure of cleft
- No postoperative shortening of palate
- Adequate velopharyngeal competence
- Normal speech
- Normal eustachian tube function
- No facial deformity
- Normal nasal physiology.

Rose position with endotracheal anesthesia and one must keep in mind to have a good hemostasis, conservation of tissues, and mucosal covering of cleft (**Figures 62.2 and 62.3**).

Various methods of repair are as follows.

Oxford Method (V-Y Pushback)

Advantage is that oxford method provides additional palatal length and two-flap technique provides a nice closure of the cleft.

Four-flap Palatoplasty

Four-flap palatoplasty converts a complete cleft into incomplete cleft in order to take advantage of V-Y repair.

Von Langenbeck Palatoplasty

Von Langenbeck palatoplasty is a precursor of the two-flap technique, in which flaps are bipedicled both posterior and anterior.

Schweckendick's Primary Veloplasty

Schweckendick primary veloplasty may be used to close the soft palate defects.

Furlow Palatoplasty

Furlow palatoplasty is an opposing Z-plasty technique for closing and elongating the soft palate (**Figure 62.3**).

Postoperative Complications

1. Hyper nasality (30% cases).
2. Oronasal fistula (10–20% cases).
3. Velopharyngeal incompetence.
4. Esthetic problems such as:
   a. Short and tight upper lip.
   b. Asymmetrical nose.
   c. Absent-labial sulcus.

1. **Cleft palate** occurs because of failure of fusion of median nasal process, maxillary process and alveolar process in the 8th to 9th week of intrauterine life.
2. **Submucous cleft palate** is a condition, in which musculature of the palate is not present but mucosal coat is intact.
3. **Chronic secretory otitis media** occurs because of eustachian tube dysfunction due to hypoplasia of levator palati and tensor palati muscles.
4. **Ideal time for repair** of the cleft palate is 10 to 18 months of age when speech articulation starts.
5. The most **important methods of cleft palate** repair are V-Y pushback repair and four-flap palatoplasty.
6. **Simonart's band** is a thin remnant of tissue or band, which bridges the medial and lateral lip and is seen in cases of severe incomplete cleft lip.

Chapter 63

Snoring and Sleep Apnea Syndrome

What Students Must Know!

- **Introduction**
- **Snoring**
- **Sleep Apnea Syndrome**
  - Introduction
  - Causes
  - Clinical Features
  - How It Occurs
  - Investigations
  - Treatment
  - Complications

INTRODUCTION

- Snoring is a noisy breathing of a person during sleep, which disturbs the other persons around him
- Sleep apnea syndrome is characterized by **30 apneic episodes each lasting for 10 seconds** or more during a bout of sleep of about 7 hours
- Stertor is a low pitched snoring during inspiration
- Apnea index is number of apneas per hour of sleep
- Snoring occurs due to airway obstruction during sleep in inspiration causing vibration of soft tissues of oropharynx
- Heroic snoring is the one, where noise may be equal to that of a railway engine and it may disturb people in the next room or even the next building
- Sleep apneas may be classified into central, obstructive or mixed
- Central is due to heart failure, brain stem lesion or trauma to frontal lobe. In this, snoring may be absent
- Arousal index is number of arousal events in one hour and less than four is considered normal
- Respiratory disturbance index is number of apnea and hypopnea per hour. Normal respiratory disturbance index (RDI) is 5 or less
- Normal sleep occurs in two phases, i.e. rolling eye movements (REM) and non-REM in an alternating cycles each lasting for 1 to 2 hours
- Dreaming occurs in REM phase.

CAUSES

- Most common cause in children is hypertrophied adenoids and tonsils. Usually seen in obese males with thick neck of more than 40 years
- Alcohol consumption also predisposes to snoring
- Drugs like sedatives, hypnotics, antihistaminics and antiepileptics may also contribute
- Obstructive causes in the nose, nasopharynx, like deviated nasal septum (DNS), macroglossia, large base of tongue Polyp and incompetence, chronic obstruction pulmonary disease (COPD) may cause snoring
- Hypertension.

How Snoring Occurs?

During inspiration when there is partial obstruction to airway due to relaxation of muscles of pharynx and collapse of soft tissues of oropharynx and supraglottis, it results in vibrations of soft palate, tonsillar pillars and base of tongue producing snoring.

It is usually due to obstruction at three levels such as nose, palate, tonsillar pillars and hypopharynx, which are the sites of snoring.

CLINICAL FEATURES

- Open mouth during sleep
- Noisy breathing
- Patients with severe obstructive sleep apnea (OSA) tend to have narrow retrolingual airway, which is the major site of obstruction in severe OSA
- Apneic spells during deep sleep may be central or obstructive. In central type, apnea stimulates the center and breathing starts, while in obstructive type in spite of efforts breathing does not start and there is loud snoring, abnormal movements like kicking, sitting up, etc.

- In OSA apnea leads to hypoxia causing pulmonary constriction leading to congestive heart failure (CHF).
- Breathlessness and sweating
- Sleep apnea is graded as mild, 5 to 20 apneas per hour, moderate, 20 to 40 apneas per hour, severe more than 40 apneas per hour
- Primary snoring when patient has less than 5 apneas–hypopnea index and absent daytime sleeping
- Body mass index is more as calculated by dividing body weight by height in centimeters
- Oropharynx examination shows hypertrophied tonsils, palate and a massive uvula or a mass in the nose.
- Epwarth sleepiness scale is used to measure the degree of OSA by giving marks (0–4) in different situations, like sleeping while sitting and reading, TV watching, travelling in a car or public transport, sitting and talking.

INVESTIGATIONS

- History and detailed nose, nasopharynx, oropharynx and hypopharynx examination
- Pulmonary function tests
- Flexible fiberoptic endoscopy during sleep may show the cause and level of obstruction
- Radiography of nose/paranasal sinuses (PNS)/neck/chest
- Sleep latency time of less than 4 minutes
- Nocturnal polysomnography is a gold standard investigation, which includes electromyography (EMG), electroencephalography (EEG), electrocardiography (ECG) and oximetry (to measure O_2 saturation levels)
- Rhinomanometry
- Multiple sleep latency test
- Computed tomography (CT) retrolingual air space and magnetic resonance imaging (MRI) of upper airway.
- Cephalometry helps to assess the site of obstruction in sleep apnea syndrome (SAS). It is accurately taken lateral head X-rays in which relationship between soft tissues and bony points is measured.

TREATMENT

Conservative Approach

1. Causative factor be eliminated, e.g. drugs such as sedatives, sleeping pills, antihistaminics and alcohol. Hypertension (HT) and obesity be controlled.
2. Continuous positive airway pressure (CPAP) or BiPAP, i.e. bilevel positive airway pressure helps by relieving obstruction and supplying oxygen (**Figure 63.1**).

   Patient wears a mask connected to a machine, which blows air pressure between 7 to 15 cm H_2O into the airway. It also acts as a pneumatic splint (**Figure 63.2**). It is safe,

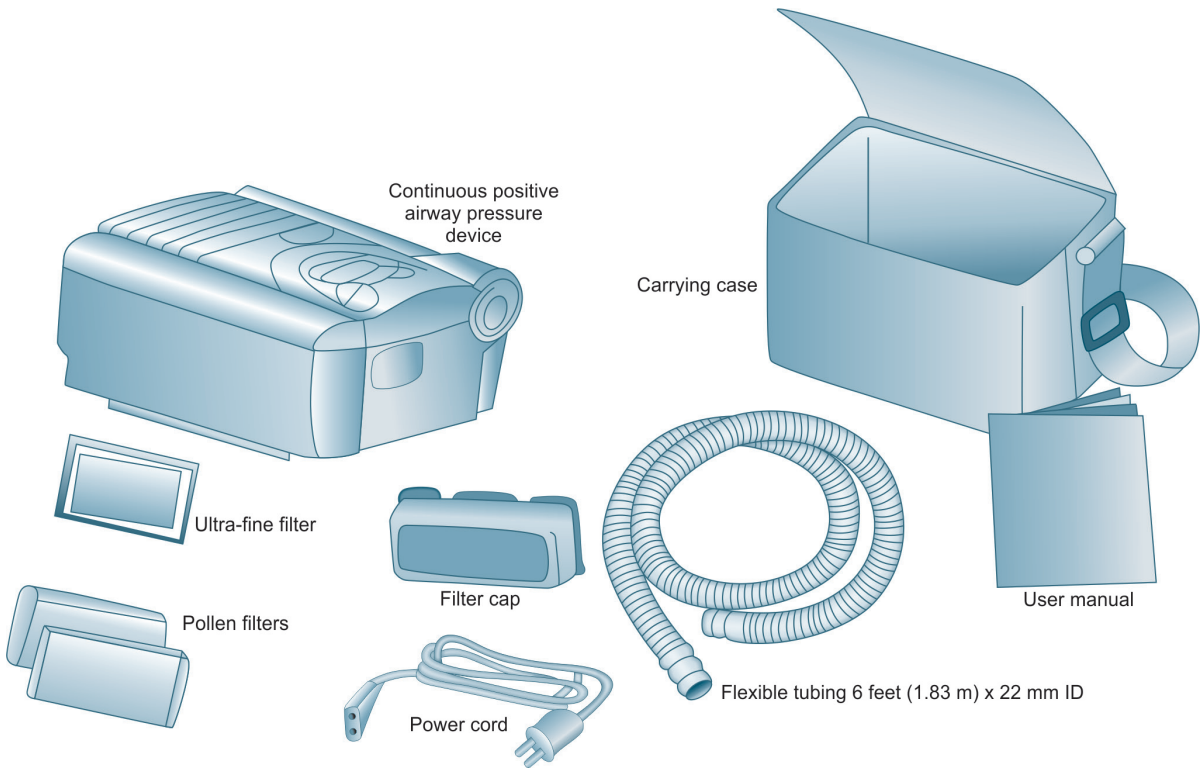


Figure 63.1 Different parts of continuous positive airway pressure (CPAP) device (ID: Internal diameter)

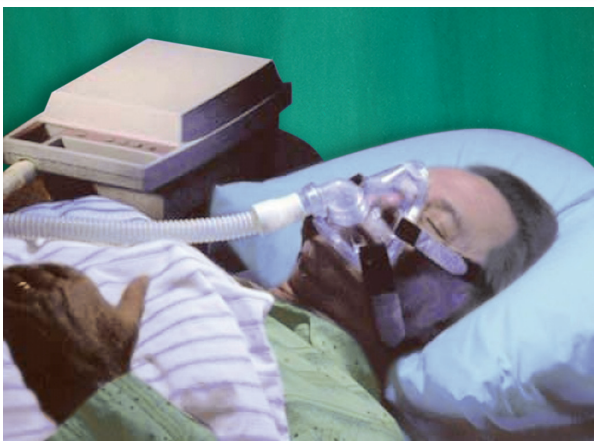


Figure 63.2 A person of obstructive sleep apnea syndrome (OSAS) with continuous positive airway pressure (CPAP) machine

efficacious and well tolerated by children. BiPAP has independent adjustment of delivered positive pressure during inspiration and expiration.

3. Intraoral prosthesis to stop falling of tongue are also used.
4. Drugs used are progesterone, acetazolamide, theophylline and oxygen therapy.

Surgical Approach

1. Any local cause in the nose or nasopharynx is removed.
2. Uvulopalatopharyngoplasty (UPPP) operation or modified UPPP (in which tonsils are not removed) is successful in 90 percent of cases of snoring. Tonsils, pillars, uvula and ring of posterior part of soft palate is excised.
3. LASER—vaporization laser-assisted uvulopalatopharyngoplasty (LAUP).
4. Radiofrequency ablation assisted technique (RAUP)—stiffens the soft palate. It is more cost effective as compared to LAUP.
5. Tracheostomy may be done in advanced sleep apnea cases.

COMPLICATIONS

- Hypertension
- Cardiac arrhythmias, heart failure and death
- Mental problems.

Key Points

1. **Sleep apnea syndrome** is characterized by 30 apneic episodes each lasting for 10 second or more in a sleep of about 6 to 7 hours.
2. **Important causes of SAS** may be upper airway obstruction, obesity, alcoholism, hypertension and drugs.
3. **Nocturnal polysomnography** investigation includes EMG, EEG, ECG and pulse oximetry to see oxygen saturation levels.
4. **Müller's sign** is a reverse Valsalva's sign, where the patient pinches his nose and performs swallowing movements. Movements of the uvula are noted with endoscope.
5. **Treatment of choice for SAS** is tracheostomy as a surgical procedure, which is 100 percent curative and CPAP being nonsurgical treatment of choice.
6. **RDI in OSA** is the sum of number of apneas (cessation of air flow for more than 10 second) and hypoapneas number (reduction of air flow by 50%) per hour
7. **Pickwickian syndrome** (So called after the fat boy Joe in Pickwick papers) includes excessive day time somnolence, obesity, right heart failure and oropharyngeal collapse. Also called chubby puffer syndrome.
8. Most common cause of **pediatric OSA** is idiopathic adenotonsillar hyperplasia.
9. **UPPP helps** if obstruction is at oropharyngeal level and not lower down.
10. **Müller's maneuver** is reverse of Valsalva maneuver. In this patient inhales with closed nostrils and mouth and is used to find the level and degree of obstruction in sleep disorders performed using a flexible nasopharyngoscope. Base of tongue, palate are examined for collapsibility and then rated from 0° to 4°.
11. **Narcolepsy** is an irrestible urge to sleep in day time.
12. **Sleep latency test** measures time taken to fall asleep which is monitored by EEG, normal value is 6 to 15 minutes while in OSAS it is less than 4 minutes.

Chapter 64

Signs/Syndromes and Spaces in ENT

What Students Must Know!

- ***Various Signs in ENT***
  - Brown's Sign
  - Delta sign
  - Griesinger's Sign
  - Hallo Sign
  - Hennebert's Sign
  - Hitselberger Sign
  - Irwin Moore's sign
  - Rising Sun Sign
- ***Various Tests in ENT***
  - Caloric Tests
  - Fistula Test
  - Crowbeck Test
  - Gelle's Test
- ***Syndromes***
  - Behcet 's Syndrome
  - Frey's Syndrome
  - Gradenigo's Syndrome
  - Meniere's syndrome
  - Patterson Brown Kelly's Syndrome
  - Ramsay Hunt Syndrome
  - Sjögren's Syndrome
- ***Spaces***
  - Facial Recess
  - Sinus Tympani
  - Parapharyngeal Space
  - Retropharyngeal Space
- ***Triangles***
  - Macewen's Triangle
  - Joll's Triangle
  - Soft Triangle
  - Trautman's Triangle

A sign is presence of an objective evidence of a disease
Many look at the sign, but only few see

VARIOUS SIGNS IN ENT

Pathognomic sign is also called signature of the disease, a sign of the disease, on which diagnosis can be based.

Sign means important and must remember:

Battle's Sign

It is a postauricular ecchymosis that occurs due to fracture through the mastoid cortex in cases of head injury or middle cranial fossa fracture.

Berry's Sign

It is absence of carotid artery pulsation in thyroid malignancy.

Biederman's Sign

Dark color of anterior pillar of tonsillar fossa in some patients of syphilis.

Bocca's Sign

Absence of laryngeal crepitus in postcricoid malignancy, perichondritis and foreign body cricopharynx.

Bomb-bay Sign

X-ray findings in fracture floor of orbit.

Bozzolo Sign

It is seen in aneurysm of thoracic aorta and there is visible pulsation of arteries in the nose.

Boyce Sign

There is gurgling sound on compression of pharyngeal pouch.

Bruins's Sign

Patient has intermittent headache, vertigo and vomiting on movements of head. It is seen in tumors of 4th ventricle of brain.

Brown's Sign

It is seen in glomus tumor. There is blanching of the mass after applying pressure with Siegal's speculum.

Charcot's Triad

Consists of nystagmus scanning speech and intentional tremors and triad is a feature of multiple sclerosis.

Chvostek's Sign

Facial twitch seen on tapping over the distribution of facial nerve and is seen in hypocalcemia.

Crescent Sign

Air shadow in nasopharynx resembles a crescent in the presence of antrochoanal (AC) polyp.

Delta Sign

Lateral sinus thrombosis on computerized tomography (CT) or magnetic resonance imaging (MRI) shows enhancement of peripheral angle of dura, whereas there is no enhancement of central part, it is also called empty triangle sign.

Griesinger's Sign

It is seen in lateral sinus thrombosis. There is pitting edema seen over the mastoid process due to thrombosis of mastoid emissary veins.

Guerin's Sign

Hematoma palate in Le Forte fracture type I.

Gutzmann's Test

Frontal pressure on thyroid cartilage lowers the pitch due to counteracting the function of crico thyroid muscle, while lateral pressure has an opposite effect. If the results are abnormal it suggests cricothyroid paralysis.

Halo Sign

Also called target sign or double ring sign and is seen in traumatic cerebrospinal fluid (CSF) leak due to blood mixed with CSF.

Hamman's Sign

When there is air in the mediastinum, there is crepitus present and auscultation with each heartbeat.

Hennebert's Sign

It is a false positive fistula test, when there is no evidence of middle ear disease causing fistula of horizontal semicircular canal (SCC). It is thought to be due to adhesions in the vestibule, e.g. Ménière's disease or hypermobile stapes footplate in congenital syphilis.

Hennebert Phenomenon

Presence of disequilibrium following nose blowing or on lifting a heavy weight and is seen in perilymph fistula.

Hitselberger's Sign

In this sign touch sensations of posterosuperior part of external auditory meatus are found to be absent in some cases of vestibular schwannoma.

Horner's Syndrome

Consists of ptosis, miosis anhidrosis and enophthalmos due to paralysis of cervical sympathetic.

Irwin Moore's Sign

Pressure on anterior pillar, pus comes out from crypts–called as septic squeeze.

Jackson's Sign

Pooling of saliva in pyriform sinus malignancy, foreign body (FB) cervical esophagus and postcricoid carcinoma.

Kernig's Sign

This sign is elicited in meningitis. The patient is unable to touch his chin with his chest.

Marcus Gunn Pupil Sign

Due to interruption of afferent papillary pathways because of retrobulbar neuritis or optic nerve disease.

When light is put on diseased side, pupils of both sides remain dilated but, when put on healthy side it constricts both pupil.

Mecca Sign

In malignant lesions of tongue patient sits with one hand on ear due to referred pain and other hand on mouth for drooling saliva.

Paracusis Willisii

Patients of otosclerosis hear better in noisy environment. This is due to good discrimination score and the person has raised his voice.

Pemberton's Sign

Seen in retrosternal goiter, engorgement of face on raising arms and taking a deep breath.

Rat Tail Sign

Barium swallow shows characteristic rat tail appearance with irregular mucosa margins in carcinoma esophagus, whereas in cardiac achalasia, there is smooth pencil tip appearance and dilatation of proximal part of esophagus.

Rising Sun Sign

There is red vascular hue seen behind the intact tympanic membrane. It is seen in glomus tumor, high jugular bulb and aberrant carotid artery in the floor of middle ear.

Rosenbach's Sign

Fine tremors of closed eyelid seen in hyperthyroidism and hysteria.

Spielberg's Sign

Seen in fracture lamina papyracea.

Steeple Sign

Narrowing of subglottic on lateral X-ray neck seen in Croup.

Schwartz's Sign

It is also called flamingo flush. It is seen because of increased vascularity in sub mucous layer of promontory in otosclerosis.

Stellwag's Sign

It is the staring look due to infrequent blinking seen in Graves disease.

Tear-drop Sign

It is defined as a tear drop-shaped opacification seen hanging from the roof of the maxillary sinus on Water's view. It is said to represent orbital contents (i.e. fat) that have herniated down into the maxillary sinus and is an indication of an orbital blowout fracture.

Teapot Sign

CSF leak increases on bending head forwards as the defect is in sphenoid sinus in CSF rhinorrhea.

Teal's Sign

A feature of acoustic neuroma.

Thumb Sign

It is a thumb-like impression seen on X-ray lateral view neck in patients with acute epiglottitis.

Tragus Sign

In acute otitis externa there is marked tenderness, when tragus is pressed against the pinna.

Trap-door Sign

Seen in fracture floor of orbit.

Tripod Sign

Seen in acute epiglottitis in children, sitting and leaning forward to have easy breathing.

Trousseau's Sign

In hypocalcemia tourniquet placed on the arm causes tetany.

Tullio Phenomenon

Loud sounds may cause vertigo in patients of Ménière's disease. It is a variation of Hennebert sign.

Von Graefe Sign

It is the lid lag seen in Graves disease.

Wartenberg's Sign

Intense pruritis of tip of nose and nostril indicates cerebral tumor.

VARIOUS TESTS IN ENT

ABLB Test of Fowler

- It is also called alternate biaural loudness balance test
- In this test, a tone is played alternatively into normal and deaf ear
- The intensity is gradually increased in the affected ear until the sound is heard equally in both ears

- In positive recruitment, ladder pattern becomes horizontal at higher frequency
- This phenomenon of recruitment is seen in cochlear type of sensorineural hearing loss (SNHL) such as in Ménière's disease and presbycusis.

Absolute Bone Conduction Test

In this test bone conduction of the patient is compared with that of the examiner after occluding the meatus. ABC equal is seen in normal or conductive type of hearing loss but is reduced in SNHL.

Acoustic Reflex Test

- Also called stapedial reflex test, in which ear is presented with a sound of 80 to 90 dB above threshold level, which causes bilateral contraction of stapedius muscle
- The reflex is elicited due to integrity of the VIII and VII nerve and helps in finding out the hearing acuity, localization of lesions of VII nerve and is useful in malingerers and infants.

Bing Test

- In this test examiner places the vibrating tuning fork on the mastoid process at the same time occluding or pening the ear canal by pressing on the tragus
- A person with SNHL or a normal person hears louder when the ear canal is occluded (Bing positive) while there is no change in conductive hearing loss (Bing negative).

Bosin's Test

TM is painted with 1 in 20 percent silver nitrate solution to see the perforation seen as a black spot against white background.

Caloric Test

- In this test ear canal is irrigated with water at 30°C and 44°C and the response is measured in seconds between the start of irrigation and cessation of nystagmus
- Response of cold is by showing of nystagmus to the opposite side and warm to the same side (COWS—cold opposite, warm same)
- In canal paresis, the duration of nystagmus is reduced for both hot and cold characteristic of peripheral vestibular lesion
- In directional preponderance response is greater in one direction both for hot and cold and is seen in both peripheral and central lesions.

Carhart's Test

It is same as tone decay test.

Chimani-moos Test

- It is a modification of Weber's test
- In this a tuning fork of 512 Hz is struck and kept on the vertex
- The patient will indicate the side, where he can hear the sound
- Now the ear with SNHL (or the ear towards which the Weber's is lateralised) is occluded
- If the patient is truly deaf, he will continue to hear the sound on the same side but a malingerer will deny hearing any sound at all.

Cottle Test

- This test if positive indicates abnormality of the vestibular component of the nasal valve. Test is done by drawing the cheek laterally and the patient breathes quitely
- If the breathing becomes normal on the test side, it is positive Cottle test.

Crowe-Beck Test

Fundoscopy examination shows engorgement of retinal veins, when pressure is applied over jugular vein in normal persons whereas there will be no change in patients with lateral sinus thrombosis.

Doerfler-Stewart Test

The test is useful in a person with functional deafness and is based on the presumption that a person with normal hearing will raise his voice in the presence of background noise.

Erhard Test

In this test the good ear is occluded and a loud sound is given to the deaf ear. Blinking of eye is noticed indicating that the voice is heard.

Fistula Test

- The air in the external auditory meatus is compressed by pressing the tragus repeatedly or with the help of a Siegle's speculum
- If there is an erosion of the horizontal SCC due to disease, there will be nystagmus to the same side and a feeling of vertigo
- False positive fistula test is also called Hennebert's sign
- Negative fistula test indicates that there is no fistula or if the fistula is present the labyrinth is dead (false negative).

Fluorescein Dye Test

- This is done to confirm the site of leakage of CSF in cases of CSF rhinorrhea.

- 0.2 cc of 5% Fluorescein diluted in 10 ml of CSF is injected through lumbar puncture and multiple cotton pledgets are kept in various sites of nose, which are subsequently examined for leakage of CSF as green birefringence on blue light endoscopy.

Fraser's Test

Audiometry test in perilymph fistula.

Frustenberg Test

Increase in the size of mass on coughing indicates intracranial communication like encephalocele.

Gault Test

In this test, the good ear is occluded by a finger. A malingerer will deny hearing any loud sound.

Gelle's Test

- In this test bone conduction is tested at the same time compressing the air in the meatus using Siegle's speculum
- In a normal person hearing is reduced on increasing the air pressure in the meatus, while it is not affected in otospongiosis.

Glycerol Test

- Glycerine given in high doses (1.5 mL/kg) causes improvement in hearing of > 10 db at least in two adjacent frequencies within 1 hr of injection (in Ménière's disease)
- Nowadays this test is done in combination with electrocochleography by cochlear micropotentials and summating potentials.

Head Shadow Effect

When in a patient with biaural hearing loss, monaural hearing aid is used, the sound has to cross the head to the contralateral ear. This amounts to 6 dB loss in intensity.

Kobrak's Cold Caloric Test

In this test 5 mL of ice water is put in the ear canal for 30 seconds. If no response is seen 10 mL or 20 mL of water is irrigated and if still there is no response, the labyrinth is considered dead.

Lombard's Test

In this test a noise box is applied to the sound ear and the patient is asked to read from a book. With true deafness, the voice is markedly raised, while malingerer continues to read in the same tone or a slightly raised voice.

Müller Test

In this test the patient is asked to breathe in forcefully by closing his mouth and his nose is pinched. No air will enter ear. Negative pressure created will cause soft tissue to collapse. Degree I collapse is noted down by using nasal endoscope. Score is given depending upon the degree of collapse.

Otoacustic Emissions (OAEs)

- These are low intensity sounds due to the functional integrity of the outer hair cells of the cochlea
- These can be recorded by a small microphone placed in the external auditory canal
- OAEs will be absent if the outer hair cells are damaged due to numerous causes
- These will be useful in diagnosis of acoustic trauma or trauma due to ototoxic drugs or for the assessment of neonatal hearing.

Radioallergosorbent Test (RAST)

This test determines the degree of sensitivity of an allergen by measuring the specific IgE for each. The test uses a radioactive isotope (I-125) labelled paper disc. The results are measured using a gamma counter or the calorimetric enzyme method.

Reverse Glycerol Test

In place of glycerol, acetazolamide (a carbonic anhydrase inhibitor is given), there is waning of the symptoms of Ménière's disease.

Rinne's Test

- Test is done using 512 Hz tuning fork because it falls in speech frequency and its decaying period is longer
- In this test air conduction (AC) of the patient is compared with bone conduction (BC)
- AC is tested by the prong of tuning fork about 2.5 cm in front of external auditory canal
- Equal or negative Rinne indicates conductive type of hearing loss and positive Rinne is seen either in normal person or with the patient with SNHL
- False negative Rinne is seen in severe unilateral SNHL.

Romberg's Test

The patient stands erect with eyes closed and direction of falling or swaying to any side is noted. In sharpened Romberg

test heel of one foot is in front of the toes of other foot, while arms lie on the chest. In peripheral lesions the patient tends to fall on the same side.

Rosenthal's Test

To test nasal patency.

SISI Test (Short Increment Sensitivity Test)

- In this test the patient is given an increase of 1 dB every 5 second at 20 dB above threshold levels
- If the patient recognises more than 60 percent increase in intensity levels, it points towards cochlear type of lesions
- While a low score of less than 15 percent is seen in retrocochlear lesions or conductive hearing loss.

Schirmer's Test

- It is a method to assess the parasympathetic innervation to the lacrimal gland via greater superficial petrosal nerve
- In this test 5 mm × 35 mm paper strips are placed in the conjunctival fornices of both the eyes and are compared for the moistening of the strips after a 5-minute period
- An abnormal test is indicated by 25 percent reduction in lacrimation in one eye as compared to the other, or 30 percent reduction in one eye versus total lacrimation or < 25 mm bilateral lacrimation.

Schwabach Test

Here the bone conduction of the patient and examiner are compared without occluding the external auditory meatus. The test is shortened in SNHL but is lengthened in conductive hearing loss.

Speech Discrimination Score (SDS)

- It is also called optimum discrimination score
- In this test phonetically balanced single syllable words are given to the patients and maximum percentage of correct score is recorded
- In a normal person or conductive hearing loss SDS is 95 to 100 percent while in cochlear and retrocochlear lesion score is low or very poor
- This test helps to decide the usefulness of hearing aid.

Speech Reception Threshold Test

It is the minimum intensity level in dB at which 50 percent of the spondee words can be repeated correctly. It is usually +/– 10 dB of average of three speech frequencies.

Stenger Test

- It can be done with tuning forks or pure tone audiometry or speech audiometry and is useful in unilateral functional deafness
- In this test two tuning forks of equal frequencies are struck and brought closer to both ears of the patient
- Then the tuning fork on the feigned side is brought closer and the patient is asked from which side he hears the tuning fork
- A normal person would continue to hear from the normal side while a malingerer will deny hearing any sound from any ear
- The principle of this test is that, when two equal frequencies are presented to both the ears simultaneously a normal person will hear from the side which is closer to the source of sound.

Tobey-ayer Test (Queckenstedt's)

- After measuring the CSF pressure of the patient, the jugular vein is occluded
- There will be rise in CSF pressure in patients without lateral sinus thrombosis which becomes normal when pressure is released
- Whereas in patients with lateral sinus thrombosis there will be no change.

Tone Decay Test (Carhart's Test)

It is also called nerve fatigue test, in which a continuous tone 5 dB above threshold is given to the ear and person should be able to hear it for 60 sec.

A tone decay of more than 30 dB, if present points towards retrocochlear lesions, i.e. acoustic neuroma.

Weber's Test

It is a very sensitive test, as it is lateralised even there is difference of 5 dB in hearing acuity of both ears. It is lateralised to worse ear in conductive hearing loss and is lateralised to better hearing ear in SNHL.

Whisper and Conversation Test

Whisper test is done with residual air after full expiration in a reasonably quite room. Normally, a person should be able to hear a whisper at 12 feet and conversation voice up to 20 to 40 feet.

SYNDROMES

Important syndromes are described below:

Alport Syndrome

- Progressive sensorineural hearing loss (SNHL)
- Hematuria
- Chronic renal failure
- Anterior lenticonus.

Alström Syndrome

- Retinitis pigmentosa
- Obesity
- Diabetes mellitus
- Progressive hearing loss.

Anterior Ethmoidal Syndrome (Sluder's)

- Pain above the superciliary ridge due to pressure on anterior ethmoidal nerve.

Bannawarth Syndrome

- Unilateral or bilateral facial nerve palsy with meningeal symptoms.

Barany Syndrome

- Occipital headache
- Periodic ipsilateral deafness
- Vertigo and tinnitus
- Barrett syndrome esophagitis due to change in the epithelium of esophagus.

Behcet's Syndrome (Behcet 1937)

- Recurrent aphthous ulcers
- Painful eye ulcers
- Ulcers on genitals.

Bloom Syndrome

- High rate of cancer in early age
- Retardation of growth immunodeficiency
- Infertility.

Brun Syndrome

- Vertigo headache vomiting
- Visual disturbances 'cause may be due to cysticercosis of 4th ventricle.

Cogan Syndrome (1945)

- SNHL
- Non-syphilitic interstitial keratitis
- Vertigo.

Crouzon Syndrome

- Deafness (SN, conductive or mixed HL)
- Shallow orbits
- Proptosis
- Maxillary hypoplasia.

Costen Syndrome

- Due to unequal bite in two sides of the mouth
- Earache
- Temporomandibular joint arthritis.

Cowden Syndrome

- Adenoid facies
- Hypoplasia of mandible, maxilla, soft palate
- Microstomia
- Multiple thyroid adenomas
- Breast hypertrophy
- CNS abnormalities.

Duane Syndrome

- Short neck
- Abducent nerve palsy
- Conductive deafness
- Enophthalmos.

Empty Sella Syndrome

- Protrusion of arachnoid cyst into sella
- Visual loss
- Spontaneous cerebrospinal fluid (CSF) leak.

Frey Syndrome

- Sweating or flushing of face on parotid gland area on eating food
- Seen after parotidectomy operation.

Goldenhar Syndrome

- SNHL
- Vertebral anomalies
- Hemifacial microsomia
- Epibulbar dermoid.

Gradenigo Syndrome

- Pain around the eye
- Otorrhea
- VI nerve palsy causing diplopia

- Facial nerve palsy rarely
- Vestibular nystagmus.

Grisel Syndrome

Non-traumatic atlantoaxial subluxation due to para-pharyngeal infection involving upper cervical region

Heerfordt Syndrome

- Seen in sarcoidosis
- Bilateral parotid enlargement
- Uveitis
- Transient facial palsy.

Hunter Syndrome

- Hearing loss of any type
- Retinal degeneration
- Ossicular malformation
- Mental retardation
- Mucopolysaccharide disorder

Kawasaki Syndrome

- Pyrexia
- Lymphadenopathy
- Bright cracked lips
- Non-purulent conjunctivitis
- Joint pains
- Red dish palms and soles.

Kartagener Syndrome (Immotile Cilia Syndrome)

- Chronic sinusitis
- Dextrocardia (situs inversus)
- Bronchiectasis
- Male infertility.

Klippel-Feil Syndrome

- Short neck
- Facial asymmetry
- Torticollis
- Cleft palate
- Abducent nerve palsy
- Deafness.

Lermoyez Syndrome

- Hearing loss
- Tinnitus
- Vertigo later on
- Loose wire syndrome
- A triad of symptoms after stapedectomy operation that improve with inflation, i.e. auditory acquity, distortion of sound, speech discrimination.

Melkersson Syndrome

- Recurring attacks of facial palsy
- Swelling of lips
- Congenital furrowing of tongue.

Ménière Syndrome

- Episodic vertigo
- Fluctuating deafness
- Tinnitus.

Osteogenesis Imperfecta

- Short stature
- Deafness
- Blue sclera.

Patterson-Kelly-Brown Syndrome/ Plummer-Vinson Syndrome

- Iron deficiency anemia
- Atrophic tongue
- Koilonychia
- Dysphagia
- Esophageal web
- More common in females.

Pendred Syndrome

- Goiter
- SN deafness

Pierre Robin Syndrome

- Cleft palate, hypoplasia of mandible, glossoptosis
- Club foot
- Mental retardation
- Microcephaly

Ramsay Hunt Syndrome (1907) (Herpes Zoster Oticus)

- Severe pain in the ear
- Vesicular eruption of pinna or around it
- VII nerve palsy
- Deafness, tinnitus and vertigo may be present.

Refsum Disease

- Retinitis pigmentosa
- SNHL (after 10 year-of-age)

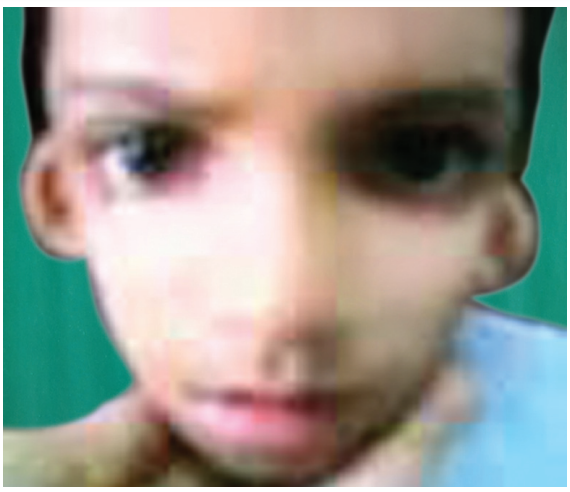


Figure 64.1 Features of Treacher Collins syndrome

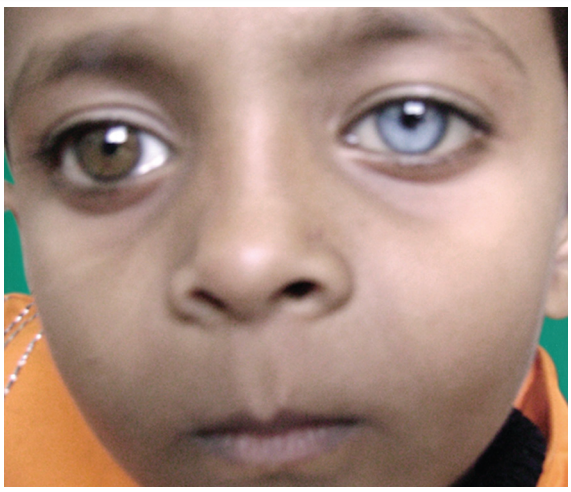


Figure 64.2 Hetrochromia iridum in Wardenberg syndrome

- Peripheral neuropathy
- Cerebellar ataxia.

Sjögren's Syndrome (Hadden 1883)

- Xerostomia
- Keratoconjunctivitis sicca
- Swelling of exocrine glands.

Stickler Syndrome

- Micrognathia
- Cleft palate
- High myopia with retinal detachment and cataracts
- Joint hypermobility
- Early adult arthritis
- Progressive SNHL.

Sturge-Weber Syndrome

- Port wine stain
- Hemangiomas of cerebrum
- Convulsions
- Superior semicircular canal (SCC) dehiscence syndrome
- Vertigo
- Oscillopia (loud noise on increased pressure)
- Superior orbital fissure syndrome
- Deep orbital pain
- Frontal headache
- VI nerve palsy.

Tolasa-Hunt Syndrome/Superior Orbital Fissure Syndrome

- III, IV, VI cranial nerve palsy
- Complete immobility of eye.

Treacher Collins Syndrome (Franceschetti-Zwahlen) (Figure 64.1)

- Hypoplasia of malar bones
- Deformed pinna
- Deafness (conductive type)
- Coloboma of lower eyelid
- Atresia of ext. auditory canal
- Webbing of neck is not a feature of this syndrome.

Turner Syndrome (XO)

- SNHL
- Low set ears
- Large lobes.

Usher Syndrome

- Retinitis pigmentosa
- Mental retardation (25 percent)
- Tunnel vision, cataract
- SN deafness
- Night blindness.

Van der Hoeve and de-Kleyn (Osteogenesis Imperfecta)

- Deafness
- Blue sclera
- Brittle bones.

Wardenburg Syndrome (Figure 64.2)

- SNHL
- Dystrophia canthorum
- Lateral displacement of inner canthi
- Hetrochromia iridum

- White forelock
- Wallenberg syndrome also called posterior inferior cerebellar syndrome it is due to thrombosis of posterior inferior cerebellar artery causing ischemia of lateral part of medulla and features are
- Vertigo, nausea, vomiting
- Horner syndrome
- Dyspagia
- Dysphonia
- Ataxia
- Loss of pain and temperature sensation.

SPACES

Important spaces are described below:

Carotid Space

- It is a potential space containing
- Carotid vessels, internal jugular vein, lower four cranial nerves as well as the sympathetic chain
- Vagal neuromas and glomus tumor may arise in this space.

Facial Recess

Also called suprapyramidal recess.

It is bounded by

- Facial nerve (medially)
- Chorda tympani nerve (laterally)
- Fossa incudis above.

Fluid Spaces of the Cochlea

- Perilymphatic space consisting of scala vestibuli and scala tympani
- Endolymphatic space consisting of scala media.

Freeway Space

At rest a gap of a few mm between the occlusal surfaces of the teeth remains and is called 'freeway space.'

Importance

Space is important to establish this physiological space, while giving dentures to edentulous patients; otherwise, the patient will have discomfort and if the space is too big, results in sagging and falling in of the soft tissues of face enhancing the ageing process.

Infratemporal Fossa

- It is a space in which the roof is formed by infratemporal surface of greater wing of sphenoid and small part of squamous temporal
- Medial wall is formed by lateral pterygoid plate and pyramidal process of palatine bone. Lateral wall is formed by ramus of mandible
- Anterior wall by posterior surface of maxilla and medial surface of zygomatic bone.

Hiatus Semilunaris

It is a space bounded by bulla ethmoidalis (above) and uncinate process (below and in front).

Paraglottic Space

It is bounded:

- Laterally by thyroid cartilage
- Inferiorly and medially by conus elasticus; ventricle quadrangular membrane medially and mucous membrane of pyriform sinus posteriorly.

Parapharyngeal Space

Extends from skull base to hyoid bone.

It is bounded by:

- *Medially:* Pharyngeal wall and vertebral column
- *Laterally:* Deep cervical fascia and sternomastoid muscle.

Contents

- Carotid artery
- Internal jugular vein
- IX, X, XI and XII nerves
- Deep cervical group of nodes.

Paratonsillar Space

It is located between the walls of the pharynx and mucous membrane of the pharynx and extends up into the soft palate.

Peritonsillar Space

It lies between the capsule of the tonsil and the superior constrictor muscle. Importance of this space is that it is the site of quinsy (Peritonsillar abscess).

Parotid Space

It is bounded by posterior border of ramus of mandible, styloid process and its muscles, the sternomastoid and the posterior belly of the digastric muscle. It contains parotid salivary gland and its lymph nodes.

Postcricoid Space

It lies in the hypopharynx between the upper and lower border of cricoid lamina.

Preepiglottic Space

Also called space of Boyer,
It is bounded
- Front by thyroid cartilage and thyrohyoid membrane
- Behind infrahyoid epiglottis and quadrangular membrane
- Above hypoepiglottic ligament
- It contains areolar tissue besides lymphatics.

Prestyloid Compartment

It contains tensor and levator palati muscle, ascending palatine and ascending pharyngeal arteries.

Prussak's Space

It lies between the neck of malleus and pars flaccida bounded above by lateral malleolar fold and below by short process of malleus.

Pterygoid Space

It is bounded by ramus of the mandible and the deep surface of masseter on the lateral side, the skull base above and pharynx medially.

Contents

- Pterygoid muscles, pterygoid venous plexus
- Maxillary artery and mandibular division of V nerve.

Pterygopalatine Fossa

It is a pyramidal space bounded above by posterior surface of maxilla; posteriorly lies at the root of pterygoid process and anterior surface of greater wing of sphenoid; medially it is bounded by perpendicular plate of ethmoid and orbital process of palatine bone.

Pyriform Sinus

It is bounded medially by aryepiglottic fold and laterally by thyroid cartilage and thyrohyoid membrane. In its floor lies the internal branch of superior laryngeal nerve.

Reinke's Space

It is a potential subepithelial space on the vocal cords, which is bounded by arcuate lines above and below, anterior commissure in front and vocal process of arytenoid behind. Edema of this space (Reinke's edema) causes a smooth and uniform swelling of the superior surface of cords.

Retropharyngeal Space

- It extends from base of skull to the mediastinum
- It lies between prevertebral fascia posteriorly and buccopharyngeal fascia covering constrictor muscles
- Space is filled with loose areolar tissue and retropharyngeal group of lymph nodes, which disappear as the child grows
- A median raphe divides the space into right and left compartments.

Retrostyloid Compartment

It corresponds to the neuro-vascular space and through it passes carotid artery, jugular vein, IX, X, XI, XII cranial nerves and sympathetic nerve and upper deep cervical lymph nodes.

Sinus of Morgagni

It is a large gap between base of skull and upper border of superior constrictor muscle through which pass eustachian tube, levator palatine muscle and ascending palatine artery.

Sinus Tympani

Also called infrapyramidal recess or medial facial recess, it is a triangular space between ponticulus and subiculum process.

Sublingual Space

It is bounded by lingual surface of body of mandible, mucous membrane of floor of mouth and the upper surface of mylohyoid muscle. It contains submandibular; sublingual salivary glands and lingual and hypoglossal nerves.

Submandibular Space

It is bounded by body of mandible, lower surface of mylohyoid muscle above and the superficial layer of deep cervical fascia below. It contains superficial part of submandibular salivary gland, anterior belly of digastric muscle and submandibular and submental lymph nodes.

TRIANGLES

Anterior Cervical Triangle

- Anterior : Median line
- Posteriorly : Anterior margin of sternocleidomastoid
- Base : Inferior mandibular border
- Apex : Manubrium

Antrum Threshold Angle

It is bounded above by horizontal semicircular canal (HSCC) and fossa incudis, medially by descending part of facial nerve and laterally by the chorda tympani nerve.

Beahr's Triangle

It is used to identify recurrent laryngeal nerve. It is bounded by tracheoesophageal groove, inferior thyroid artery and common carotid artery.

Carotid Triangle

- Posterior : Sternocleidomastoid
- Anterior : Superior belly of omohyoid
- Superior : Stylohyoid and posterior belly of digastric.

Digastric Triangle

- Above : Base of mandible
- Posteroinferior : Posterior belly of digastric and stylohyoid.
- Anteroinferior : Anterior belly of digastric.

Ho's Triangle

It is bounded by lateral and medial ends of the clavicle with a point where neck meets the shoulder.

Glands in this triangle may point towards nasopharyngeal carcinoma.

Joll Triangle

Also called sternothyrolaryngeal triangle.External branch of the superior laryngeal nerve lies deep to the upper pole of the thyroid gland as it passes to the cricothyroid muscle.

Kawase's Triangle

In petrous bone lateral to root of trigeminal and medial to internal auditory canal for approach to midclivus lesions (in middle fossa approach).

Macewan's Triangle

- Above : Posterior root of zygoma
- Anterior : Posterosuperior canal wall
- Behind : Imaginary line tangential to posterior canal wall below and cuts the posterior root of zygoma above.

Muscular Triangle

- Medially : Median line from hyoid bone to sternum
- Posteroinferior : Anterior border of sternocleidomastoid muscle
- Posterosuperior : Superior belly of omohyoid.

Nasal Valve Area

Nasal valve in the nose is triangular in shape bounded by septum, pyriform aperture and upper lateral nasal cartilage.

Sinodural Angle

It is the angle between tegmen antri and sigmoid sinus.

Simon's Triangle

- Anteriorly: It is bounded by recurrent laryngeal nerve (RLN)
- Posteriorly: Common carotid artery
- At the base: Inferior thyroid artery

Soft Triangle of Nose

It is the apex of nostril beneath the lobule.

Solid Angle

It is formed by three semicircular canals.

Submental Triangle

- Apex : At the chin
- Base : Body of hyoid
- Floor : Mylohyoid muscle.

Trautmann's Triangle

- Posterior : Sigmoid sinus
- Anterior : Bony labyrinth
- Superior : Superior petrosal sinus.

Trotter's Triad

- Seen in carcinoma nasopharynx
- Unilateral middle ear effusion (conductive deafness)
- Immobility of soft palate on the same side
- Pain in ear, jaw or tongue.

Woodruff's Plexus

- Collection of large vascular plexus on the lateral wall of inferior meatus posteriorly and may be a cause of bleeding in old age
- Posterior pharyngeal vessel anastomose with sphenopalatine vessel to form a plexus behind the posterior end of inferior turbinate.

Section 10 Operative Surgery

Chapter 65 Myringotomy and Tympanostomy Tubes

What Students Must Know!

- **Myringotomy**
  - Indications
  - Procedure
  - Postoperative Care
  - Contraindications
  - Complications
- **Myringopuncture**
- **Tympanostomy Tubes**

MYRINGOTOMY

- Myringotomy is a procedure in which the tympanic membrane (TM) is incised to drain suppurative or nonsuppurative fluid in the middle ear.
- It is also used to give aeration to middle ear in case eustachian tube is not functioning and tympanostomy tube needs to be inserted.

Indications

- Acute suppurative otitis media (ASOM), particularly exudative stage with bulging drum
- Persistent features, even after apparent control of ASOM
- ASOM with impending intracranial complications
- ASOM with a very small perforation in the stage of suppuration, where the middle ear discharge is not adequately draining
- Hemotympanum
- Aero-otitis media
- Catarrhal type of mastoiditis
- Secretory otitis media or atelectatic ear. This requires a grommet along with myringotomy in case of failure of conservative treatment.

Contraindications

- Suspected glomus tumor for fear of profuse bleeding
- Local infection like otitis externa.

Premedication

Injection atropine 0.6 mg IM is given half an hour pre-operatively.

Instruments

- Ear speculum
- Myringotomy knife
- Grommet holding forceps
- Suction cannula.

Anesthesia

General anesthesia is preferred especially in children, although it can be done under local anesthesia.

Position

Supine with the head turned to the opposite side.

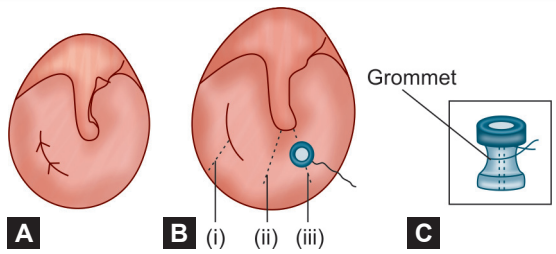
Procedure

Myringotomy should be performed under the operating microscope. There are two types of incisions—posterior and anterior (**Figures 65.1A to C**).

Posterior Myringotomy

A 'J'-shaped incision is made in the posteroinferior quadrant in TM, as this is the most accessible area, relatively less vascular and there are less chances of damage to ossicular chain. J-shaped incision cuts across radia fibers and does not close soon. Posteroinferior quadrant of tympanic membrane is preferred in acute suppurative otitis media.

Posteroinferior quadrant is preferred in myringotomy as it is the **least vascular** and most accessible and is seen first.



Figures 65.1A to C Different types of myringotomy incision: (A) Incision in ASOM; (B) (i) Curvilinear incision, (ii) Radial incision in secretory otitis media, (iii) Radial incision with grommet in place; (C) Magnified view of a grommet

Anterior Myringotomy

In secratory otitis media incision in anteroinferior quadrant is preferred.

A radial incision is given in the anteroinferior quadrant for insertion of grommet and facilitating drainage of serous fluid (**Figures 65.2A and B**). Circular incision is not good as it leads to inversion of edges of TM and cutting of its blood supply from annulus causing permanent perforation.

LASER myringotomy using CO_2 or potassium titanyl-phosphate (KTP) 532 is useful if TM is vascular.

Postoperative Care

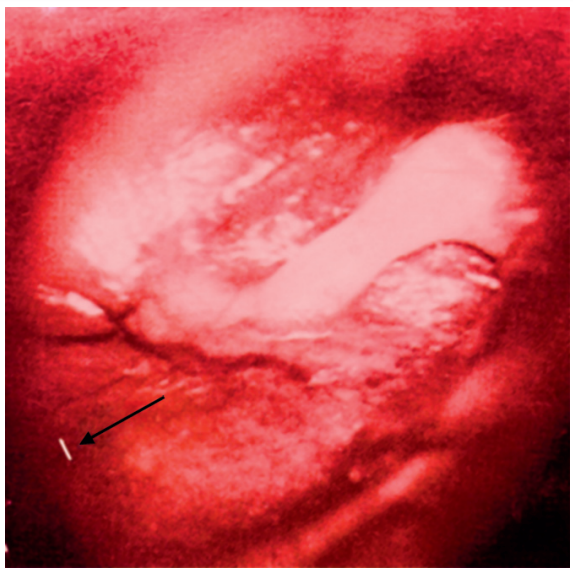
- A sterile cotton plug is placed in the external auditory canal (EAC) at all times
- Antibiotics
- Analgesics
- Nasal decongestants.

Complications

- Dislocation of incudostapedial joint
- Injury to chorda tympani nerve, ossicles, facial nerve and round window
- Injury to a high jugular bulb
- Infection
- Bleeding
- Cardiac arrest
- Loss of tube in middle ear
- Secondary cholesteatoma.

MYRINGOPUNCTURE

Myringopuncture means puncturing the drum with a long and wide bore injection needle. It is not as effective as myringotomy but antibiotics along with myringopuncture may be helpful.



Figures 65.2A Myringotomy incision

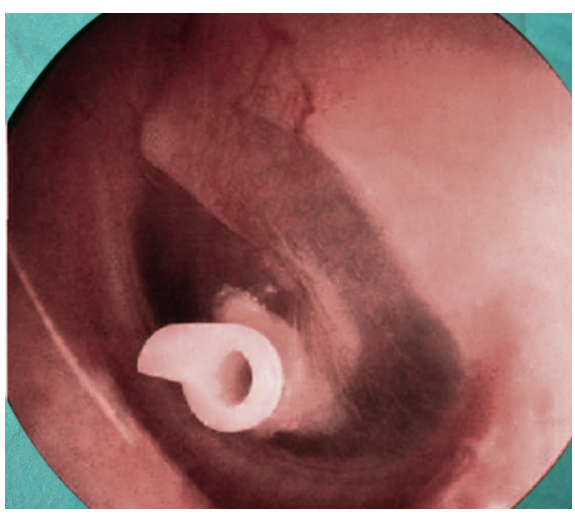


Figure 65.2B Grommet in place

TYMPANOSTOMY TUBES

Tympanostomy tubes are also called grommets made of silastic, titanium or polythene or silver oxide.

These are very useful in conditions like:

- Otitis media with effusion
- Persistent retraction of TM
- Patulous eustachian tube
- Treatment of Meniere's disease for gentamicin instillation.
- Hyperbaric (Oxygen) O_2 therapy.

Key Points

1. **Only contraindication** to myringotomy is suspected glomus jugulare tumor.
2. Various **types of ventilation tubes** are Shepard tube, Shah type, Donaldson tube, Armstrong tube and Good-T tube.
3. **Radial incision** is preferred in serous otitis media for grommet insertion as it spares radial fibers of eardrum, which is useful for holding the grommet in place.
4. In **myringopuncture** technique, the tympanic membrane is perforated with a thick needle to aspirate the secretions.
5. The **first myringotomy** was performed in 1760 by Eli, while Cooper in 1801 devised paracentesis.
6. **Myringotomy** for acute suppurative otitis media is done in posteroinferior quadrant.
7. **4R's**—Right tympanostomy tube for right indication for right period of time reduces incidence of otitis media.
8. **Internal diameter** of ventilation tube varies from 0.76 mm to 1.30 mm.

Chapter 66 Mastoidectomy

What Students Must Know!

- **Mastoidectomy**
  - Types
- **Simple Mastoidectomy**
  - Indications
  - Contraindications
  - Complications
- **Radical Mastoidectomy**
  - Indications
  - Contraindications
  - Postoperative Care
  - Complications
- **Modified Radical Mastoidectomy**
  - Indications
  - Steps
- **Bondy's Operation**
- **Atticotomy**

INTRODUCTION

Mastoidectomy means transcortical exploration of the mastoid air cells system to exenterate all accessible diseased air cells.

TYPES

The types of mastoidectomy are as follows (**Figures 66.1A to D**):

- Simple or cortical mastoidectomy
- Radical mastoidectomy
- Modified radical mastoidectomy.

SURGICAL APPROACHES AND INCISIONS

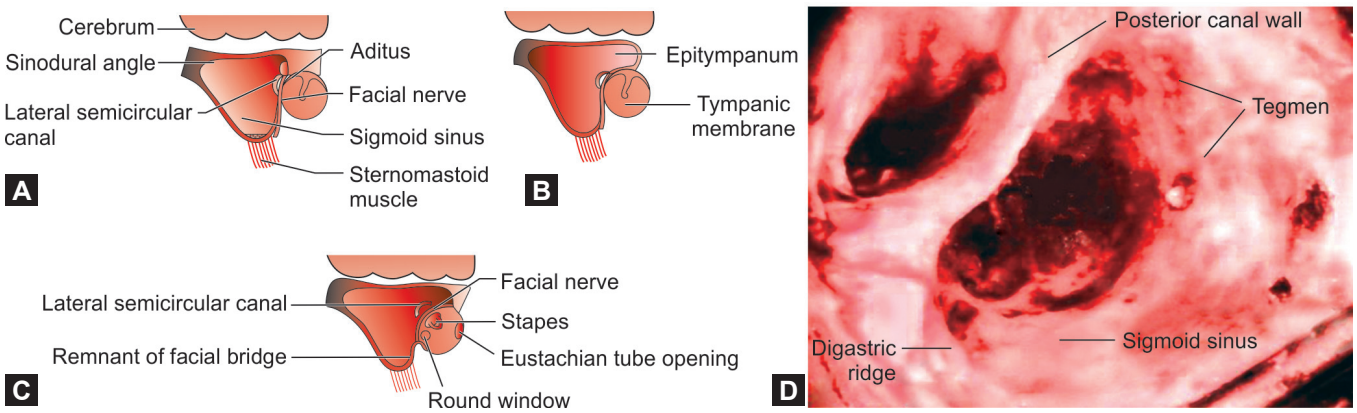
1. **Transcanal or permeatal approach (Rosen):** It used mainly for stapedectomy and tympanoplasty operations.
2. **Endaural approach (Lempert's):** A semicircular incision is made from 12'o clock to 6'o clock position in posterior canal wall at bony cartilaginous junction (Lempert's I), Second incision starts at 12'o clock and passes upwards between tragus and crus of helix (Lempert's II). It is good incision for mastoidectomy and diseases of external auditory canal.
- **Post aural approach (Wilde's):** It is given approximately 1 cm behind retroauricular sulcus ending at mastoid tip. The incision is most commonly used for mastoid surgery, tympanoplasty and facial nerve surgery.

Canal-wall-up and Canal-wall-down Procedures

- These terms are used if while doing mastoidectomy one removes the posterior canal wall (Canal wall down or open cavity) such as radical and modified radical mastoidectomy and atticotomy.
- If it is not lowered as in limited disease of the mastoid it is called canal wall up such as cortical mastoidectomy or combined approach tympanoplasty (CAT).
- Each has its advantages and disadvantages as for as control of disease and recurrence of cholesteatoma is concerned.

How to Decide Technique for Cholesteatoma?

1. **Local factors:**
   - Extent of disease
   - Mastoid pneumatization
   - Presence of a fistula
   - Eustachian tube function
   - Hearing status of both ears.



Figures 66.1A to D (A) Cortical mastoidectomy; (B) Modified radical mastoidectomy; (C) Radical mastoidectomy; (D) Canal-wall-up procedure

2. **General factors:**
   - General medical condition
   - Occupation
   - Reliability.
3. **Skill and experience of the surgeon.**

Aims of Operation

- Complete removal of disease
- Establishing of drainage
- Preservation of hearing.

SIMPLE MASTOIDECTOMY

Synonyms—Schwartz Operation/Complete Mastoidectomy

- This operation consists of removal of all the diseased mastoid air cells and aims to drain the mastoid cavity such as in acute coalescent mastoiditis.
- Existing middle ear contents are not disturbed and hence the hearing remains unaffected. It is also called conservative mastoidectomy. It is a canal wall up operation.

Indications

- Acute coalescent mastoiditis and masked mastoiditis not responding to treatment
- Impending complications of mastoiditis
- Refractory cases of secretory otitis media
- With tympanoplasty in the presence of glue in middle ear
- As an approach for:
  - Endolymphatic sac decompression
  - Facial nerve decompression
  - Excision of acoustic neuroma
  - Vestibular neurectomy
  - Labyrinthectomy
  - Cochlear implants.

Contraindications

- Cholesteatoma in the middle ear and mastoid
- Other general contraindications such as diabetes, hypertension, severe anemia or malignancy of the ear.

Instruments

The following are the instruments for mastoidectomy (**Figure 66.2**):

- BP handle with knife
- Periosteum elevator
- Postaural wound retractor (Mollison's self-retaining type)
- Mastoid gouge of different sizes and hammer
- Burr machine complete with different Burr points
- Aural forceps
- Artery forceps
- Fine granulation tissue forceps
- Mastoid curettes
- Facial nerve protector
- Fine suction tips
- Bone nibbler
- Curette with cell seeker
- Needle holder
- Stitching material.

Anesthesia

Mastoidectomy is usually done under general anesthesia but can also be performed under local anesthesia in cooperative patients, especially using long-acting local anesthetics.

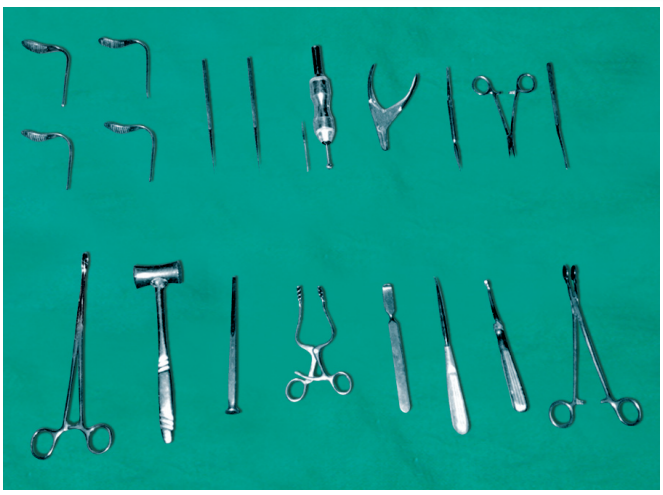


Figure 66.2 Instruments for mastoidectomy

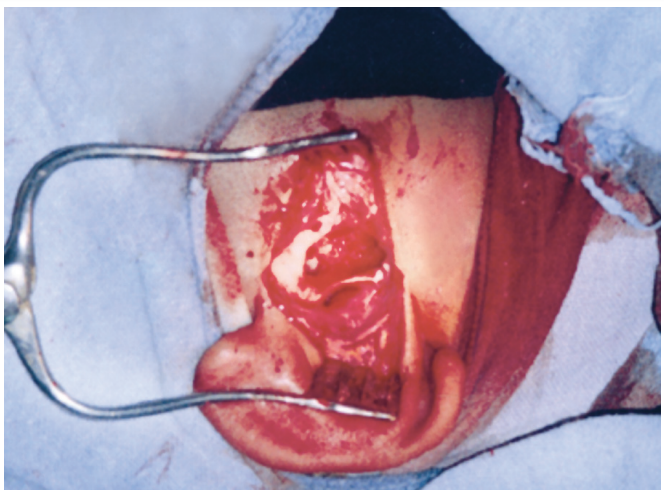


Figure 66.3 Cortical mastoidectomy—posterior meatal wall is kept intact

Position

Supine with ring below the head and head turned to the opposite side.

The surface marking of the mastoid antrum is the **Macewan's triangle**. This triangle is bounded:

- Anteriorly, by the posterosuperior meatal wall
- Superiorly, by the supramastoid crest
- Posteriorly, by a tangent drawn from the external auditory canal.

Normally this triangle lies 1.5 cm lateral to the mastoid antrum.

Steps

1. The area to be operated upon is shaved by two fingers above and all along the helix.
2. A postaural (Wilde's) incision is given 3 to 5 mm away from the retroauricular sulcus (this incision is horizontal in children less than 2 years of age as the VII nerve is more superficial and the tip of mastoid is not fully developed).
3. A 'T'-shaped incision is given over the mastoid and the periosteum elevated. The temporalis muscle should not be injured. A self-retaining mastoid retractor is applied.
4. The Macewan's triangle is identified and bone of the mastoid cortex is removed with gouge and hammer or with electric drill till one reaches the mastoid antrum.
5. Exenteration of all the mastoid air cells is done with its superior limit up to tegmen plate, posteriorly up to sinus plate, inferiorly to the mastoid tip, anteriorly up to bony external auditory canal, anterosuperiorly up to aditus ad antrum and medially to the lateral semicircular canal (**Figures 66.3 and 66.4**).

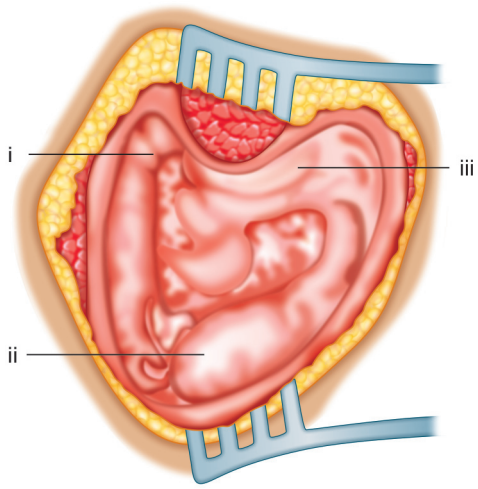


Figure 66.4 Complete cortical mastoidectomy—(i) Aditus ad antrum; (ii) Sigmoid sinus; (iii) Posterior bony meatal wall

6. Widening of the aditus ad antrum is done to provide adequate drainage and aeration with care to avoid injury to incus.
7. A drain is kept in the mastoid cavity and wound closed in layers. Pressure bandage is given in the form of mastoid dressing.

Postoperative Care

Postoperative care is as essential as the surgical operation and the operating surgeon is as much responsible for this as for operation itself.

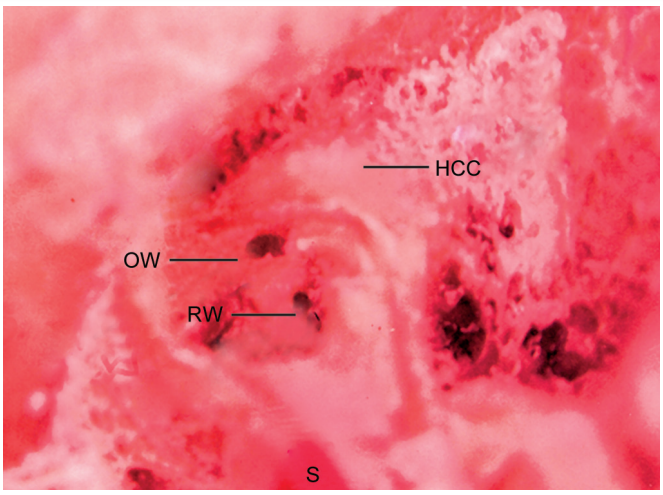


Figure 66.5 Temporal bone dissection to show various landmarks, such as: oval window (OW), round window (RW) and facial nerve canal, horizontal semicircular canal (HSCC)

1. The drain is to be removed after 48 hours
2. Antibiotics, analgesics and decongestants are given adequately.

Complications

Immediate

1. Bleeding may be severe in acute pathology
2. Damage to surrounding structures:
   i. Sinus plate may get injured leading to venous bleeding. It is controlled by gelfoam sponge kept under pressure for a few minutes.
   ii. Tegmen plate (dural plate) may get injured leading to CSF leak. It is controlled by strip of gelfoam sponge adequately packed, with head end raised and drugs to lower the CSF pressure. The patient is put on antibiotics to prevent meningitis.
   iii. Facial nerve may be injured in its vertical segment.If seen immediately find out the extent of injury by clinical or facial nerve tests. It may require re-exploration and decompression of facial nerve with in 24 hours of surgery before granulations start forming and degeneration sets in.
   iv. Labyrinth may be injured while widening the aditus.
   v. Incus may get dislocated while working close to the aditus.

Late

1. Late effects of damage to surrounding structures.
   i. Sigmoid sinus thrombophlebitis may occur.
   ii. Extradural abscess, subdural abscess or meningitis may occur, though they are rare.
   iii. Facial nerve palsy noticed immediately after surgery warrants urgent facial nerve decompression. Paralysis occurring in 24 to 48 hours is usually due to edema and is treated by steroids and antibiotics.
   iv. Injury to the labyrinth may lead to giddiness and sensorineural deafness.
2. Persistent discharge may be due to inadequate exenteration of mastoid air cells, petrositis or cholesteatoma.
3. Rarely stenosis of the external auditory canal can occur.
4. Mastoid fistula especially in mastoid abscess cases.
5. Fixation or injury to incus or malleus.

RADICAL MASTOIDECTOMY (SYNONYMS—ZAUFAL'S OPERATION)

- It is a radical operation in which middle ear and mastoid cavity is cleared of the disease which drains into or communicates with external auditory canal for subsequent follow up.
- It includes complete removal of disease from middle ear ,attic and mastoid antrum, with removal of all diseased tissue, tympanic membrane remnants, malleus and incus. It is a Canal wall down operation
- This surgery is characterized by exteriorizing the mastoid air cells and converting the mastoid, middle ear and external auditory canal into a single smooth-walled cavity
- All the diseased ossicles with remnants of the eardrum are removed except for the footplate of stapes (**Figure 66.5**)
- This does not involve any reconstruction and because of this the operation is becoming obsolete
- In classical radical mastoidectomy operation ear canal, middle ear and mastoid are converted into a single cavity which communicates with exterior through orifice of external auditory canal

Indications

- Unsafe type of otitis media with cholesteatoma extending to middle ear
- Chronic osteitis or osteomyelitis of the mastoid and the middle ear
- Secondary acquired cholesteatoma
- Decompression of facial nerve
- To approach the labyrinth for labyrinthectomy operation
- Carcinoma of the external auditory meatus and middle ear
- Necrotising otitis media leading to secondary acquired cholesteatoma.

Contraindications

- Chronic SOM (safe type)
- Primary acquired cholesteatoma
- Severe anemia, acute infections, diabetes, and hypertension

- Acute SOM with coalescent mastoiditis
- Chronic secretory otitis media or allergic otitis media.

Instruments

- BP handle with knife
- Periosteum elevator
- Postaural wound retractor (self-retaining type)
- Mastoid gouge of different sizes and hammer
- Electric drill machine
- Aural forceps
- Artery forceps
- Fine granulation tissue forceps
- Mastoid curettes
- Facial nerve protector
- Fine suction tips
- Bone nibbler
- Needle holder
- Stitching material.

Anesthesia

Mostly done under general anesthesia. Premedication with injection fortwin and injection atropine is given half an hour preoperatively.

Position

Same as that of simple mastoidectomy.

Steps

The approach can be either postaural or endaural:

1. The area of operation is cleaned with savlon and spirit and the patient is draped with sterilized sheets.
2. Injection saline with adrenaline 1:1,000 is given in the postaural region and posterior bony meatal wall.
3. Bone deep incision is given 1/4th inch behind the retroauricular groove extending from upper part of pinna to the mastoid process. Periosteum is also incised and elevated.
4. Any bleeder is caught and ligated and the mastoid wound retractor is introduced.
5. Macewan's triangle is recognized and spine of Henle is identified.
6. With gouge or drill machine, the cortex is removed till the antrum is reached. Its site is confirmed by the location of aditus.
7. Various groups of cells such as perisinus, dural angle cells, zygomatic and retrofacial are removed till the normal bone is reached.
8. The facial ridge, which is a wall separating the mastoid from external auditory canal is lowered down to a level just lateral to the facial nerve without injuring it.
9. The bridge which is the lateral wall of the aditus ad antrum is removed, thus exposing the short process of incus and the lateral semicircular canal lying medial to the incus. Anterior and posterior buttresses of the bridge are removed.
10. The diseased mucoperiosteum along with remnants of the eardrum and ossicles are removed leaving the footplate of stapes, so that the labyrinth is not destroyed.Facial Recess is exposed and middle ear is examined through this recess.
11. The lateral end of eustachian tube is curetted and packed with gelfoam. This is done to prevent any infection entering the middle ear via nasopharynx.
12. A wide meatoplasty is done so that the mastoid cavity can be examined and cleaned regularly. This is done to make a communication with the tympanomastoid cavity.
13. Mastoid cavity is packed with ribbon gauze and wound stitched in layers.

Postoperative Care

- Nothing orally for 6 hours
- Record TPR and BP every 1/2 hourly and as requried
- Injection BSA or any other suitable antibiotic
- Injection Fortwin, 10 mg intramuscular as required
- Packing is removed after 48 hours and outer bandage is changed after 24 hours
- Stitches are removed after 5 to 7 days
- The patient is advised to observe regular cavity care before being discharged.

Complications

- Facial nerve palsy
- Injury to sigmoid sinus/dura mater (accidental tear)
- Meningitis
- Labyrinthitis
- Brain fungus
- Perichondritis
- Chocolate or mucous cyst in the radical cavity
- Recurrence of cholesteatoma and granulation tissue.
  - Complications of mastoid cavity are (4D's): Discharge, deafness, disability and dizziness
  - Following the operation, safety of the patient is achieved as now the disease even if it remains will not spread to cranium. Conductive deafness may increase due to the removal of eardrum and ossicles. The patient has to come repeatedly for cleaning of the tympanomastoid cavity.

MODIFIED RADICAL MASTOIDECTOMY

1. It is a modification of radical mastoidectomy
2. In this the disease is localized to attic and mastoid antrum,

which is exteriorized into meatus. It is a **Canal wall down operation**

3. In this operation healthy and normal middle ear structures such as mucosa, ossicles and remnant of tympanic membrane are preserved with no compromise on the removal of disease. These are used for reconstruction of hearing mechanism.
4. So the procedure is radical as for as disease is concerned but conservative as for as preservation of structures concerned with reconstruction of hearing mechanism.

Indications

- Unsafe CSOM with cholesteatoma confined to attic and antrum
- Localized chronic otitis media
- For fenestration operation in otospongiosis.

Anesthesia

General anesthesia is preferred.

Preoperative Preparation

Same as that of radical mastoidectomy.

Position

Same as that of radical mastoidectomy.

Steps

Steps are same as that of the previous operation except for that the remnants of the eardrum and healthy ossicles are preserved as much as possible and only the head of malleus is excised, leaving the rest for reconstructing the hearing mechanism (ossiculoplasty). The procedure resembles radical operation in the sense ridge is lowered, bridge is removed, meatal flap constructed and cavity is exteriorized.

Postoperative Care and Complications

They are similar to that of radical mastoidectomy operation.

Bondy Operation

Bondy (1910) described a modification of radical mastoid operation, which was best indicated for otorrhea with limited cholesteatoma in attic and mastoid region.

Bondy technique can be described as inside out mastoidectomy starting with atticotomy and progressing as required. Usually it does not require entering into mesotympanum with preservation of ossicles and middle ear spaces.

Atticotomy

- Also called epitympanotomy and procedure is done by removing all or part of the outer attic wall (also called Scutum) and adjoining posterior meatal wall to expose the attic to remove disease. It is a **Canal wall down operation**
- Outer attic wall (scutum) is reached just lateral to notch of Rivinus
- Atticotomy is done when the disease is limited to attic part only
- Malleus head and incus are removed if cholesteatoma has engulfed these structures
- Attic has two spaces formed by genu of facial nerve and these must be cleared when doing atticotomy.

Atticoantrostomy

This operation is done when disease process has also involved mastoid antrum in addition to epitympanum.

Tympanomastoidectomy term is used while doing mastoidectomy with tympanoplasty.

Advantages of Canal-wall-up Procedure

- Normal anatomy is maintained
- Patient can swim
- Patient can use hearing aid
- No cavity care required.

Disadvantages of Canal-wall-up Procedure

- Chances of recurrent/residual disease in 30 percent cases
- May need revision surgery after 6 months.

Contraindications to CWU Procedure

- Only hearing ear
- Recurent cholesteatoma
- Posterior canal wall if already destroyed
- Labyrinthine fistula.

Key Points

1. **In cortical mastoidectomy** all the diseased mastoid air cells are removed.
   - In **radical mastoidectomy** besides the removal of cholesteatoma or granulation tissue from middle ear cleft, remnant of necrosed ossicles and tympanic membrane are also removed and meatoplasty is done for drainage
   - In **modified radical mastoidectomy** the operation is kept radical as far as the disease is concerned, but conservative as far as the functional aspect of hearing is concerned.
2. **Bridge** is the most posterosuperior part of bony meatal wall lateral to aditus ad antrum, which overlies the notch of rivinus while facial ridge lies lateral to fallopian canal. Bridge is removed and ridge is lowered in radical or modified radical operation.
3. **Combined approach tympanoplasty (CAT)** is done only when one is sure of total eradication of the disease from the mastoid bowl. In fact, it is a transmeatal, transmastoid approach on either side of intact posterosuperior bony canal wall.
4. Postaural incision is named after **William Wilde**, endaural after Lempert and permeatal incision after Rosen.
5. **Most common causes of wet ear** after mastoidectomy are recurrent or residual cholesteatoma in facial recess and sinus tympani area, high facial ridge or a closed meatoplasty.
6. **Atticotomy** also known as epitympanotomy is done when cholesteatoma is limited to the attic or epitympanic region. Scutum (lateral attic wall) is lowered to expose the disease and the cavity is cleaned.
7. **Atticoantrostomy** also referred to as Bondy's mastoidectomy is indicated for primary acquired cholesteatoma with disease limited to pars flaccida, attic and antrum.
8. **Donaldson's line** is an imaginary line from lateral semicircular canal, bisecting the perpendicular formed by posterior semicircular canal. Importance is that the superior part of endolymph sac is located here.
9. A **spine of bone, called cog,** hangs inferiorly from the tegmen. Facial nerve lies anterior to the cog just before it turns into 1st genu.
10. **Mike's dot** is an area in the elliptical recess and it is a useful landmark to the lateral end of internal auditory canal. It is a cribriform area.
11. **Bleeding from bone** in mastoid surgery is controlled by using bone wax or by diamond burr or by bipolar cautery.
12. **Opening of facial recess** provides access to middle ear structures from mastoid side.
13. **Nerves used in facial nerve repair** are sural nerve, greater auricular nerve and lateral femoral cutaneous nerve.
14. **Lesion of chorda tympani nerve** in mastoidectomy spares taste sensation because otic ganglion is connected to chorda and vidian nerve providing an alternative pathway of taste.
15. **Suture materials**
    - Plain catgut derived from submucosa of sheep's jejunum and absorption time is 7 days.
    - Chromic catgut is catgut with chromic acid, is brown in color and absorption time is 21 days.
    - Vicryl (polyglactic acid) is a synthetic suture and absorption time is 90 days.
    - **Prolene is synthetic monofilament suture material blue in color.**
    - As the size of suture material increases from 1 to 9 zero it becomes thinner.
16. **Speed of drill** in mastoid surgery is between 15,000 to 20,000 rpm.
17. **Bleeding during drilling** can be stopped by using diamond burr or bone wax, gelfoam, bipolar cautery or reverse rotation of drill.
18. **Biomaterials** may be metallic (tantalum, steel, titanium, platinum or gold) non-metallic (plastics, teflon/silastic, proplast/plastipore) ceramics (hydroxypatite, aluminium oxide or ceravital.
19. Complications of canal wall down procedure—**remember mneumonic: 3 D's:** Discharge; Deafness; Dizziness.

Chapter 67

Myringoplasty and Tympanoplasty

What Students Must Know!

- **Introduction**
- **Various Methods to Improve Hearing**
- **Myringoplasty**
- **Pre-requisites for Myringoplasty**
  - Advantages of Myringoplasty
  - Indications
  - Contraindications
  - Complications
- **Ossiculoplasty**
- **Tympanoplasty**
- **Types**
  - Aims of Tympanoplasty
  - Contraindications
- **Other Methods to Close the Perforation**

INTRODUCTION

- Wullstein (1953) was the first to use the term tympanoplasty
- Tympanoplasty is defined as the eradication of the disease from the middle ear along with reconstruction of hearing mechanism
- When there is repair of ossicular chain without repair of tympanic membrane perforation, it is called ossiculoplasty
- Repair of pars tensa tympanic membrane perforation without ossicular chain repair is called myringoplasty
- When tympanoplasty is combined with removal of disease from the mastoid, it is called tympanomastoidectomy.

VARIOUS METHODS TO IMPROVE HEARING

- TCA or silver nitrate cautery
- Splinting of perforation
- Myringoplasty
- Tympanoplasty
- Fat graft myringoplasty
- Theta myringoplasty
- Endoscopic myringoplasty.

MYRINGOPLASTY

- It is the simple repair of the perforation of tympanic membrane
- First myringoplasty was done in 1878 by Berthold
- It does not include removal of disease from middle ear or repair of ossicular chain.

Objectives of Myringoplasty

- To improve hearing
- To enable proper hearing aid usage
- To make ear dry by avoiding exposure to outside allergens directly.

Prerequisites for myringoplasty

- There should be no active infection of middle ear
- Good cochlear function (no sensory neural hearing loss)
- Eustachian tube should be patent and functional
- Functional oval and round window
- Ear should be dry for more than 6 to 8 weeks without any medication
- Ossicular chain should be intact (It can be tested by simple patch test)
- Healthy middle ear mucosa.
- No upper respiratory tract infection (URTI).

Advantages of Myringoplasty

- Improvement of hearing takes place
- The patient also achieves a dry ear
- The patient can go for swimming
- Fit to join military/police service.

Indications

- A dry central perforation without mastoid pathology and with intact ossicular chain and only conductive hearing loss
- In elderly people, although hearing improvement may not occur, a person can have a dry ear with intact IM.

Contraindications

- Active disease of middle ear and unsafe ear
- Small children below 3 to 5 years.
- Extensive allergic rhinitis
- Severe otitis externa
- Unsafe ear
- One dead ear
- Sensorineural hearing loss (SNHL) of more than 30 dB (may be done to close the perforation).

Graft Materials

Temporalis fascia is mostly preferred because:
- It is tough
- Has low basal metabolic rate (BMR)
- Available in the same surgical field
- No size limitation
- Easy to harvest
- Histologically close to TM

Heerman was the first to use temporalis fascia graft (1961).

- Whole thickness skin graft from over the mastoid process or deep meatal skin (not used these days).
- Vein graft (Shea—1960).
- Tragal perichondrium.
- Homologous temporalis fascia, perichondrium and dura mater.

Ossicular Graft Materials

- Fashioned autograft or homograft ossicles
- Conchal or tragal cartilage
- Tooth
- Ceramics, or biomaterial like teflon, gold or partial ossicular replacement prosthesis (PORP) and total ossicular replacement prosthesis (TORP).

Types of Operation

The underlay and overlay techniques of myringoplasty are shown in **Figures 67.1A and B**.

Overlay or Onlay Technique

In this technique, the graft is placed on the outer aspect of the drum in contact with fibrous layer after lifting the outer epithelial layer.

Advantages

- A technique, which can be used in all cases
- Gives excellent exposure
- Middle ear space is not reduced
- Anterior recess can be seen
- Blunting of anterior meatal recess is a big problem in this technique.

What is Blunting ?

In normal circumstances of middle ear, tympanomeatal angle is less than 90 degree, but in blunting due to fibrosis after onlay technique angle becomes more than 90 degree and the grafted drum shifts away from handle of malleus giving rise to conductive hearing loss.

To Avoid Blunting

- Pack the anterior angle to keep the recess intact
- Avoid placing graft on the anterior wall
- Tympanomeatal angle should not be disturbed
- Do not use big and thick grafts.

Underlay or Inlay Technique

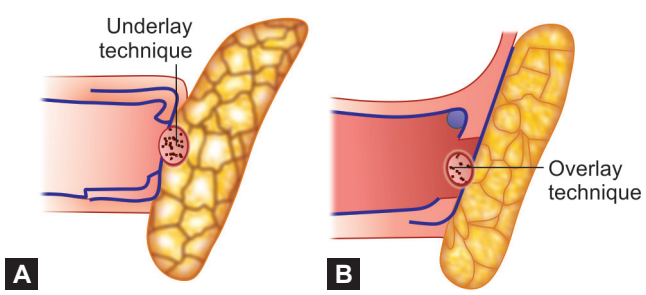
In this, the graft is placed on the inner side of drum in contact with raw mucosal surface.

Other Techniques

Through technique and Reverse through technique in which the graft is introduced through the perforation itself.

Basis for Tympanic Membrane Grafting

Graft acts as a scaffold to support the regenerating mucosa.



Figures 67.1A and B Underlay and overlay techniques of myringoplasty

Approach

- It can be permeatal, if the meatus is adequately wide.
- It can be endaural (suitable for posterior perforation) or postaural (suitable for anterior perforation). Postaural is mostly preferred these days.

Technique

- Under local anesthesia or general anesthesia, graft is taken from the temporalis fascia (**Figures 67.2A to E**)
- Tympanic perforation is exposed by any suitable route
- Margins of TM perforation are excised before lifting the tympanomeatal flap forward towards the anterior wall to expose the ossicular chain and promontory
- Graft (size 1.3–1.5 cm) is placed in contact with mucosal surface over the gelfoam in underlay technique and on the fibrous layer of TM in onlay technique.

Postoperative Care

- The patient is given antibiotics for 2 weeks
- Ear pack is removed after 7 to 10 days
- Complete epithelialization may take 6 to 8 weeks.

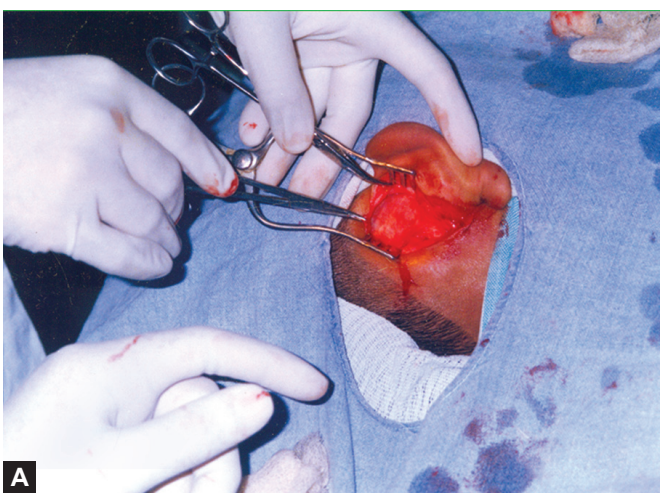
Causes of Failure

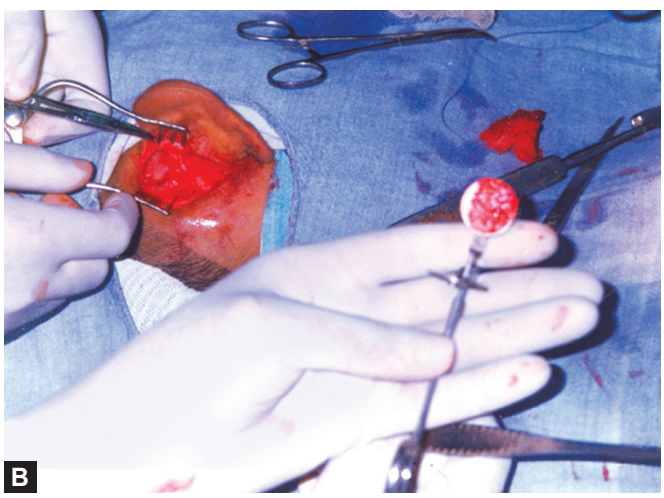
- Infection
- Allergy
- Poor technique.

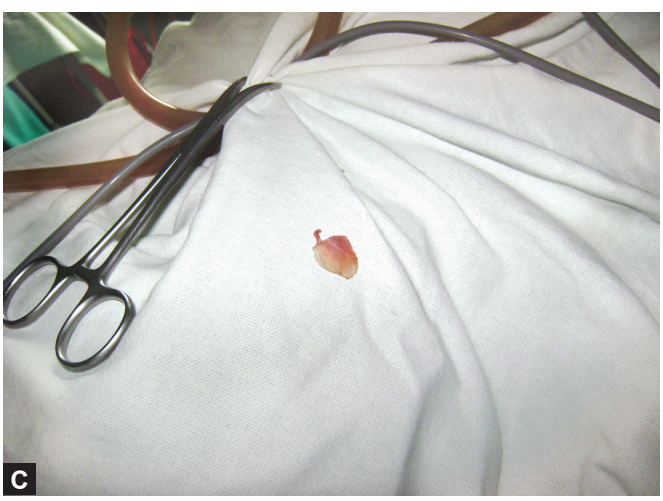
Complications

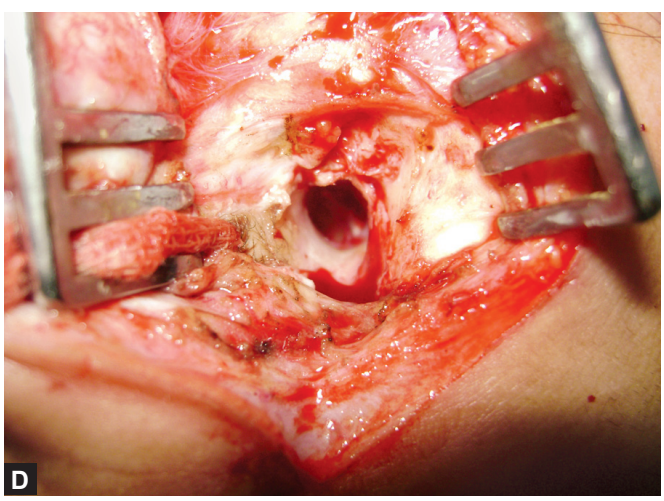
Onlay Technique

- Blunting of the anterior sulcus giving rise to conductive loss
- Epithelial pearls due to burying of squamous epithelium under the graft (**Figure 67.2F**)

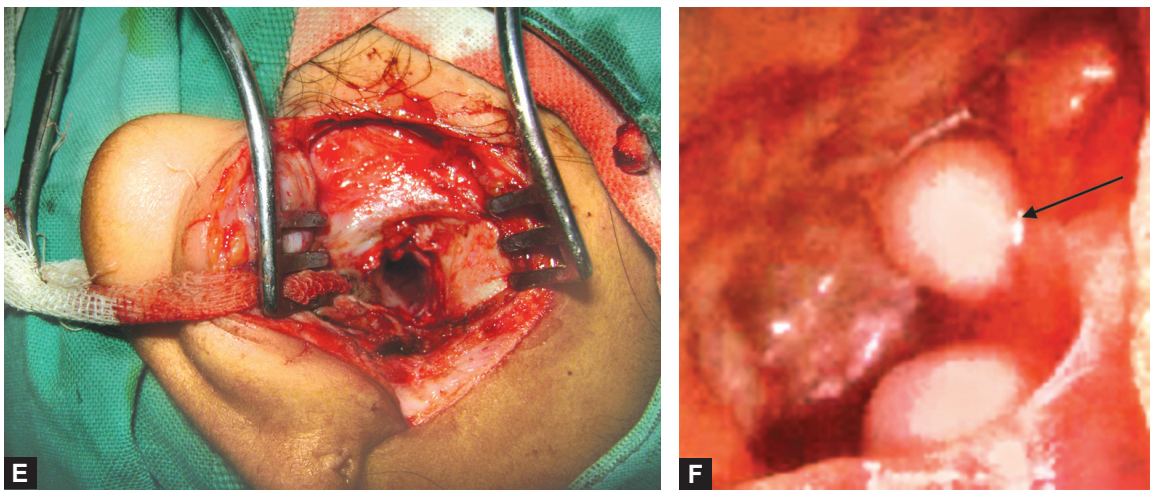








Figures 67.2A to D (A) Temporal fascia exposed via postauricular route; (B) Harvested temporalis fascia for grafting; (C) Exposure of perforation by postaural route; (D) The temporal fascia graft



Figures 67.2E and F (E) After the placement of graft; (F) Epithelial pearls after onlay type of tympanoplasty

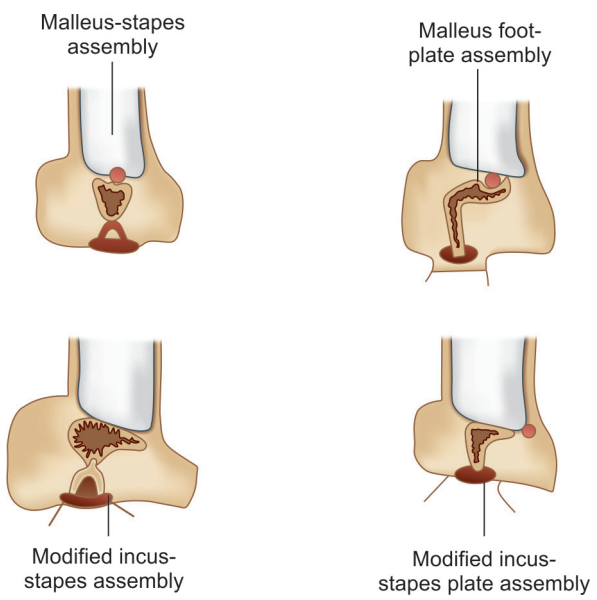


Figure 67.3 Various types of ossiculoplasty

- Lateralization of the graft, which can be prevented by making a V-cut in the graft and putting it under the handle of malleus
- Infection and rejection of the graft may take place.

Underlay Technique

- Shallow middle ear
- Graft may become adherent to the promontory
- Graft may not get fixed in the anterior part leaving a perforation
- Taste disturbances
- Facial weakness
- Tinnitus and dizziness.

Success Rate

In experts hands it is between 60 and 85 percent.

OSSICULOPLASTY

1. Repair or reconstruction of ossicular chain is called ossiculoplasty.
2. Usually, it is the long process of incus and handle of malleus, which are necrosed by the disease (**Figure 67.3**). In some cases, stapes suprastructure may also be lost.
3. Ossicular chain can be reconstructed by using:
   - Autograft tragal or conchal cartilage, incus
   - Biomaterials
   - Prosthetic implants made of teflon or gold
   - Ceramics such as TORP or PORP.
4. Its advantage is that, the results are available very early, i.e. hearing improves faster and the patient can resume normal activity very soon.

TYMPANOPLASTY

- It is a procedure to remove disease from middle ear and reconstruct hearing mechanism.
- It is done when there is presence of TM perforation along with defect in ossicular chain without any complications.

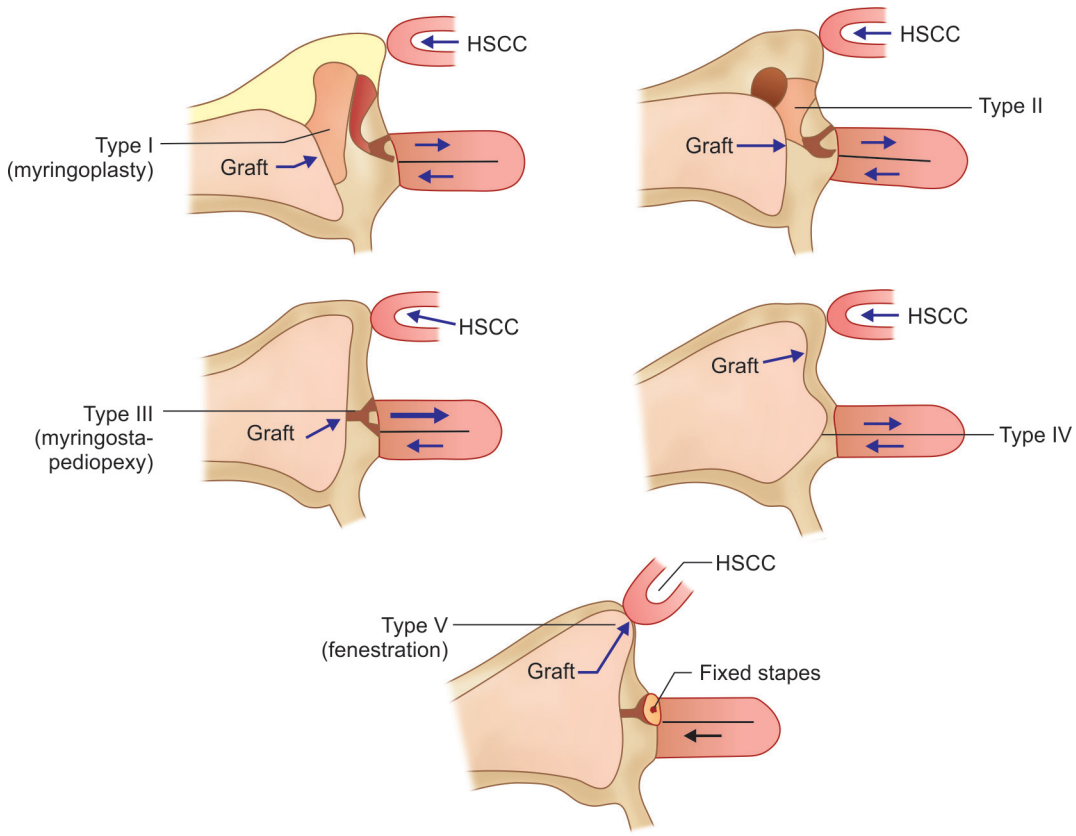


Figure 67.4 Various types of tympanoplasty (HSCC - Horizontal semicircular canal)

- The term was originally described in 1964 by American Academy of Ophthalmology and Otology Committee.

Types

Wullstein and Zollner (1953) classified tympanoplasty into five types (**Figure 67.4**).

Type I

- Only the ear drum is repaired and middle ear is inspected for the disease (**Figure 67.5A**).
- Here ossicular chain is intact and mobile, so no repair required.
- It differs from simple closure of perforation (myringoplasty) in that here middle ear is also examined to rule out any pathology.
- So, Temporal fascia graft lies on malleus.

Type II

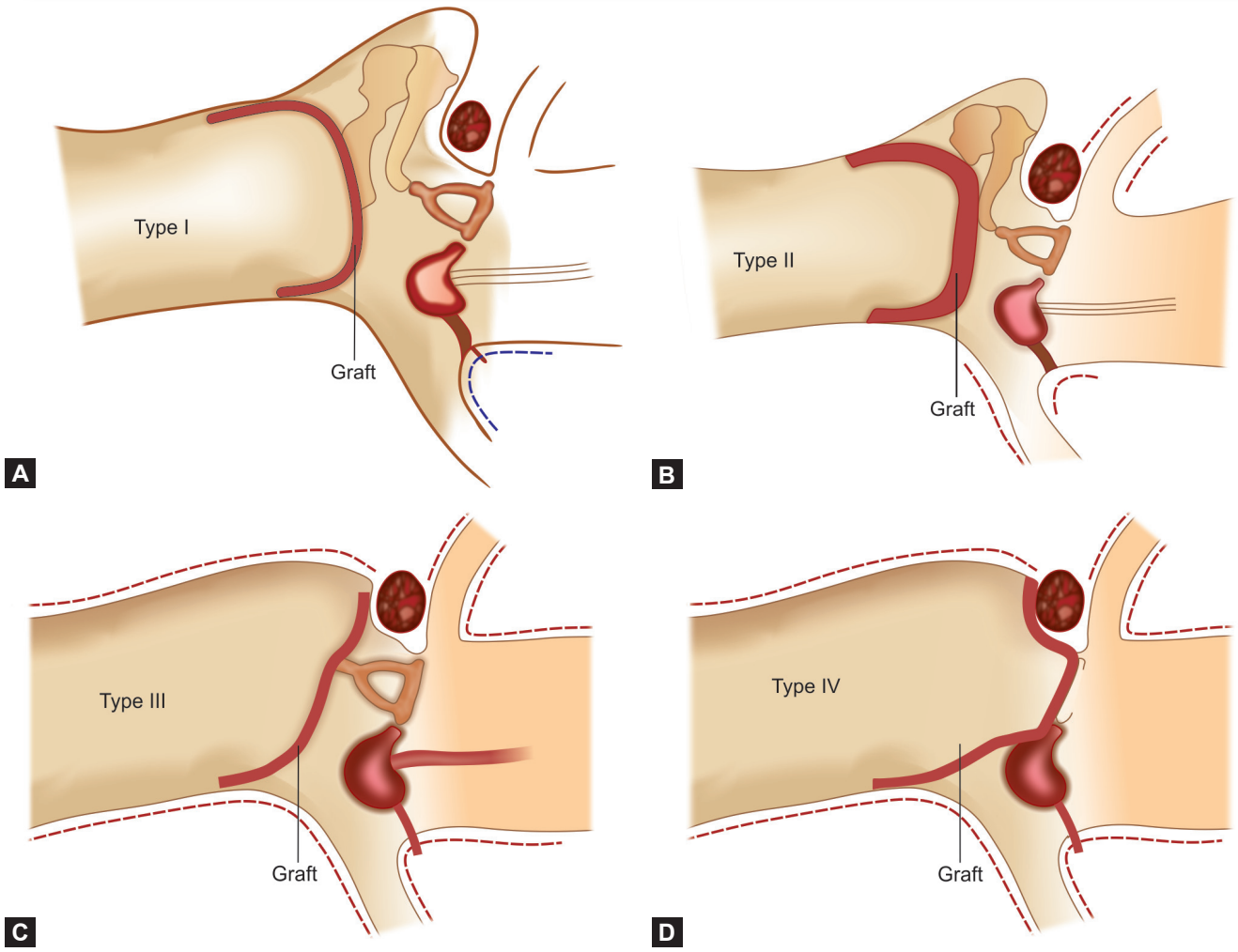
- It is done where there is partial or total damage of malleus and incus (**Figure 67.5B**)
- Temporalis fascia graft is placed along with minor reconstruction of ossicles such as repositioning of the incus or a bone graft between fascial graft and head of stapes
- Temporal fascia graft lies on incus/any ossicular graft.

Type III

- Columellar type (or collumellar effect). It is done when malleus and incus are destroyed and absent, but stapes is healthy and mobile (**Figure 67.5C**)
- It is also called myringostapediopexy
- Graft is placed on the head of mobile stapes.

Type IV (Figure 67.5D)

- Round window baffle effect
- Footplate of stapes is mobile
- All ossicles including stapes head are eroded and absent.
- Footplate of the stapes should be mobile and is left exposed to sound waves
- Graft is placed in such a way that a small air-containing cavity with eustachian tube and round window is created (baffle effect).



Figures 67.5A to D (A) Type I tympanoplasty; (B) Type II tympanoplasty; (C) Type III tympanoplasty; (D) Type IV tympanoplasty

Type V

- It is also called fenestration operation
- When footplate of stapes is fixed and no ossicles are present
- A window is created in the lateral semicircular canal
- Round window is shielded by graft
- Sound waves travel through the fenestra.

Type VI (Sound Inversion)

- Sono inversion of Garcia
- Round window is exposed to sound wave
- A graft is placed protecting the oval window with a graft.

Aims of Tympanoplasty

- To remove the disease from the middle ear
- To improve the hearing.

Tympanoplasty can be performed under general or local anesthesia depending upon the age and general condition of the patients.

Indications for tympanoplasty are similar to myringoplasty except that dry ear and intact ossicular chain is not a prerequisite.

Contraindications

- Only hearing hear due to fear of irreversible SNHL
- Chronic otitis externa and eustachian tube dysfunction
- Dead ear
- Malignancy.

Other Methods to Close the Perforation

- Silver nitrate (20%) cautery of small perforation (Roosa—1876)

- Splinting in traumatic perforation
- TCA (50%) cautery and gelfoam application (Okuneff—1895).

Types of Myringoplasty

Fat Graft Myringoplasty

In this to close small perforation the margins are freshned and fat harvested from ear lobule is plugged in the perforation like a dumble or hour glass.

Theta Myringoplasty

It is indicated for residual perforation after removal of tympanostomy tubes.

In this, cigarette paper patch is stented on residual perforation after cauterization with TCA.

Endoscopic Myringoplasty

- A minimally invasive day care procedure
- It provides better visibility of hidden areas and recesses of middle ear
- Economical and less operating time
- Disadvantages are:
  - Bleeding problems
  - Holding of endoscope
  - Lacks 3D perception.
- Procedure may be useful in:
  - Performing fat or theta myringoplasty
  - For LASER assisted grommets insertion or for photography.

Key Points

1. **Wullstein** (1953) is the father of tympanoplasty.
2. The term **tympanomastoidectomy** is used when tympanoplasty is performed along with mastoidectomy.
3. In **underlay technique of myringoplasty,** graft is kept medial to fibrous layer, whereas in overlay technique graft is kept lateral to fibrous layer of tympanic membrane.
4. **Tympanoplasty type III** is also called myringostapediopexy or columella operation. This columella effect is normally present in birds.
5. ***Patch test:*** This test is performed to know whether ossicular chain is intact or not. Here, a piece of cigarette foil or gelfoam is kept over the perforation. If there is subjective improvement of hearing, the patient can undergo myringoplasty operation.
6. **Cardinal principles of tympanoplasty** are control of infection and reconstruction of sound-conducting mechanism.
7. **Advantages of skin graft over fascia** is that it stands better the infection and formation of granulations.
8. Graft should be positioned tightly in the **anterior sulcus** as here the branches of anterior tympanic and deep auricular arteries provide critical blood supply to the graft.
9. **Blunting of anterior sulcus,** if severe causes fixation of handle of malleus leading to conductive hearing loss.
10. **Maximum conductive hearing loss** (60-65 dB) is seen in ossicular chain disruption because both windows lie behind sound protection and there is no pressure transformation for oval window.

Chapter 68 Stapedectomy/ Stapedotomy

What Students Must Know!

- **Stapedectomy**
  - Aims of the Operation
  - Anesthesia
  - Procedure
  - Indications
  - Contraindications
  - Complications
- **Neostapedectomy**

INTRODUCTION

- Shea (1958) was the pioneer of stapedectomy operation
- In this operation, stapes head and crura are removed and a prosthesis, Teflon Piston, 4.0 to 4.5 mm long is inserted between long process of incus and footplate of stapes
- Improvement in hearing occurs in 90 percent cases
- In 2 percent cases sensorineural hearing loss (SNHL) may result and dead ear may occur in 0.5 percent
- In case of loose prosthesis in stapedectomy hearing improves on Valsalva and hearing deteriorates after swallowing
- The patient's only hearing ear is a contraindication for stapedectomy because of the risk of SNHL (1:100)
- **Stapedotomy—procedure resembles stapedectomy, but differs in the sense that footplate is not removed, rather a hole is drilled in it by an electric drill, LASER (Argon or KTP) or hand held perforator for the insertion of prosthesis**
- Reverse stapedotomy means insertion of prosthesis before removing superstructure of stapes (Fisch).

STAPEDECTOMY

Aims of the Operation

To transmit sound waves to the inner ear bypassing the fixed footplate of stapes.

Indications

Otospongiosis.

Contraindications

- Active otospongiosis
- Young patients age less than 15 years for fear of refixation
- Active infection of meatus
- Medical conditions like diabetes, hypertension, pregnancy, Paget's disease
- Cochlear otosclerosis
- Congenital ossicular fixation
- Only hearing ear
- Tympanic membrane perforation.

Instruments

Required are:

- Microscope
- Instruments for tympanoplasty like:
- Endaural retractor
- Ear speculum
- Circular knife
- Fine periosteum elevator
- Burr machine with fine burr points
- Micro scissor

- Fine pick
- Hand driven long micro burr
- Crocodile forceps
- Zic to measure the distance between long process of incus and stapes footplate.

Anesthesia

Local anesthesia is preferred because of less bleeding and improvement in hearing can be tested on the table.

Procedure

- Patient lies supine with the ear to be operated upwards
- Operating microscope with high magnification is used
- Various incision such as Rosen's endomeatal or Lempert's endaural or Wilde's postaural incision is used depending upon one's convenience
- Tympanomeatal flap is raised forward to inspect the ossicular chain (**Figure 68.1**)
- Incudostapedial joint and footplate is visualized and fixation of footplate is confirmed
- Stapedius tendon is cut near its origin
- Incudostapedial joint is dislocated and stapes supra structure is removed (**Figure 68.2**)
- A fenestra is made in the fixed footplate thus making a communication between middle and inner ear
- After thinning the footplate it is removed partially or completely
- A Teflon piston is placed between long process of incus and the fenestra in footplate of stapes (Stapedotomy or in the mucoperiosteum separating middle ear and inner ear (Stapedectomy) (**Figure 68.3**)
- Mobility of the chain is again tested and patient's hearing is also tested to see the results of the operation
- Typanomeatal flap is replaced and Gelfoam pack is put
- **Postoperative care:** Antibiotics and anti-inflammatory drugs—patient is advised to avoid flying, swimming, straining or lifting heavy weight and sneezing.

Complications of Stapedectomy

- Floating footplate (mostly iatrogenic)
- Perilymph leak and gusher (increases the risk of SNHL)
- SNHL (Anacusis 1 to 2%).
- Perforation of tympanic membrane
- Vertigo
- Facial nerve injury
- Chorda tympani nerve injury (Dysgeusia)
- Labyrinhitis
- Conductive hearing loss due to dislocation of piston.

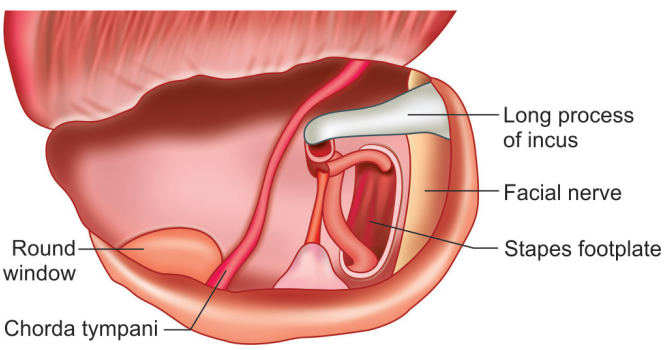


Figure 68.1 Incudostapedial area after posterior tympanotomy

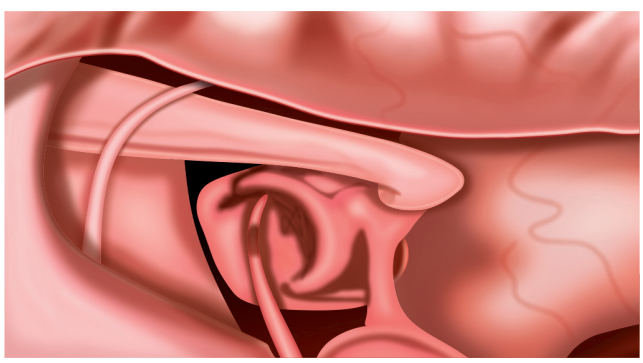


Figure 68.2 Removal of stapes suprastructure

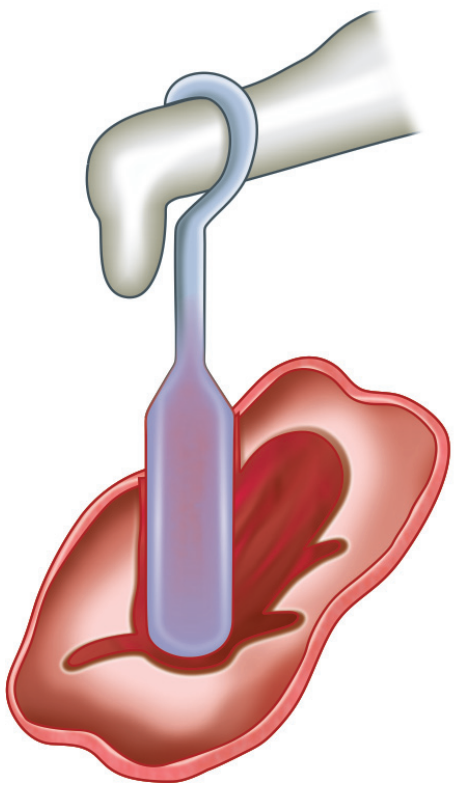


Figure 68.3 Teflon piston between incus and fenestrated footplate of stapes

Key Points

1. **Stapedectomy** is the surgical treatment of choice. If not willing or unfit for surgery, hearing aid is the best.
2. **Neo stapedectomy** procedure—stapedial tendon and incudostapedial joint is preserved.
3. **Cookie bite audiogram** is seen in cochlear otosclerosis.
4. Definite **diagnosis of otospongiosis** can be made by exploratory tympanotomy and not by CT or impedance audiometry.
5. **Important complications of stapedectomy** are:
   - Injury to facial nerve, chorda tympani
   - Tympanic membrane perforation
   - SNHL
   - Perilymph fistula
   - Floating foot plate
   - Displaced prosthesis
   - Dead ear.
6. Contraindications of stapedectomy—**remember mneumonic: IPOD:** I: **I**nfections in external/middle ear; P: **P**erforation should be closed first; O: **O**nly hearing ear is a contraindication; D: **D**eafness (sensorineural).

Chapter 69 Nasal Packing

What Students Must Know!

- **Anterior Nasal Packing**
  - Instruments
  - Procedure
- **Posterior Nasal Packing**
  - Procedure
  - Complications

INTRODUCTION

Nasal packing is one of the most common ear, nose and throat (ENT) procedure, where packing of the nose is done with ribbon gauze for giving pressure or controlling the bleeding. Every attempt should be made to avoid nasal packing as it causes further trauma to nasal mucosa and delays recovery.

TYPES

Nasal packing is of two types (**Figure 69.1**):

1. Anterior nasal packing.
2. Posterior nasal packing.

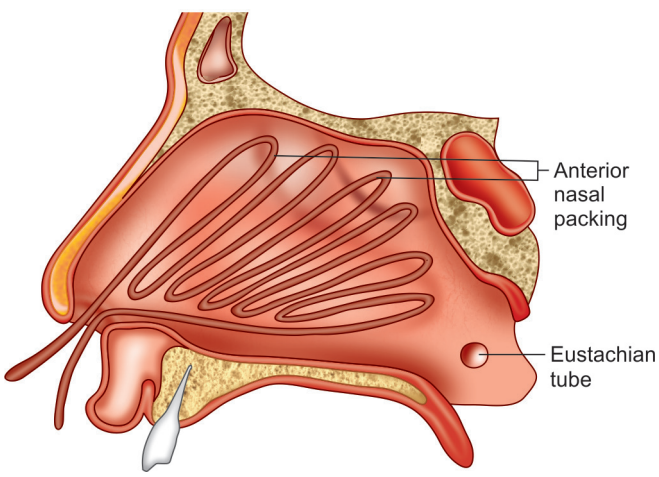


Figure 69.1 Anterior nasal packing

Instruments Required

1. Nasal speculum.
2. Tilley nasal dressing forceps.
3. Rubber catheters.
4. Ribbon gauze packs (48 to 72 inches in length and ½ inch width).

ANTERIOR NASAL PACKING

Procedure

- Here, the nose is packed with ribbon gauze impregnated with lubricants like vaseline or liquid paraffin
- Packing should never be done with dry gauze as it sticks to the nasal mucosa leading to painful removal and fresh bleeding
- The nose is packed from bottom to top in layers and the pack is removed after 48 hours
- Packing with ribbon gauze always gives discomfort to the patient; therefore, packing with Gelfoam or Abgel is done these days.

Indications

Anterior nasal packing is usually done in nose bleeding following trauma, surgery or idiopathic epistaxis. Sometimes, it is done to give support to the nasal framework.

POSTERIOR NASAL PACKING

- If bleeding continues in spite of proper anterior nasal packing, then posterior nasal packing is indicated using

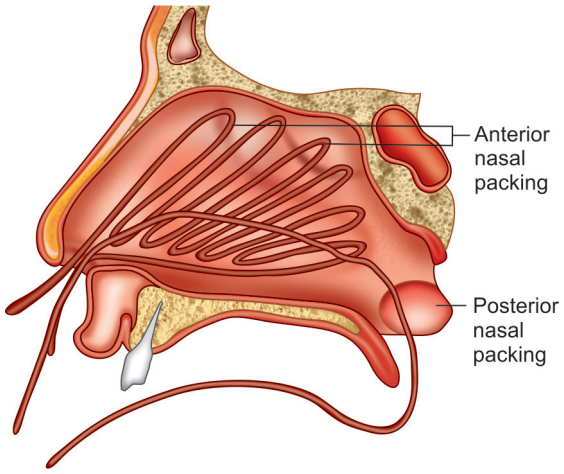


Figure 69.2 Posterior nasal packing

either ribbon gauge and its alternative is rubber balloon or a Folley's catheter (**Figure 69.2**)

- The procedure is performed under general anesthesia (GA) or local anesthesia supplemented by mild sedation.
- It is mostly required in posterior epistaxis or after surgery for lesions of nasopharynx such as angiofibroma.

Procedure

1. One rubber catheter is passed through each nostril and is brought out through the mouth.
2. These are tied to 2 tapes attached to a single bolus of gauze.
3. Catheters are pulled out through the nose, till the gauze bolus guided by the fingers gets snuggly fitted into the nasopharynx.
4. Tapes are tied in front of the nasal columella, which is protected by a piece of gauze or rubber.
5. Relatively tight anterior nasal packing is performed in addition.
6. A separate thread attached to the gauze is brought out through the mouth and stuck with leukoplast.
7. Pack should be removed after 48 hours.

COMPLICATIONS

1. Injury to the nasal mucosa, which delays healing.
2. Synechia formation indicates poor packing and bad postoperative care.
3. Toxic shock syndrome (TSS), if pack gets infected with staphylococci and is kept in place for more than 72 hours.
4. Otitis media, due to obstruction to Eustachian tube opening.
5. Injury to soft palate, uvula and necrosis of columella.
6. Sinusitis because of disturbed aeration and drainage of the sinuses.

Key Points

1. Most important indications for **anterior nasal packing** are nose bleed, after nasal surgery or to give support to the framework of nose after reconstructive procedures.
2. **Posterior nasal packing** is usually done in posterior epistaxis or after surgery of tumors of nasopharynx.
3. **Foley's catheter or rubber balloon** is an alternative for posterior nasal gauze packing.
4. **Complications** of anterior nasal and posterior nasal packing include synechia formation, otitis media, chronic sinustis, difficulty in swallowing and respiration and toxic shock syndrome.
5. **Excessive sedation** in nasal packing may cause death due to cardiopulmonary failure.
6. **Approximate size of nasal pack** is 48 to 72 inches (long) × 1/2 inch (wide).
7. **Alternative to ribbon gauze packing** is Gelfoam or Abgel, which gives much less discomfort to the patient, but is costly.

Chapter 70 Antral Wash and Intranasal Antrostomy

What Students Must Know!

- **Antral Wash**
  - Indications
  - Contraindications
  - Instruments Required
  - Anesthesia
  - Technique
  - Difficulties and Complications
- **Intranasal Antrostomy**
  - Procedure
  - Complications

ANTRAL WASH

- It is also called antral irrigation
- It is a surgical procedure in which a cannula is inserted into the maxillary antrum through its medial wall via inferior meatus
- It is also called proof puncture or diagnostic puncture because it gives proof of the infection
- It becomes a therapeutic puncture when done subsequently to clear the infection (**Figure 70.1**).

Indications

Diagnostic

- Chronic sinusitis when returning fluid is mucopurulent and to carry out culture and sensitivity test
- Exfoliative cytology of the returning fluid to rule out any malignancy.

Therapeutic

- Chronic maxillary sinusitis not responding to medical treatment
- Oroantral fistula, if associated with sinusitis
- Acute maxillary sinusitis not responding to conservative methods.

Contraindications

- Children below the age of 12 years as the size of sinus is small and chances of false passage formation are there
- Acute maxillary sinusitis as it may lead to osteomyelitis

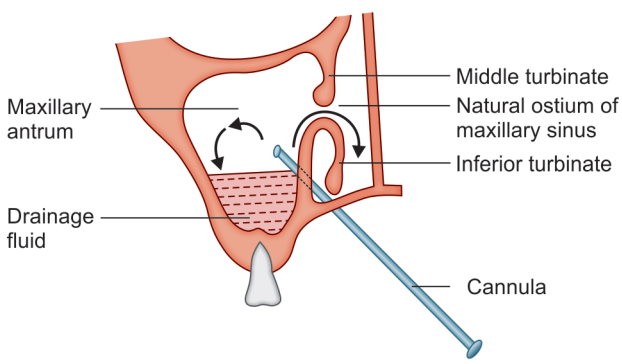


Figure 70.1 Antral wash

- Fracture of maxilla
- Diabetes, hypertension and bleeding disorders.

Instruments Required

- Lichtwitz's antral trocar with cannula
- Higginson's rubber syringe
- Tilley's forceps
- Nasal speculum.

Position

Semi-sitting position.

Anesthesia

Local anesthesia is mostly preferred in majority of cases. Four percent xylocaine with adrenaline is applied over the mucosa of the inferior meatus and posterior end of middle turbinate. Atropinization of patient prevents vasovagal attack and also decreases secretions. General anesthesia may be needed in children.

Technique

- Light is focussed over the nose. Cotton wools impregnated with 4 percent xylocaine are removed and anterior rhinoscopy is done
- The Tilley Lichtwitz trocar and cannula is held in the right hand like a pen and inserted in the inferior meatus about 1/2 inch from the anterior end of inferior turbinate. Direction of trocar is kept towards outer canthus of the ipsilateral eye
- With firm and steady pressure, nasoantral wall is entered by a screwing motion. One enters the maxillary sinus with sense of sudden loss of resistance to the trocar. The trocar is withdrawn and cannula placed properly in the sinus cavity
- A little amount of normal saline is inserted through the syringe and contents aspirated and sent for culture and sensitivity
- The sinus is lavaged with Higginson syringe using sterile lukewarm saline or water. The patient is made to bend his head downwards and he breathes through his mouth. If the ostium is blocked, a second cannula may have to be inserted for draining the secretions
- The water along with discharge comes out from the natural ostium of the sinus. The procedure is repeated until clear fluid comes out.

The nature of fluid indicates the possible diagnosis.
- Amber color fluid indicates antral cyst
- Mucopus that of hyperplastic sinusitis
- Foul-smelling purulent discharge is of purulent sinusitis
- Blood stained indicates malignancy.

- Now, the cannula is withdrawn and nasal cavity is packed with cotton-wool plug.

Difficulties and Complications

- Hemorrhage, which is mostly slight and stops with cotton-wool plug
- Formation of false passage. Trocar may enter into the orbit if entered with great force. So, a close watch should be kept over the eyes for any swelling
- The trocar may enter into the soft tissue of cheek, which may lead to swelling of the cheek
- Air should not enter into sinus as there is danger of developing air embolism through damaged vessels and may be a fatal complication
- Vasovagal shock
- Complications of anesthesia
- Infection of the maxillary sinus
- Cardiac arrest rarely
- At times, the bone of the maxillary sinus may be hard, rendering the procedure difficult
- Epiphora due to injury to nasolacrimal duct.

Postoperative Care

- The patient lies down for 10 to 15 minutes after operation
- Antibiotics depending upon culture and sensitivity
- Analgesics to relieve pain
- Oral and local decongestant as nasal drops
- Steam inhalation.

INTRANASAL ANTROSTOMY

- Intranasal antrostomy is a procedure in which maxillary antrum is opened through inferior meatus for purpose of drainage and subsequent washes
- The opening can be made either through middle meatus which is more physiological as the drainage is always towards the natural ostium
- The opening is usually 1.5 × 2.5 cm in dimension. This operation has now been replaced by functional endoscopic sinus surgery (FESS).

Indications

- Chronic purulent sinusitis not responding to other forms of treatment
- Antrostomy is done as a part of Caldwell-Luc operation
- For taking biopsy from maxillary antra
- For drainage of maxillary sinus hematoma
- For inspection of maxillary sinus
- For fracture of maxilla and orbital floor
- In non-healing oroantral fistulas.

Contraindications

- Irreversible changes in sinus mucosa
- Suspicion of malignancy
- Osteitis of maxilla
- Children.

Procedure

Under local anesthesia, inferior meatus is punctured using Myle's antral perforator and opening is smoothened with antral burr and rasp. Size of antrostomy should be limited posteriorly because of the sphenopalatine vessels and inferiorly lowered up to the floor of nasal cavity. Light packing controls the bleeding.

Complications

- Hemorrhage
- Neuralgias
- Closure of antrostomy opening
- Synechia formation
- Injury to nasolacrimal duct.

Key Points

1. In proof puncture, **Lichtwitz's antral trocar** is entered into maxillary sinus through inferior meatus or canine fossa puncture.
2. **In oroantral fistula**, proof puncture is done to confirm or treat the infection of maxillary sinus.
3. Presence of **malignant cells** in the returning fluid confirms the malignancy, but its absence does not rule out the malignancy.
4. It is **not done in fracture maxilla**, as fluid may pass through fracture lines causing other complications.
5. Direction of trocar should be **backwards and laterally** towards the outer canthus of same eye.
6. Proof puncture **through middle meatus** is not done due to the fear of **injury to orbit and reactionary edema** blocking the natural ostium.

Chapter 71

Radical Operations on Maxillary Sinus

What Students Must Know!

- **Caldwell-Luc Operation**
  - Indications
  - Contraindications
  - Anesthesia
  - Steps of Caldwell-Luc's
  - Postoperative Care
  - Complications
- **Oroantral Fistula**
  - Causes
  - Symptoms
  - Management
- **Canfield's Operation**
- **Denker's operation**
- **McNeil's Operation**

CALDWELL-LUC

The operation was described by **George Caldwell of New York (1893) and Henry Luc of Paris (1897).** This is a surgical procedure in which the maxillary antrum is entered by making an opening in its anterior wall by sublabial approach through canine fossa and the pathology is removed. This is followed by an inferior meatal antrostomy for drainage. It is also **called radical antrostomy** operation. Functional endoscopic sinus surgery (FESS) has almost replaced the operation.

Indications

- Recurrent antrochoanal polyp for permanent cure
- Chronic maxillary sinusitis when the lining mucosa is permanently damaged
- Foreign bodies, e.g. tooth/bullet
- For fracture of maxilla for reduction and packing
- For elevation of orbital floor/blow out fractures
- Dental or dentigerous cyst
- Oroantral fistula failing to heal
- Transantral ethmoidectomy, sphenoidectomy and hypophysectomy
- As an approach to pterygopalatine fossa for maxillary artery ligation and vidian neurectomy
- Atrophic rhinitis for implantation of Stensen duct into the maxillary antrum (Whitmacc operation) or implantation of maxillary sinus mucosa into the nasal cavity (Raghav Sharan operation)
- To approach suspected maxillary tumors for biopsy or inserting radioactive implants or needles
- In sinuscopic surgery, failed cases of chronic maxillary sinusitis
- For orbital decompression in malignant exophthalmos.

Contraindications

- In children or patients below 17 years as growth of face and teeth of secondary dentition may be disturbed
- Acute infection of sinus
- Systemic diseases like diabetes, hypertension and bleeding disorders
- Recent traumatic lesions of maxilla.

Instruments Required

Common instruments used for Caldwell-Luc's opertion is shown in **figure 71.1**:

- Thudicum's nasal speculum
- Long-bladed nasal speculum
- Bard-Parker (BP) handle with knife
- Periosteal elevator
- Hammer with gouge
- Luc forceps
- Tilley's forceps
- Antral burr and harpoon
- Antral rasp
- Needle holder
- S-shaped lip and cheek retractor
- Bone cutting forceps
- Tongue depressor
- Suction tips

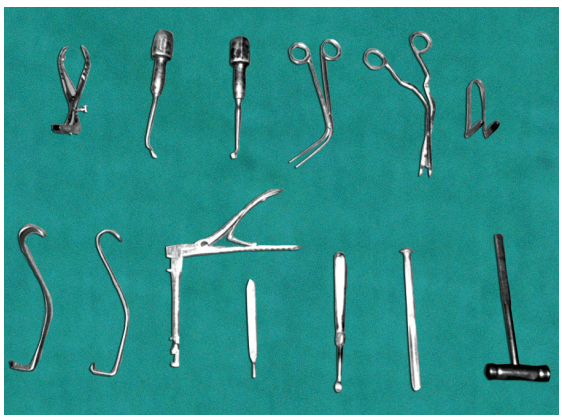


Figure 71.1 Instruments for Caldwell-Luc operation

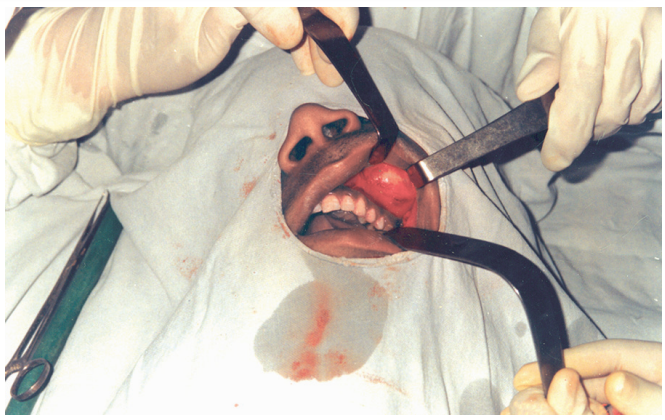


Figure 71.2 Caldwell-Luc operation

Anesthesia

General anesthesia is preferred, however, it can be done under local anesthesia. Two percent xylocaine with adrenaline is used for local infiltration.

Position

Supine with semi-sitting position.

Steps

Canine fossa lies on the anterior wall of maxilla bounded anteriorly by canine ridge superiorly by infraorbital ridge and foramen.

- Infiltration is done with 2 percent xylocaine with adrenaline
- A horizontal incision is given at the gingivolabial sulcus extending from the lateral incisor to the first molar
- Periosteum over the canine fossa is elevated up to the infraorbital foramen (**Figures 71.2 and 71.3**).
- At the region of canine fossa, an opening is made in the antrum with the help of gouge and hammer. Opening is enlarged with bone cutting forceps as to admit the little finger (**Figure 71.4**)
- Any pathology in the antrum is dealt with accordingly.
- Inferior meatal antrostomy is made in the nasoantral wall with the help of nasal harpoon and edges are smoothened.
- The antrum is packed with ribbon gauze impregnated with Vaseline and Betadine, and is brought out through the antrostomy opening into the nose. Anterior nasal packing is done on the side of antrostomy
- The wound is closed with catgut.

Postoperative Care

- Antibiotics and analgesics are to be given for 5 to 7 days
- Antral pack is to be removed after 48 hours.

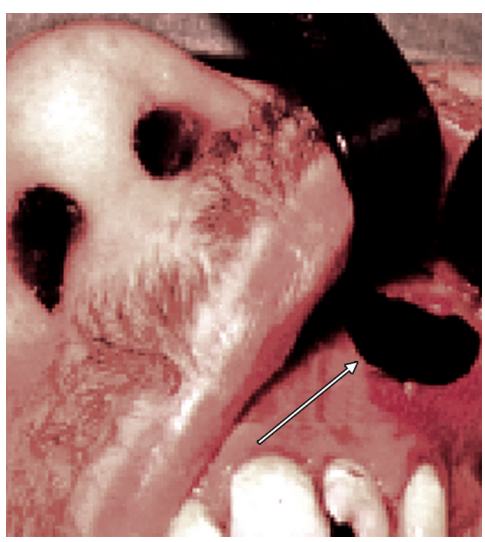


Figure 71.3 Caldwell-Luc operation (magnified view)

Complications

- Infraorbital paresthesia due to injury to infraorbital nerve
- Injury to orbit
- Hemorrhage
- Orbital infection
- Osteomyelitis
- Oroantral fistula
- Antral drip
- Recurrence of disease process
- Devitalization of teeth.

OROANTRAL FISTULA

Oroantral fistula is an abnormal tract a communication between oral cavity and maxillary antrum.

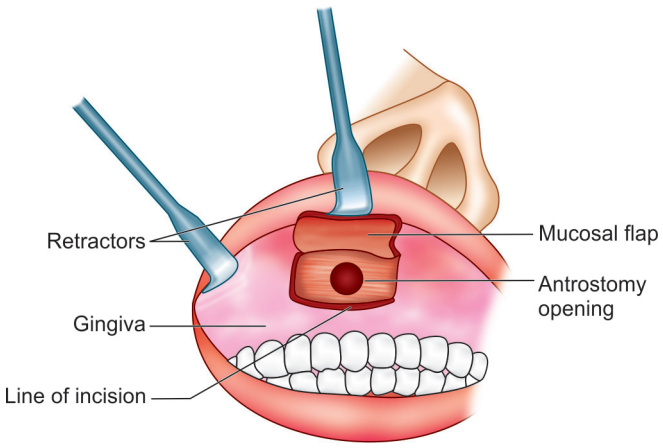


Figure 71.4 An opening made in the canine fossa area (diagrammatic)

Causes

- After dental extraction, particularly upper molars and second premolar
- Carcinoma maxillary antrum
- After Caldwell-Luc (CWL) operation
- Traumatic
- Chronic granulomatous diseases like syphilis or fungal infections.

Symptoms

- Foul-smelling discharge
- Regurgitation of food and fluids
- Unable to build positive or negative pressure in the mouth, so not able to blow wind instruments and drink through a straw.

Management

- After control of infection, surgical repair using a buccal or palatal flap is done
- Dental obturator may be used.

CANFIELD'S OPERATION (1908)

Canfield's operation is a modification of Caldwell-Luc operation, in which intranasal incision is made behind the vestibule. Anterior angle of maxillary sinus is chiseled off to expose the antrum and this opening is continued backwards into intranasal antrostomy.

DENKER'S OPERATION (1906)

Another modification of Caldwell-Luc in which incision is given as in the Caldwell-Luc operation, but is continued medially, so that when tissues are elevated, nasal cavity, as well as canine fossa are exposed. This approach gives good access to the nasal cavity and maxillary antrum.

MCNEIL'S OPERATION (1966)

McNeil's operation is an obliterative operation on the maxillary sinus in which abdominal fat is used to close the sinus. It is done in cases, where no other maxillary sinus operation helps the patient.

Key Points

1. **CWL operation called radical antrostomy** operation was described by George Caldwell of New York (1893) and Henry Luc of Paris (1897).
2. Important **noninfective indications** for CWL are impacted foreign bodies, dentigerous cyst, for approach to pterygo-palatine fossa for ligation of maxillary artery or for vidian neurectomy, for implantation of Stensen duct, for biopsy of growths or in case of fracture of orbit/maxillary walls.
3. **CWL is not done is children** before secondary dentition for fear of disturbing the dental centers.
4. **Oroantral fistula** is both an indication, as well as a complication of CWL operation.
5. **Canfield and Denker operations** are modifications of CWL operation.
6. **McNeil's operation** is an obliterative operation for unresponsive chronic maxillary sinusitis to any other form of surgical/medical treatment.
7. **Indications of Caldwell-Luc's operation—remember mneumonic: Coffee board:** C: **C**hronic maxillary sinusitis; O: **O**roantral fistula; F: **F**ungal sinusitis; F: **F**oreign body of maxilla; E: **E**thmoidectomy; E: **E**levation of floor of orbit; B: Biopsy; O: **O**pening sinus for maxillary artery ligation; A: **A**ntrchoanal polyp; R: **R**eduction of fracture maxilla; D: **D**ental cyst.

Chapter 72 Operations for Nasal Polypi

What Students Must Know!

- **Polypectomy**
  - Indications
  - Contraindications
  - Technique of the Operation
  - Complications
- **Ethmoidectomy**
  - Types
  - Complications of Ethmoidectomy
  - Indications
  - Polypectomy using a Microdebrider

Surgery is an art of learning not only when to cut, but also when not to cut. So better learn the right way.

Nasal polypi, which may be ethmoidal or antrochoanal polypi need to be treated conservatively in early stages, but usually have to be managed by surgical means. Various operations for nasal polypi are:

- Polypectomy.
- Ethmoidectomy.
- Caldwell-Luc (CWL).
- Functional endoscopic sinus surgery
- Using a microdebrider.

POLYPECTOMY

Definition

It is on operation done to remove polypoidal masses in the nasal cavity.

Instruments

- Microdebrider complete set
- Nasal speculum both short and long
- Nasal speculum with handle
- Glegg's nasal snare
- Luc's forceps
- Tilley's forceps
- Suction tips.

Indications

- Ethmoidal polypi
- Antrochoanal polypi.

Contraindications

- IIIrd recurrence
- Severe hypertension
- Severe anemia
- Diabetes, bleeding disorders or acute infections.

Anesthesia

- Local anesthesia
- General anesthesia.

Local anesthesia is usually employed in most of the cases, unless there is an indication for the use of general anesthesia, e.g. in children or when the patient is sensitive to local anesthesia.

How to Obtain Local Anesthesia

Premedication: Injection fortwin (or pethidine or morphine) + injection atropine is given ½ an hour before the operation. Four percent xylocaine with 1:1000 adrenaline, Moffat's

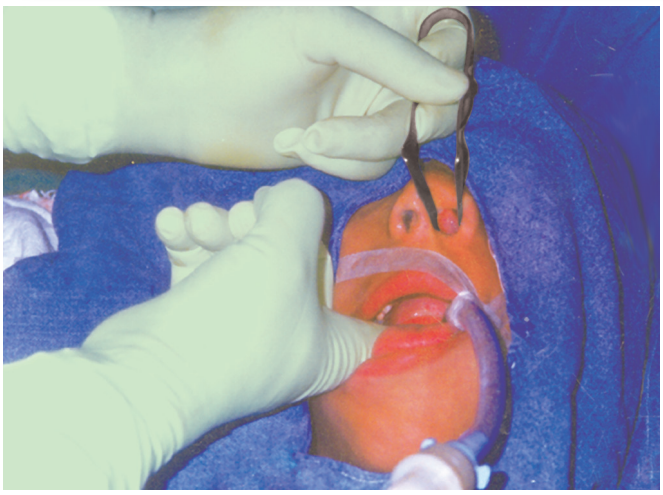


Figure 72.1 Polypectomy-digital palpation of choanal part of AC polyp and anterior rhinoscopy

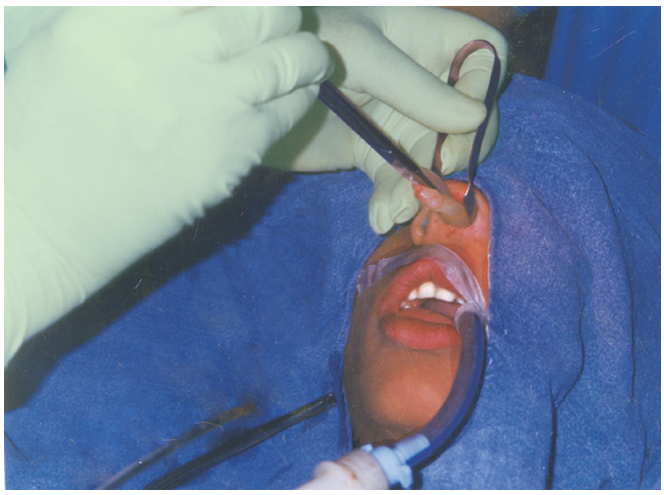


Figure 72.2 Polypectomy

solution consisting of cocaine (or 4% xylocaine) to which is added soda bicarb. Solution and adrenaline is sprayed or instilled in the nose 5 to 7 minutes before the operation and nasal cavity may also be packed with the 4 percent xylocaine-soaked ribbon gauze 3 to 5 minutes before the operation.

In addition to above, Injection diazepam 10 mg may also be given I/V just before the operation.

Technique of the Operation

1. Polypi are visualized with the help of nasal speculum with handle.
2. Nasal snare is taken and its wire is looped around the polypi. It is tried to go as near the base as possible and then the loop is tightened and polypi are pulled out. The procedure is repeated till all the polypi are removed.
3. If there is no nasal snare, or its wire cannot be passed around the polypi, Luc's forceps may be used in a similar fashion. It is best to avoid removing polypi in small bits, as it will cause bleeding and operation field cannot be seen, thus obscuring the removal of small polypi.
4. Suction is done repeatedly to see any remaining mass near the roof which, if seen, should be removed.
5. Gloved finger should be passed in the choanae and see if it is free of any mass (**Figure 72.1**). In antrochoanal polypi, if the polyp is large and hanging, it is best to remove the choanal part of polyp first of all and then the nasal polypi. If antrochoanal polyp is small, the patient might have to be put in tonsillectomy position. With head hanging low, soft palate is retracted with soft rubber catheters and polyp is held with Luc's forceps and removed in toto (**Figure 72.2**).
6. After removal of polypi, nose is checked for nasal patency and if alright, nose is packed with vaseline roller gauze in a gloved finger to obtain hemostasis which avoids synechiae formation later on.
7. Recent addition is the use of microdebrider, which uses a cutting and rotating knife with attached suction, but the only point is that it is very costly instrument.

Postoperative Orders

1. Record pulse, blood pressure (BP) and bleeding every 2 hours and then SOS.
2. Nothing orally for 3 hours (under local anesthesia).
3. Antibiotics for 5 to 7 days.
4. Analgesics for relieving the pain.
5. Dressing in the nose is removed after 24 to 48 hours and if there is bleeding, a light pack might have to be given. Nose should be inspected under a spray of local anesthesia and any small polypi if left, should be removed at the same time.
6. Antiallergics are also given.
7. The patient is discharged after 5 to 7 days and is advised to remain under observation for sometime to avoid recurrence.

Complications

- Hemorrhage
- Adhesions
- Recurrence of polypi
- Atrophic rhinitis
- Cerebrospinal fluid (CSF) rhinorrhea
- Orbital cellulitis.

ETHMOIDECTOMY

Ethmoidectomy means exenteration of ethmoidal group of cells along with diseased mucosa. It may be intranasal ethmoidectomy, external ethmoidectomy or through trans-antral route (Horgan's operation).

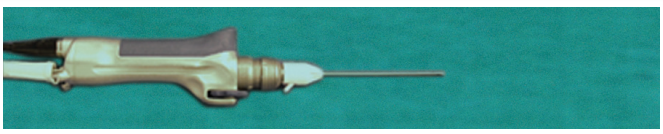


Figure 72.3 Microdebrider

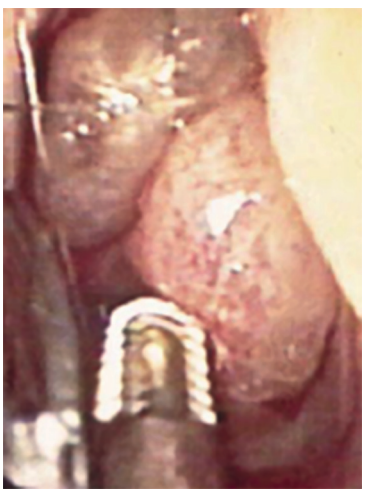


Figure 72.4 Polypectomy with microdebrider

Indications

- Chronic ethmoiditis
- Recurrent ethmoidal polypi
- Ethmoidal or pyocele.

Types

Intranasal Ethmoidectomy

In intranasal ethmoidectomy operation, diseased air cells are removed through middle meatus route. It is a blind procedure and can cause dangerous complications such as extensive bleeding, damage to orbital contents, optic nerve injury causing blindness and CSF rhinorrhea.

External Ethmoidectomy

External ethmoidectomy is a much more safer procedure as the approach is not blind, which is made through medial canthus incision. Now it has been replaced by FESS.

Indications

- Repeated recurrences after intranasal procedures
- Complicated cases of chronic sinusitis such as pyocoele or orbital cellulitis
- The approach is made use of in CSF rhinorrhea repair, approach to optic nerve, ligation of anterior ethmoidal vessel for massive nose bleeding and transethmoidal hypophysectomy.

Transantral Ethmoidectomy

This is also known as **Horgan's operation**. This approach is made use of when ethmoid and maxillary sinus both are affected by the disease or in cases of malignant exophthalmos for orbital decompression.

After doing CWL operation, ethmoids are approached by directing the forceps in superior, medial and posterior direction towards opposite parietal eminence.

Complications of Ethmoidectomy

- Orbital cellulitis, proptosis and blindness
- Cerebrospinal fluid (CSF) rhinorrhea
- Hemorrhage
- Meningitis
- Synechiae formation
- Fistula formation at the site of incision.

Polypectomy using a Microdebrider

This is a new addition to the treatment of nasal polypi (**Figures 72.3 and 72.4**). It is used with FESS and the procedure is fast with fewer complications.

Key Points

1. **Nasal snare**, although not used commonly for removal of nasal polypi, is **of avulsion type** so that some part of diseased mucosa and bone comes out with polypi causing less recurrence.
2. Simple polypectomy done for nasal polypi is usually followed by recurrence sooner or later.
3. In recurrent AC polypi—**Caldwell-Luc operation or FESS** gives good results; while in recurrent ethmoidal polypi, FESS has replaced all forms of ethmoidectomy operations.
4. If frontal sinus is involved along with ethmoidal sinuses, then **external fronto, ethmoidectomy** is done by Patterson's approach or Lynch-Howarth operation or Killian's operation.
5. **Complications** of operations on ethmoidal sinus may be eye complications, Cerebrospinal fluid (CSF) rhinorrhea, meningitis, hemorrhage, and synechiae formation.

Chapter 73 Functional Endoscopic Sinus Surgery

What Students Must Know!

- **Introduction**
  - Principles of FESS
  - Advantages of FESS
  - Indications
  - Contraindications
  - Postoperative Care
  - Complications
- **Navigational FESS**
- **Baloon Sinuplasty**

INTRODUCTION

- Functional endoscopic sinus surgery (FESS) is a recent addition in the management of chronic sinusitis
- Surgical treatment of chronic sinusitis, till now, has been based on the concept that diseased sinus mucosa should be radically removed to enable new healthy mucosa to grow in its place for which most popular operation in the past has been Caldwell-Luc procedure.
- Messerklinger's work on sinus mucosa and mucociliary transport has now shown that pathology is not primarily in larger sinuses, but is always secondary to impaired drainage caused by the disease in the ethmoidal air cells blocking their natural ostia in the middle meatus.
- It has now been clearly demonstrated that if the ostium of the diseased sinus is unblocked surgically by removal of diseased ethmoidal air cells, the rest of the diseased mucosa reverts back to normal.

Relevant Anatomy

- Assume that ethmoidal labyrinth is like a matchbox open at both ends.
  - Roof of matchbox corresponds to ethmoidal fovea.
  - Lateral wall to lamina papyracea.
  - And medial wall to middle turbinate.
  - Posterior wall to rostrum of sphenoid.
- Natural ostium of paranasal sinuses are protected by transition spaces called prechambers.
- Importance of these prechambers is that when these get diseased corresponding paranasal sinus may get affected.

Principles of FESS

- The FESS improves mucociliary clearance pathways of the **osteomeatal unit—a key area**
- The obstruction to the drainage of ostia is removed in the osteomeatal complex.

Advantages of FESS

- Good illumination and visualization of the areas
- Absence of external scar
- Minimal hospitalization
- Good for documentation and teaching purposes
- Postoperative morbidity is minimal.

Indications

Diagnostic

- To see inaccessible areas in nose and nasopharynx.
- To diagnose cause of sinusitis, nosebleed, headache and anosmia.
- To find out the site of leak in cerebrospinal fluid (CSF) rhinorrhea.
- To examine nasopharynx for eustachian tube and other lesions.
- To diagnose and biopsy/follow-up in tumors of nose, paranasal sinuses (PNS) and nasopharynx.

Therapeutic

The following list of conditions are amenable to an endoscopic approach:

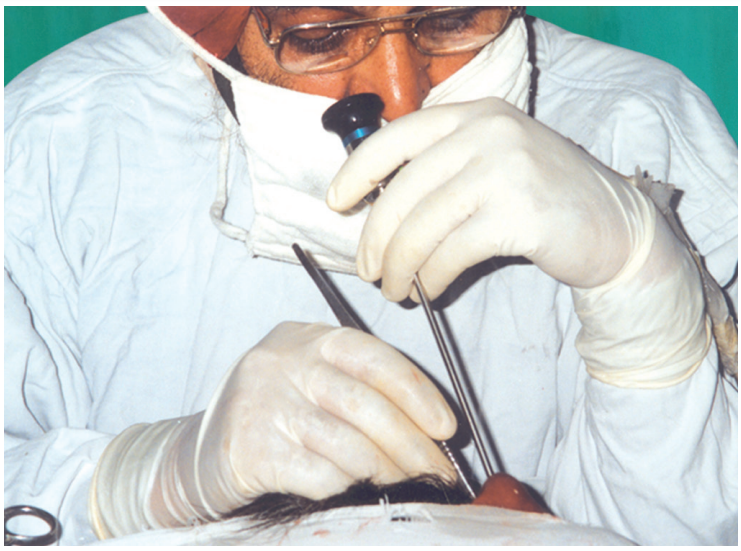


Figure 73.1 Performing FESS

- Chronic sinusitis
- Acute recurrent sinusitis
- Nasal polyposis
- Frontoethmoidal mucoceles
- Allergic fungal sinusitis and mycetoma
- Evaluation and repair of CSF leaks
- Orbital and optic nerve decompression.
- Repair of blow out fractures.
- Intranasal Dacryocystorhinostomy (DCR)
- Choanal atresia
- Hypophysectomy
- Septal and turbinate surgery
- Management of epistaxis
- Drainage of periorbital abscess
- To remove hidden foreign body in nose or PNS.

Contraindications

- Acute sinus infections associated with intracranial complications or orbital cellulitis with visual field defects as well as osteomyelitis
- Infiltrative lesions
- A markedly stenosed frontonasal duct
- Aggressive invasive fungal infections of paranasal sinuses such as mucormycosis will require an external approach
- Advanced malignancy.

Instruments

- 0° and 30° sinuscopes
- Light source and cable
- Sickle knife
- Straight and angled forceps
- Straight and curved suction cannulas.

Method

1. Preoperative CT of sinus serves as a road map for surgery.
2. Preferably performed under local anesthesia/GA.
3. Patient is put in supine position with elevation of head.
4. The 0° and 30° endoscopes are commonly used along with special Blakesly straight and angled forceps (**Figure 73.1**).
5. After the Ist pass (examination of nasopharynx and inferior meatus) the sinuscope is moved medial to middle turbinate to see sphenoethmoidal recess, opening of posterior ethmoids and sphenoidal sinus (second pass).
6. Third pass, when endoscope is passed into middle meatus to see OMC also called key area.
7. Uncinate process, ethmoidal bulla, hiatus semilunaris and frontal recess are visualized (**Figure 73.2**)
8. Uncinectomy is done to visualize the opening of maxillary sinus.
9. Ethmoidal Bulla if enlarged is also removed by opening at its medial and inferior portion with a Blakesley's forceps. Posterior ethmoidectomy is done by identifying the ground lamella posterior to the bulla, which is pierced by a upcutting forceps.
10. Any other pathology is also dealt likewise.
11. Gel foam or a light pack is kept to be removed after 24 hours.

Postoperative Care

- Diligent postoperative care is as critical in the successful management of chronic rhinosinusitis, as the surgery itself
- This includes endoscopic cleaning and continued medical therapy until mucociliary clearance has been restored and the cavity is fully healed

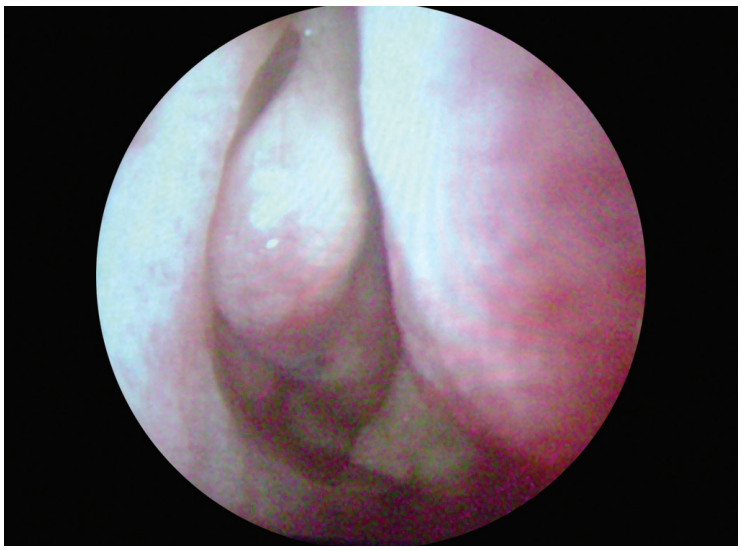


Figure 73.2 Endoscopic view of nasal cavity

- Long-term management of endoscopically visualized persistent inflammation is required even when asymptomatic, if the incidence of recurrent disease and revision surgery is to be minimized.

Complications

Major

- Bleeding
  - Intraoperative
  - Postoperative
- Cerebrospinal fluid leak
- Intracranial hemorrhage and death
- Optic nerve injury
- Internal carotid artery injury
- Orbital injury (retro-orbital hematoma/emphysema)
- Nasolacrimal duct injury
- Anosmia
- Meningitis and brain abscess

Minor

- Overlooked disease
- Synechia
- Stenosis of maxillary sinus ostium
- Postoperative infection
- Dental pain

Mini FESS

Mini FESS is a procedure in which only uncinectomy needs to be done because the disease is limited.

Navigational FESS

- Also called image guided FESS.
- Electromagnetic navigational system can be readily incorporated and will be effective in reducing risks.
- In this preoperative loading of computerized tomography (CT) scan is done which can be visualized, while doing surgery.
- This helps to do surgery in difficult areas such as frontal or sphenoidal areas or in revision cases.

Baloon Sinuplasty

Baloon sinuplasty is another latest procedure being tried in some centers, where the natural ostium of the sinus is dilated by using a balloon catheter and a sinus guide cannula and guide wire for entry into the particular sinus. It is safe and less time consuming with minimal morbidity.

Revision FESS

Revision FESS is required in 10 to 15 percent cases of FESS even in the best of hands. Revision is required, when ever there is recurrence of symptoms and signs. This in turn may be due to the following causes:

- Retained or incompletely removed uncinate process
- Persistant ethmoidal septa
- lateralization of remnant of middle turbinate
- Persistant agger nasi cells
- Persistant allergy.
- Persistant/recurrent frontal sinus disease.

Prerequisites for Revision FESS

Repeat CT with a course of antibiotics and steroids followed by revision FESS using angled endoscopes, may be along with microscope—combined microscopic and endoscopic technique (COMET).

Key Points

1. The **term functinal endoscopic sinus surgery** (FESS) was introduced by David Kennedy, who aimed at restoring natural mucociliary clearance by minimally invasive technique of establishing drainage and aeration of the sinuses.
2. **First endoscopy** was performed by Hirschmann's in 1901 using modified cystoscope, but was popularized by Messerklinger's in 1978.
3. Understanding the anatomy of **ethmoidal labyrinth**, bounded by middle turbinate (medially); lamina papyracea (laterally) and fovea ethmoidalis (superiorly), for taking up of FESS is very essential.
4. **Ground lamella** separates the anterior and posterior ethmoids.
5. The **0° rigid Hopkin's endoscopes** are best for diagnostic and therapeutic purposes because with angled endoscopes one becomes disoriented.
6. FESS is done mostly under **local anesthesia** as it leads to less chances of complications, as the patient keeps on warning.
7. **Advantages of FESS** over conventional surgery are better visualization of area; less chances of injury to important structures and for endoscopic photography.
8. **Naumann** described the anterior ethmoid complex in middle meatus as the osteomeatal complex.
9. The area of **ethmoidal infundibulum** where frontal, anterior ethmoidal and maxillary sinuses drain are called key areas.
10. In **Messerklinger's technique**, middle turbinate is not resected, hence, it is a relatively conservative approach; while in **Wigand's technique**, partial or complete resection of the middle turbinate is done to clear the key areas.
11. **Frontal recess** is bounded by aggar nasi anteriorly, bulla ethmoid posteriorly, lamina papyracea medially and middle turbinate laterally.
12. In **Messerklinger's approach** one goes from anterior to posterior while in Wigand's technique from posterior to anterior.
13. **OMC comprises of** ethmoidal infundibulum, frontal recess and maxillary sinus ostia.
14. **Infundibulotomy** includes complete removal of uncinate process to expose the frontal recess and maxillary ostium.
15. **Ostium of maxillary sinus** can be enlarged towards anterior fontanelle.
16. Direction of **nasolacrimal duct** is downward, backward and laterally.
17. Indications of FESS—**remember mneumonic: FARMER:** F: **F**ungal sinusitis; A: **A**/C polyp; R: **R**ecurrent sinusitis; M: **M**ucocele; E: **E**ndoscopic septoplasty; R: **R**emoval of Foreign body.

Chapter 74

Nasal Endoscopic Dacryocystorhinostomy

What Students Must Know!

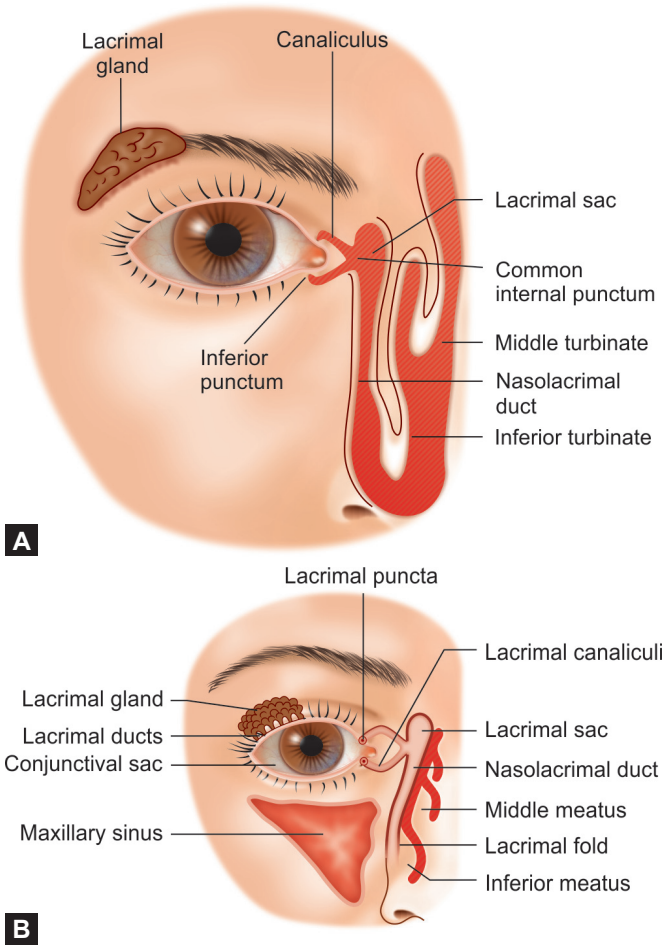
- **Introduction**
  - Lacrimal Sac
  - Endoscopic Anatomy
  - Surgical Procedure
  - Postoperative

INTRODUCTION

- Chronic dacryocystitis is a condition in which there is stagnation of secretions or contents of the sac, because of stricture of nasolacrimal duct (NLD) due to chronic inflammation secondary to nasal causes or congenital blockage of duct
- Endoscopic dacryocystorhinostomy (DCR) is done for the treatment of patients who present with epiphora or dacryocystitis from naso-lacrimal duct obstruction
- It was first **described in 1904**. Since then various types of intranasal approaches have been described for the successful treatment of NLD obstruction
- Feasibility of endoscopic **DCR was reported first in 1988 by Rice DH** in a cadaver study
- In addition to avoiding a skin incision, endoscopic DCR enables the surgeon to identify and correct common intranasal causes of DCR failure, such as adhesions, an enlarged middle turbinate, or an infected ethmoid sinus and any comorbid conditions, such as deviated nasal septum.

Endoscopic Anatomy

- The lacrimal sac can be found beneath the bone of the lateral nasal wall just anterior to the attachment of the middle turbinate (**Figures 74.1A and B**)
- The superior border of the sac may extend above the level of the turbinate attachment
- The posterior edge of the sac often extends beneath the middle turbinate, behind a landmark called to as the maxillary line
- The maxillary line is an important land-mark for endoscopic DCR. It is a curvilinear eminence along the lateral nasal wall that runs from the anterior attachment of the middle turbinate to the root of the inferior turbinate
- Its location corresponds approximately to the suture line between the maxillary and lacrimal bones that runs in a vertical direction through the lacrimal fossa
- Exposure of the posterior half of the sac typically requires removal of the thin uncinate process and underlying lacrimal bone located posterior to the maxillary line
- In contrast, exposure of the anterior sac necessitates removal of thicker bone located just anterior to the maxillary line
- As the nasolacrimal duct (NLD) courses inferiorly, it passes an average of 10 mm anterior to the natural ostium of the maxillary sinus
- Injury to the duct can occur if the maxillary ostium is enlarged too far in an anterior direction during middle meatal antrostomy, but the hard surrounding maxillary bone usually protects the duct
- The inferior end of the lacrimal sac tapers as it enters the nasolacrimal canal formed by the maxillary, lacrimal, and inferior turbinate bones
- The NLD runs in this osseous canal for a distance of 12 mm
- It continues beneath the inferior turbinate as a membranous duct for an additional 5 mm before opening into the inferior meatus
- The duct orifice is found at the junction of the middle and anterior thirds of the meatus, 8 mm behind the anterior tip of the inferior turbinate and 29 mm from the anterior nasal spine
- It is often covered by a flap of mucosa, known as **Hasner's valve**, which is thought to prevent reflux of nasal secretions
- Gentle pressure over the medial canthal region in a downward inward and medial direction will often produce fluid or bubbles at the duct orifice to confirm its location.



Figures 74.1A and B Surgical anatomy of DCR

SURGICAL PROCEDURE

- Endoscopic DCR may be performed under either local or general anesthesia.
- With the patient supine and the head slightly elevated to decrease venous pressure at the operative site, nasal packing soaked in a 4 percent lidocaine with 1:5,000 diluted adrenaline solution is placed along the lateral nasal wall.
- The lower punctum is enlarged with a lacrimal probe.
- A 0-degree, 4 mm diameter nasal endoscope is used for visualization intranasally.
- Various methods can be used for visualization. The assistant may pass methylene-blue dye or normal saline through lower punctum. Some centers pass an optic cable through the punctum and look for a glow intranasally.
- Submucosal injections of 1 percent lidocaine hydrochloric acid with epinephrine 1:100,000 are placed in the middle turbinate just anterior to the attachment of the turbinate.
- Surgical dissection is begun with removal of a 1 cm diameter circle of mucosa and bone along the lateral nasal wall overlying the lacrimal sac. Cautery should be avoided as it increases chances of scarring.
- Initial tissue removal usually includes a portion of the uncinate process located posterior to the maxillary line.
- An air space is often entered that corresponds to the infundibulum or an anterior ethmoid air cell overlying the lacrimal sac.
- As dissection is carried more anteriorly, the lacrimal bone is opened and the underlying medial wall of the sac will be exposed.
- Next, the maxillary bone, which forms the anterior aspect of the lacrimal fossa, must be removed.
- Removal of this relatively thick bone is technically very difficult. Endoscopic burrs or Kerrison's punch may be used.
- The surgical laser also has been used for endoscopic DCR, because of its ability to remove bone with excellent hemostasis.
- After the medial sac wall has been exposed, it is entered with an angled Blakesley's forceps. It is often helpful to use a lacrimal probe within the sac to tent up the medial sac wall as it is opened.
- This maneuver serves to isolate the medial wall and prevent inadvertent injury to the underlying structures.
- Once the sac is entered, the probe will be visible.
- The opening into the lacrimal sac is enlarged to a diameter of 10 mm. Its inferior edge should extend to the level of the sac-duct junction.
- No attempt is made to create mucosal flaps.
- The location of the internal common punctum, where the two canaliculi enter the lacrimal sac is usually visible with a 30-degree nasal endoscope.
- Visualization of the common punctum ensures that the lacrimal sac has been opened widely enough and in the correct location to obtain a successful surgical result.
- The location of this punctum is verified by passing stents attached to a Silastic tubing through the superior and inferior canaliculi.
- The stents are grasped with a Blakesley's forceps, withdrawn from the nasal cavity, and cut from the tubing.
- The ends of the tubing are then tied and trimmed within the nasal cavity, so as to form a continuous loop around the canaliculi.
- Endoscopic revision DCR is performed in a similar fashion to endoscopic primary DCR; however, bone of the lateral nasal wall overlying the lacrimal sac has already been removed. Revision DCR is therefore, usually easier to perform than primary DCR.

This factor makes revision DCR patients who have already failed an external DCR approach very appropriate initial candidates for the surgeon who wishes to learn endoscopic DCR.

POSTOPERATIVE INSTRUCTIONS

- If nasal packing is placed for hemostasis at the conclusion of surgery, it is removed the next day
- Patients are discharged with instructions to begin twice a day nasal saline douching with a bulb syringe
- Intranasal debris is removed from the operative site at the first postoperative visit 1 week following surgery
- The Silastic tubing used to stent the surgical ostium is typically removed 2 months after surgery
- It may be removed early if excessive granulation tissue formation is seen to occur around the tube at the ostium
- Patency of the lacrimal drainage system is verified by endoscopic observation of fluorescein dye flowing from the eye through the surgical ostium into the nose.

CONCLUSION

Endoscopic DCR has proved itself to be a safe and effective technique for the treatment of lacrimal duct obstruction with greater than 90 percent surgical success rate for patients who undergo primary endoscopic DCR.

Key Points

1. **Endoscopic DCR** is now the procedure of choice for NLD obstructive conditions.
2. **Maxillary line** is a curvilinear eminence on the lateral nasal wall that runs from the anterior attachment of the middle turbinate to the root of the inferior turbinate.
3. **Mitomycin-C** is flushed through the NLD to keep the new opening patent.
4. The new opening of the **lacrimal sac** is in the middle meatus.
5. The operation **may fail due to**:
   - Synechia
   - Lateralization of middle turbinate
   - Nasal polyposis
   - Restenosis of the NLD or the new orifice
   - Wrong selection of case of canalicular block for DCR.

Chapter 75 Operations of Nasal Septum

What Students Must Know!

- **Submucous Resection of Septum**
  - Indications
  - Contraindications
  - Anesthesia
  - Steps of Operation
  - Complications
- **Septoplasty**
  - Clinical Indications for Septoplasty
  - Contraindications
  - Steps
  - Complications of Septoplasty
- **Submucous Resection versus Septoplasty**

It takes 5 years to learn when to operate and 20 years to learn when not to operate.
It applies rightly to this operation, which is indicated for symptomatic deflected nasal septum.

SUBMUCOUS RESECTION OF SEPTUM

- Submucous resection of septum is the surgical procedure in which submucosal resection of nasal septum is done
- The operation was described by **Killian (1904) and Freer (1905)**.

Indications

- Symptomatic deviated nasal septum (DNS) causing:
  - Nasal blockade
  - Recurrent cold and sinusitis
  - Recurrent anterior epistaxis
  - Headache and middle ear infections
  - DNS preventing removal of polypi.
- Harvesting septal cartilage for graft purpose in septorhinoplasty or for ear operations
- An access to trans-sphenoidal hypophysectomy and vidian neurectomy.

Contraindications

- Acute infection of upper respiratory tract
- Asymptomatic DNS
- Age below 18 years
- Systemic diseases like diabetes, hypertension, bleeding disorders or tuberculosis.

Instruments Required

- Nasal speculum—short bladed and long bladed (**Figure 75.1**)
- Bard-Parker (BP) handle with knife
- Periosteum elevator
- Raspatories—left and right
- Turbinectomy scissor

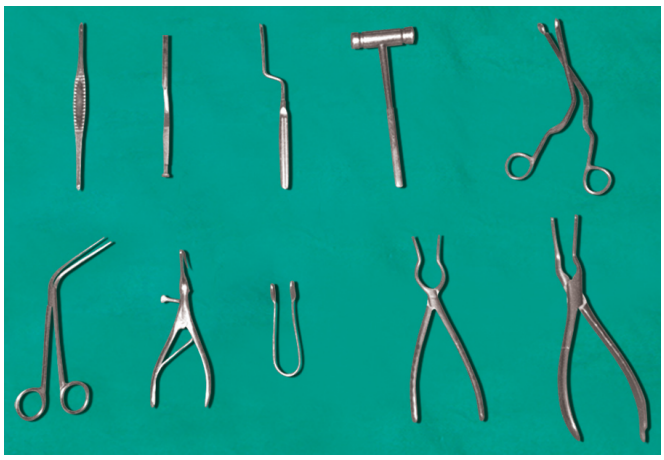


Figure 75.1 Instruments of submucous resection of septum

- Ballenger Swivel knife
- Luc's forceps
- Septal punch
- Bone nibbler
- Tilley's forceps
- Hammer with gauge
- Needle holder
- Suture material.

Anesthesia

Local anesthesia (LA) is preferred in adults and general anesthesia in children and nervous patients. Local anesthesia is preferred in adults because of simple technique and early postoperative recovery.

The nose is packed with 4 percent xylocaine and after 10 minutes, 2 percent xylocaine with adrenaline is infiltrated (3 to 5 cc is enough). It also helps in easy lifting of flaps.

Position

Supine with semi sitting (Proetz position).

Steps of Operation

1. Incision is given on the left side of the septum about 5 mm away from the caudal end of septum at the mucocutaneous junction (**Figure 75.2A**) (**Figure 75.2B,** Killian's incision).

   Freer's incision (Hemitransfixation incision) is given at the caudal border of septal cartilage. Transfixation incision is given on both sides of septum such as in rhinoplasty or degloving operation.
2. The mucoperichondrium flap is raised with the help of elevator (**Figure 75.2C**). The incision is deepened to just cut the cartilage leaving the other side of mucoperichondrium uninjured.
3. The mucoperichondrium of other side is elevated with elevator.
4. Mucoperiosteum flaps are raised on both sides.
5. A long-bladed nasal speculum is inserted separating the two perichondrial flaps and making the septal skeleton naked.
6. With the help of Ballenger swivel knife, deviated part of cartilage nasal septum is removed (**Figure 75.2D**). If there is any spur, that is also removed. Maxillary crest is removed with gouge and hammer. A strip of septal spur cartilage is left over the columella and nasal dorsum, so as to prevent any deformity of external nose.
7. The incision site is sutured with catgut or can be left as such. Both the nasal cavities are packed with ribbon gauze impregnated with Vaseline or liquid paraffin to prevent its sticking to nasal mucosa.

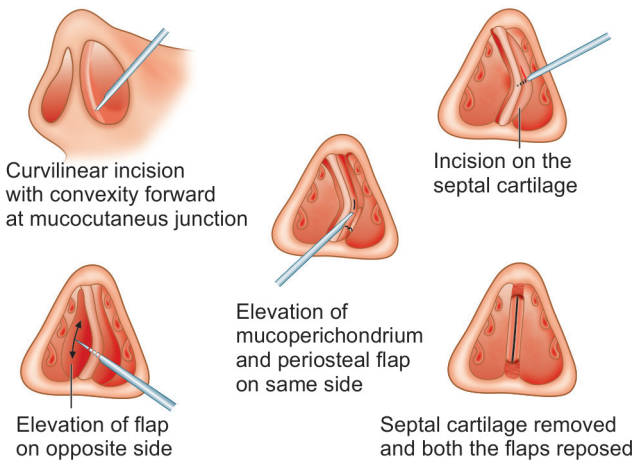


Figure 75.2A Steps of SMR operation

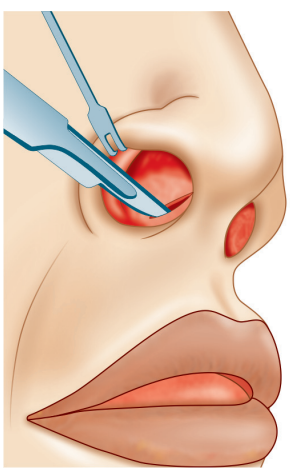


Figure 75.2B Killian's incision

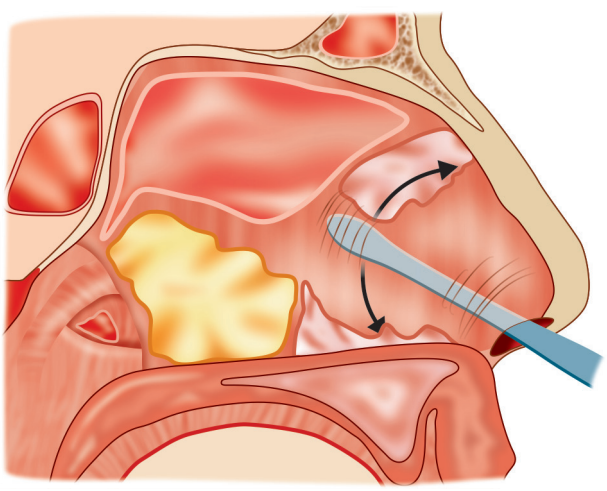


Figure 75.2C Lifting the mucoperichondrium from cartilage

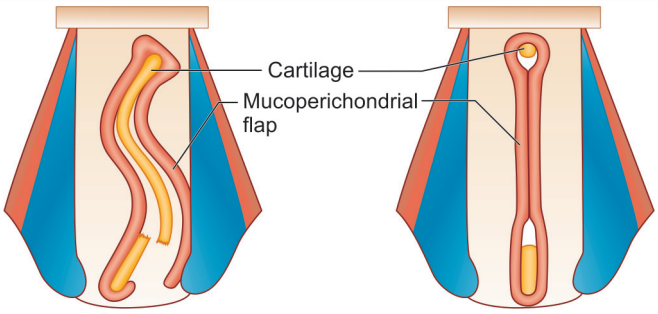


Figure 75.2D Lifting the mucoperichondrium and cutting the cartilage

Postoperative Care

- Antibiotics and analgesics for 5 to 7 days
- Nasal packs are to be removed after 48 hours
- Forcible blowing of nose is avoided
- Vigorous exercise and straining are avoided
- Liquid paraffin and local decongestants are given.

Complications

- *Hemorrhage:* It may be primary or secondary and it usually stops with anterior nasal packing and good antibiotics. Troublesome bleeding from bone is rarely encountered and is controlled by bone wax or curetting the area with a mastoid curette or a diamond burr
- Injury to mucoperichondrial flaps may lead to septal perforation
- Septal hematoma
- Septal abscess
- Injury to lateral wall may lead to synechiae formation
- Cerebrospinal fluid (CSF) rhinorrhea is a rare complication, if cribriform plate is injured
- Flapping septum due to redundant mucosa and it gets okay due to subsequent fibrosis
- Nasal blockade may persist due to inferior turbinate hypertrophy or residual deviation
- Overenthusiastic removal of septal cartilage or subsequent fibrosis may lead to columellar retraction or saddle nose deformity
- **Toxic shock syndrome** is not common. It is due to **staphylococcal infection** and patient comes with nausea, vomiting and purulent discharge, low blood pressure. It is treated by removal of pack, good antibiotics and proper hydration.

SEPTOPLASTY

- It is a modification of submucous resection of septum (SMR) operation
- It is a more conservative procedure, where maximum respect is given to septal cartilage

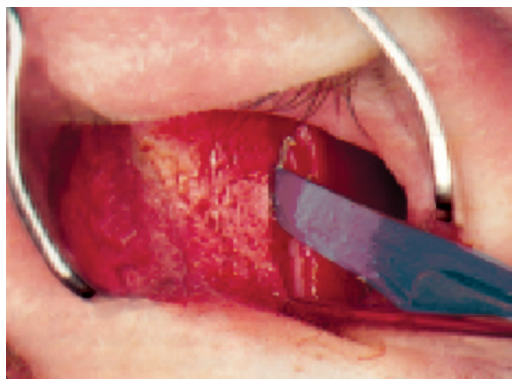


Figure 75.3 Endoscopic removal of deviation and spur of nasal septum

- Proponents of septoplasty were **Converse (1950) and Cottle (1958)**
- It is particularly advisable in children and in deviations, which lie anterior to the vertical line drawn between nasal spine of maxilla and nasal process of frontal bone
- If the procedure is combined with rhinoplasty, it is called septorhinoplasty
- Endoseptoplasty is done with endoscope, while doing functional endoscopic sinus surgery (FESS) when deviation or a spur is interfering in doing the procedure (**Figure 75.3**).

Aims of septoplasty are:

- To restore function of nose
- To have no complication.

Clinical Indications

- Along with rhinoplasty, where it is called septorhinoplasty
- It is done in children, where SMR operation is contra-indicated
- Anterior subluxation of cartilage
- In anterior deviations of nasal septum
- Deviation of the nasal septum, with partial or complete unilateral or bilateral obstruction of airflow
- Persistent or recurrent epistaxis
- Evidence of sinusitis secondary to septal deviation
- Headaches secondary to septal deviation and contact points
- Anatomic obstruction that makes indicated sinus procedures difficult to perform efficiently
- Obstructive sleep apnea/hypopnea syndrome
- As an approach to trans-septal-trans-sphenoidal approach to pituitary fossa.

Contraindications

- Acute infections of upper respiratory tract
- Systemic diseases like diabetes, hypertension, tuberculosis and bleeding disorders.

Instruments Required, Anesthesia, Position of Patient

All above are similar to SMR operation.

Steps

1. Unilateral hemitransfixation Freer's incision is made over the caudal border of septal cartilage on concave side.
2. The mucoperichondrial flap is raised on one side making the anterior tunnel.
3. Another incision is given on the mucoperiosteum over the maxillary crest on the same side, elevating the mucoperiosteum, thus making one more tunnel called inferior tunnel.
4. In inferior tunnel, flap one works below chondrovomerine junction, but in making anterior tunnel one stays above this junction.
5. The two tunnels are joined by sharp dissection.
6. Inferior tunnel is created on the opposite side also.
7. Septal cartilage is then separated from vomero-ethmoidal bone posteriorly and maxillary crest inferiorly.
8. A small strip of cartilage is removed along the inferior border. Minor deviations are corrected by making criss-cross incisions, thus breaking its spring action. The cartilage loses its elasticity and remains in midline.
9. The incision is sutured with catgut or may be left as such. Both the nostrils are packed with ribbon gauze impregnated with Vaseline or liquid paraffin.

Postoperative Care

Same as SMR. The differences between SMR and septoplasty are given below in **Table 75.1**.

Table 75.1: Differences between SMR and septoplasty

	SMR	*Septoplasty*
1.	It cannot be done under 16 years of age.	It can be done in all age groups.
2.	It is a radical operation.	It is a conservative operation.
3.	In this, flap is elevated on both sides.	Here, flap is elevated only on concave side.
4.	Most of the cartilage is sacrificed.	Most of the cartilage is preserved.
5.	Anterior dislocation cannot be corrected.	It can be corrected.
6.	Cannot be done along with rhinoplasty.	It can be done along with rhinoplasty.
7.	Complications such as perforation, supratip saddling and retraction of columella are common.	Complications such as septal perforation, columellar retraction, saddle nose deformity are rarely seen.
8.	Revision surgery is difficult.	Revision surgery is easily possible.

Complications

- Hemorrhage—primary, reactionary and secondary type.
- Septal hematoma/abscess
- Synechia
- Failure to resect adequate cartilage or bone and hence, persistent nasal obstruction
- Septal perforation
- Anosmia
- Excessive resection of dorsal strut can lead to saddle deformity
- CSF rhinorrhea may result from too much traction on the perpendicular plate of ethmoid bone
- Toxic shock syndrome
- Rarely, aspiration pneumonitis.

Key Points

1. Remember all the **symptoms of DNS are indications** for SMR operation.
2. **Asymptomatic indications for SMR** are—for approaching sphenoid sinus, vidian nerve and pituitary gland, recurrent epistaxis and for taking a cartilage graft in rhinoplasty or tympanoplasty operation.
3. SMR operation is **not done in children**, because of recurrence of deviation due to continued growth of bones.
4. **Septal abscess** may lead to cellulitis of nose and face, cavernous sinus thrombosis and meningitis.
5. **Complications** such as septal perforation, columellar retraction, saddle nose, etc. are not seen in septoplasty.
6. **Metzenbaum's operation** is indicated for caudal dislocation of septum.
7. **Cauterizing agents** commonly used are 15 percent silver nitrate, 50 percent trichloroacetic acid, chromic acid, carbolic acid or copper sulfate.

Chapter 76 Adenoidectomy

What Students Must Know!

- **Adenoidectomy**
  - Advantages
  - Indications
  - Various Methods
  - Postoperative Care
  - Complications

INTRODUCTION

- Adenoidectomy is the removal of nasopharyngeal lymphoid tissue (adenoids) in children.
- The operation of adenoidectomy may be done alone or along with removal of tonsils.
- It is true that surgery may hurt, but it cures if done in the right way.

Indications

- Enlarged adenoids with mouth breathing and features of adenoid facies
- Recurrent rhinosinusitis
- Chronic adenoiditis
- Chronic secretory otitis media (SOM)
- Sleep apnea syndrome.
- Failure to thrive
- Speech anomalies.

Contraindications

- Cleft palate or short palate: adenoidectomy is avoided in palatopharyngeal incompetence, as it may result in velopharyngeal insufficiency
- Normal adenoids
- Other general contraindications such as anemia, hypertension, diabetes, bleeding disorders, acute infections and active tuberculosis
- Age below 3 years.

Instruments

- Mouth gag with jack (Boyle Davis or Mcivor's mouthgag)
- Long forceps
- St Clair-Thompson adenoid curette with and without guard
- Luc's forceps.

Methods of Adenoidectomy

- By using adenoid curette
- By an adenotome
- By finger dissection.
- Endoscopic adenoidectomy
- Electrocautery method (safety issues must be understood by the operating surgeon)
- Power-assisted adenoidectomy (PAA) method—1997.

Position

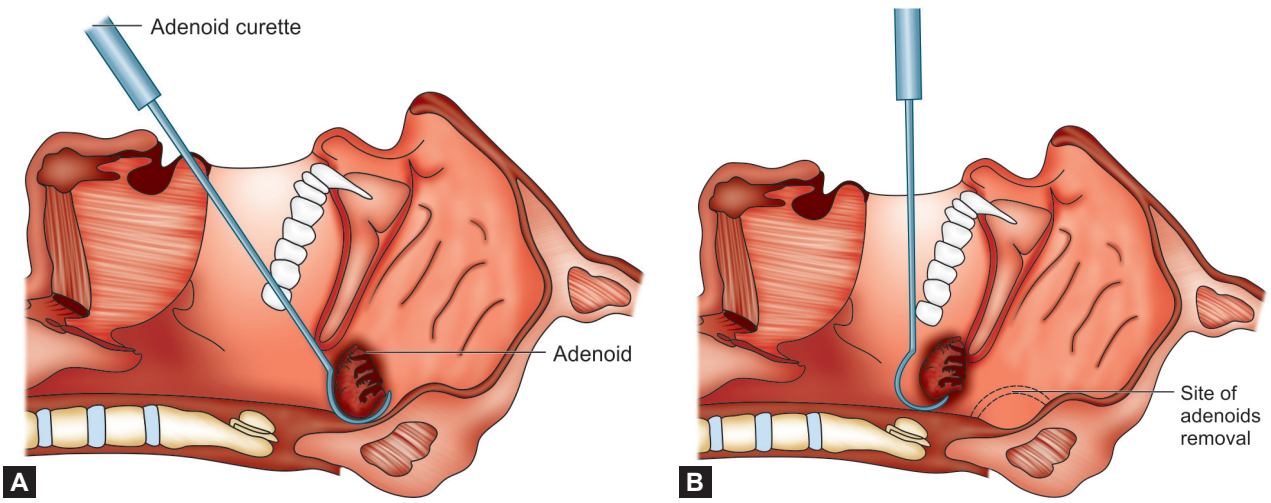
Supine position without extension of neck.

Anesthesia

- Premedication is given usually ½ hour before operation (phenergan and atropine or any other such combination can be used).
- General anesthesia is usually employed with endotracheal intubation performed transorally with a pack of ribbon gauze around the tube
- But, if tonsillectomy is being done under local anesthesia in an adolescent patient, a spray of 4 percent xylocaine in the nasopharynx before operation is helpful.

Steps

1. *Palpation:* Adenoids are to be palpated in the nasopharynx after opening mouth with mouth gag. Feel of the adenoids



Figures 76.1A and B Adenoidectomy (diagrammatic)

is like that of a bag of worms. During palpation one must see for the size of adenoids and any significant pulsations.
2. Adenoid curette with guard is taken behind soft palate, where it rests against the posterior end of nasal septum.
3. A **sweeping or shaving movement downward and forward** is carried out disengaging the curette as it touches the posterior pharyngeal wall, while with left hand holding occiput and with little flexion of head.
4. Suction is done to clear any bleeding. Curette without guard is next taken and light sweeping movements are repeated.
5. Finger palpation is again done to make sure that all adenoid tissue is removed. Any left out tag is removed with Luc's forceps under direct vision by lifting the soft palate with a tongue depressor.
6. Roller gauze packing is done in the nasopharynx for few minutes to control bleeding. Very rarely does one require a postnasal pack to control bleeding (**Figures 76.1 and 76.2**).

Postoperative Care

Same as for tonsillectomy operation, i.e. antibiotics, hygeine of oral cavity, pain killers and normal diet.

Complications

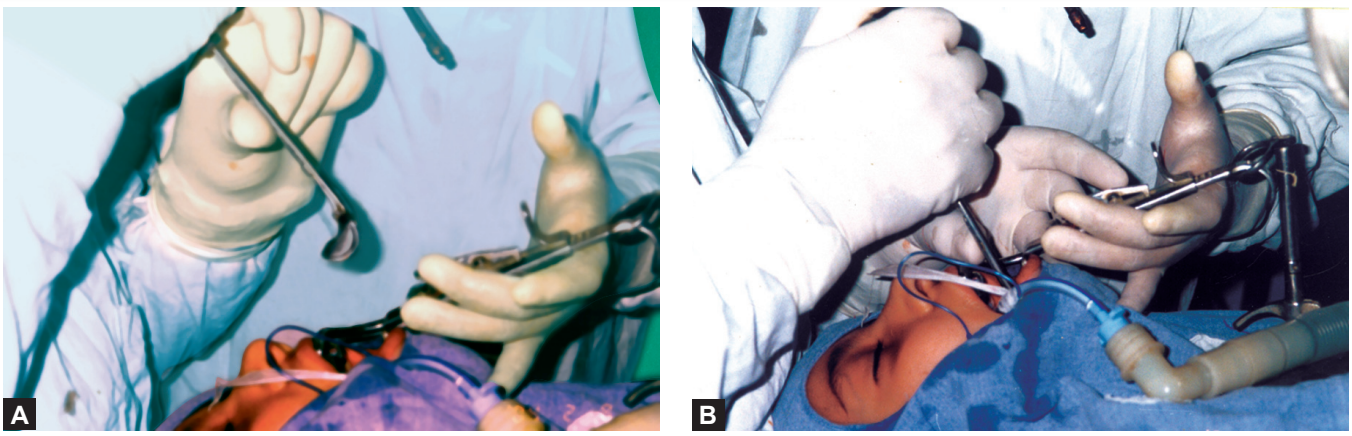
- Hemorrhage
  - **Primary**, which occurs during operation
  - **Reactionary:** It is treated in the same way as primary hemorrhage and is usually due to incomplete removal of adenoid tissue or excessive curetting of nasopharynx
  - **Secondary:** Conservative treatment with injectable antibiotics, usually arrests bleeding. Postnasal pack is rarely required.
- *Trauma:* To the uvula, soft palate, eustachian tubes and subluxation of atlantoaxial joint may occur
- *Otitis media:* May occur in badly performed adenoidectomy leading to fibrosis of eustachian tube opening
- *Nasal twang:* May occur if large adenoids are removed or the surgery is performed in submucous cleft palate due to velopharyngeal insufficiency
- Torticollis and neck pain (Gridsel syndrome): Due to spasm of neck muscles
- Chronic nasopharyngitis
- *Incomplete removal:* As it is a blind procedure
- Nasopharyngeal stenosis
- Cervical spine problems such as atlanto-occipital dislocation.

ENDOSCOPIC ADENOIDECTOMY

Endoscopic adenoidectomy is done by using 0 and 30 degree endoscopes transnasally and adenoid tissue is removed under direct vision with Blakesle's forceps. This will avoid trauma to eustachian tube, but the procedure is more time consuming.

Power-assisted Adenoidectomy

Endoscopic shaver is used by transnasal or transoral approach (**Figure 76.3**).



Figures 76.2A and B Adenoidectomy

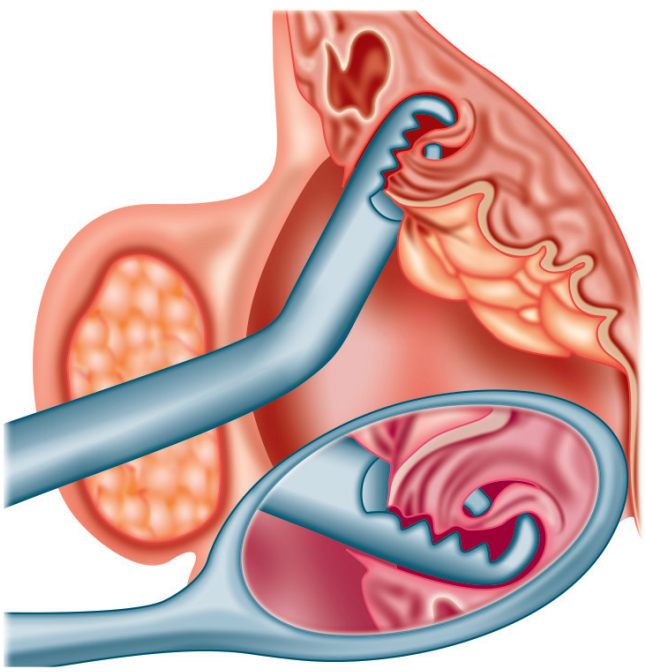


Figure 76.3 Adenoids being removed with power-assisted adenoidectomy

Key Points

1. **Adenoidectomy** may be done by adenoid curette, adenotome or by finger dissection or by endoscope.
2. During its removal, a **downward and forward shaving movement** with head flexed is applied.
3. **Secretory otitis media** is an indication, as well as a complication of adenoidectomy.
4. **Primary hemorrhage** in adenoidectomy is mostly due to partial removal of adenoids and it usually stops after complete removal of tags and sometimes by postnasal packing.
5. **Nasal twang** is a short-term complication of adenoidectomy.
6. **Cleft palate or short palate** is a contraindication for adenoidectomy.

Chapter 77 Tonsillectomy

What Students Must Know!

- **Tonsillectomy**
- **Introduction**
  - Indications
  - Contraindications
  - Methods of Tonsillectomy
  - Steps
  - Complications

Surgery is not only just cutting, but is an art of learning when not to cut.

INTRODUCTION

- Tonsillectomy used to be a very commonly done operation in ear, nose and throat (ENT) practice.
- First known procedure of tonsillectomy was referred by Cornellus Celsius almost 2,000 years ago.
- First documented surgery on tonsil by Cague of Rheims in 1757.

SURGICAL REMOVAL OF TONSILS

Advantages/Myths of Tonsillectomy

- Health of patient improves
- Attacks of tonsillitis will never occur as is often thought
- Upper respiratory tract infections will occur like any other person
- Septic focus will no more be present
- Voice usually will not be affected in expert hands.

Indications

Indications can be divided into local, focal and general or absolute and relative.

Local Indications

Absolute Indications

When the lesion is in the tonsil:

- **Chronic tonsillitis:** Recurrent attacks of tonsillitis more than 4 to 6 times in a year or more than 3 attacks per year for more than 3 years is a justifiable indication for surgery.
- **Quinsy:** Can be done immediately (hot tonsillectomy) or after an interval of 6 weeks (Interval tonsillectomy).
- **Hypertrophic tonsils:** Leading to obstruction in deglutition, respiration and impinging upon the pharyngeal end of eustachian tube.
- **Diphtheria:** When a person is a carrier
- Tonsillolithiasis
- **Tonsillar foreign body:** Foreign body embedded in the substance of tonsil, which cannot be removed.
- Benign tumors or cysts of the tonsil
- As an approach to styloid process or avulsion of the glossopharyngeal nerve.
- **Branchial fistula:** It is done in branchial fistula to remove the complete tract, one end of the tract being in posterior faucial pillar.
- **Malignancy:** It is done for diagnostic purposes in suspected tonsillar malignancy, where simple biopsy is inadequate.
- **Sleep apnea syndrome:** Due to enlarged tonsils.

Focal Indications

Relative Indications

When a neighboring organ is affected by the tonsil:

- Persistent jugulodigastric lymphadenopathy following chronic tonsillitis

- **Tuberculous jugulodigastric lymphadenitis:** Tonsillectomy can be done under cover of anti-tubercular treatment (ATT)
- **Chronic otitis media:** Due to enlarged tonsils impinging upon the eustachian tube
- Chronic pharyngitis, laryngitis
- Halitosis
- As a part of uvulopalatopharyngoplasty (UPPP) operation.

General Indications

When tonsil acts as a septic focus to distant parts of the body.

- Rheumatic heart disease and subacute bacterial endocarditis
- Glomerulonephritis
- Chronic bronchitis, if it follows after acute tonsillitis
- Rheumatic arthritis/Rheumatic fever
- Stunted growth or weak built.

After tonsillectomy, the number of attacks are reduced and are of lesser intensity, hence body metabolism improves resulting in normal growth.

Instruments

Instruments for tonsillectomy is given in **Figure 77.1**:

- Mouth gag with jack (Mcivor's or Boyle-Davis type)
- Toothed and non-toothed long forceps
- Tonsil holding forceps or tonsillar vulsellum
- Tonsillar knife
- Anterior pillar retractor with blunt dissector
- Sponge holding forceps
- Eve's tonsillar snare
- Straight and curved artery forceps
- Negus knot tier and thread adjustor
- Tonsillar fossa compression forceps
- Tonsillar guillotine (not used these days).

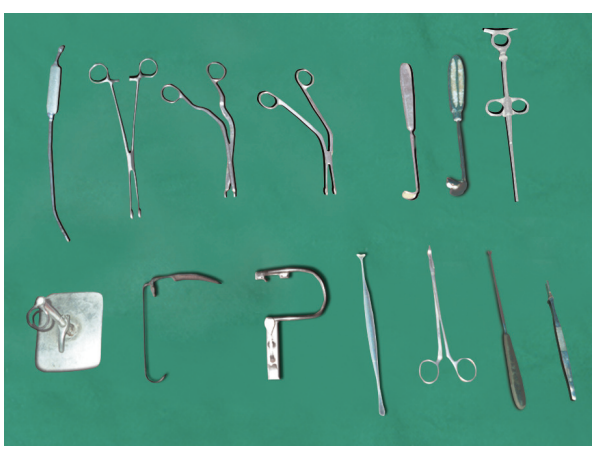


Figure 77.1 Instruments for tonsillectomy

Anesthesia

Local Anesthesia

- Premedication is given half an hour before the operation, i.e. injection pethidine 100 mg or injection morphine 15 mg plus injection atropine 0.6 mg. It is to be strictly done in very cooperative patients or if the patient is an adult or if there is sufficient contraindication to the use of general anesthesia.
- The throat is sprayed with four percent xylocaine solution. The peritonsillar tissue is then infiltrated with two percent xylocaine with adrenaline (dose of xylocaine is to be strictly monitored as mucosal absorption of xylocaine is very quick).
- Injection diazepam 10 mg IV slow, if still required, can be given just before start of the operation.

General Anesthesia

General anesthesia is preferred over local anesthesia, because of safety of the technique and cooperation. Endotracheal intubation with cuffed tube is done and a ribbon gauze packed all around the tube to prevent aspiration of blood.

Position of Patient

Supine position with extension of neck, which is achieved by keeping a sandbag below the shoulders (Rose position) (**Figure 77.2**).

Various Methods

Various methods for tonsillectomy are:

1. **Dissection method** also called Cold-Knife method (Warthington of Baltimore 1907)
2. **Guillotine method**
3. **Electrocautery.**

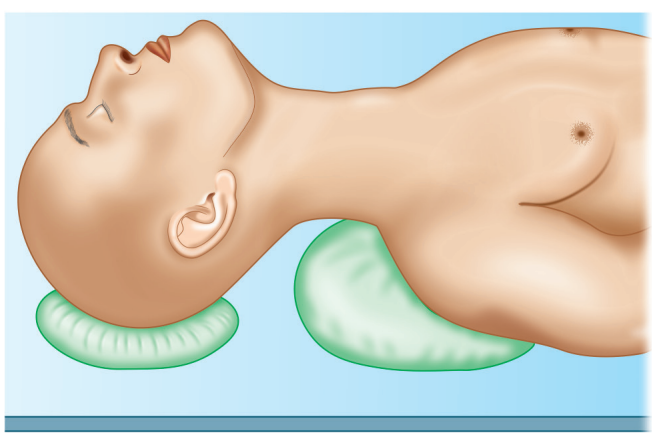


Figure 77.2 Rose position for tonsillectomy

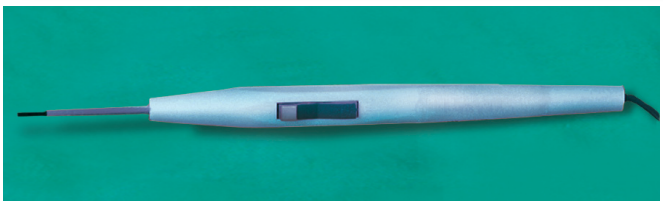


Figure 77.3 Electrocautery

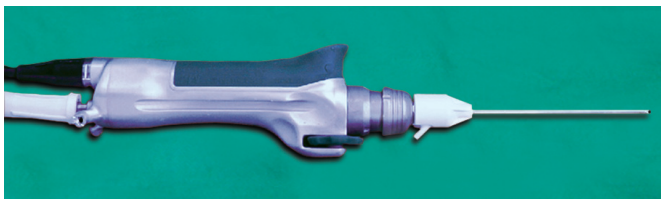


Figure 77.4 Power induced tonsillar ablation instrument

- It may be **monopolar or bipolar** electrocautery.
- The effect is to produce a concentrared current at the electrode, which passes through tissues, generating heat due to electrical resistance causing evaporation of water in tissues and charring of organic material due to very high temperature.
- It is a sort of extracapsular hot tonsillectomy-which is most commonly used method in USA (**Figure 77.3**).
- It is a good technique with less bleeding and less pain electrocautery is the use of electricity to heat an object such as knife and to use it to burn tissue, while electrosurgery is the use of radiofrequency energy applied directly to tissues to generate heat.

4. **Cryosurgery** (cold method) good for patients with blood dyscrasias such as Hemophillia patients. Tissues and blood vessels are frozen at -195 degree centigrade for 1 to 2 minutes.
5. **Laser assisted tonsillar ablation (LATA)** (Gurd Meyer 1946) in hypertrophic tonsillitis and can be done under LA and is good for patients not fit for GA. Time taken is short, operative time and blood loss is minimal.It may be done as an OPD procedure.
6. **Plasma tonsillectomy or coblation tonsillectomy** (cold method) During this procedure conductive saline solution is converted to ionized plasma layer resulting in molecular dissociation which causes minimal thermal energy transfer.
7. **Microdebrider tonsillectomy or powered instrument for tonsillar ablation (PITA):** It is a intracapsular tonsillar ablation using a debrider (Whillis and Pybus 1910) (**Figure 77.4**).
8. **Monopolar and bipolar diathermy**
9. **Harmonic scalpel or ultrasonic method** (Cold method) using ultrasonic energy to cut and coagulate tissues. It does not cause thermal injury. Cutting and coagulation occurs at lower temperature than with electrocautery or LASER.

Guillotine Method

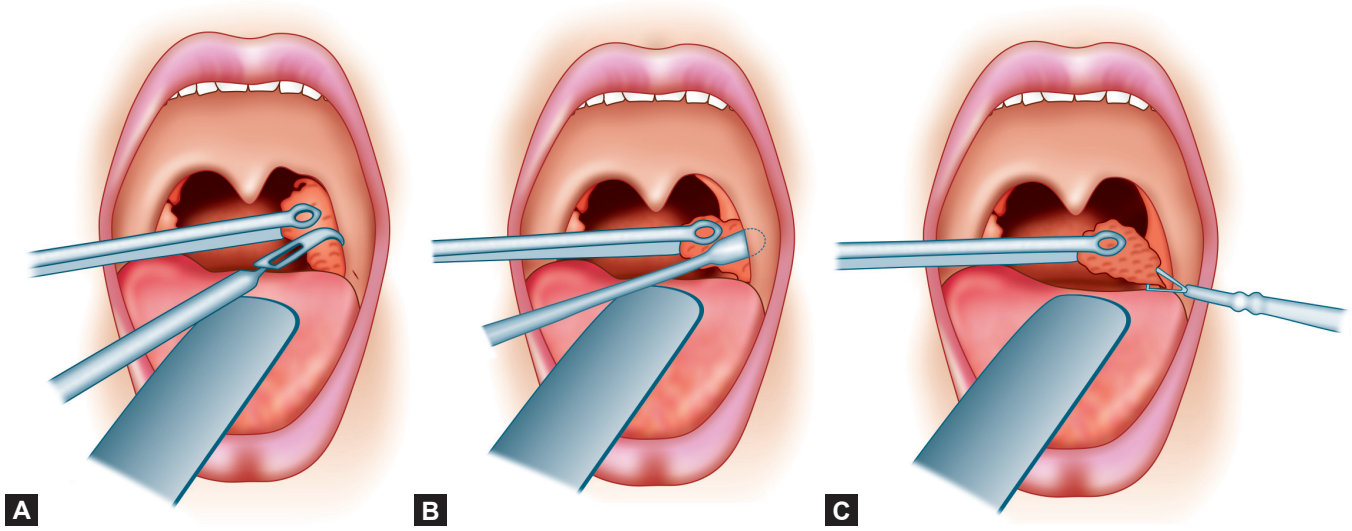
- Guillotine method is not used nowadays
- The word 'Guillotine' was derived from the French world war prisoners, because they were guillotined by putting the guillotine around their neck to chop their head
- In guillotine method, tonsils having extensive fibrosis are difficult to remove
- It is good for hypertrophic tonsils and cannot be used after attacks of quinsy
- Tonsils may be removed incompletely
- Hemostasis is achieved by pressure
- It takes less time than tonsillectomy by dissection method
- It cannot be done after quinsy
- May need revision surgery.

Dissection Method

- Mouth gag is inserted and packing around endotracheal tube (in general anesthesia) is done. Steps of tonsillectomy is given in **Figure 77.5A to C**.
- It is fixed with the help of Draffin bipods or a chest piece.
- Tonsil is held with tonsil holding forceps near its upper pole
- Incision, hockey shaped, is made on the mucosa just inside the pillars starting with a cut in the semilunar fold (mucosa just above the crypta magna)
- A space or cleavage is made between the upper pole and tonsillar fossa
- Now the tonsil is dissected from its bed with the help of tonsillar dissector or sponge-holding forceps
- Once the tonsil is attached only at its lower pole, tonsillar snare is used to crush and cut the pedicle before removing the tonsil. Remember, tonsillar pedicle contains the insertion of palatoglossus muscle.
- Tonsillar fossa is then packed with roller gauze and other tonsil is then dissected likewise
- Fossa is inspected and any bleeding point is caught with straight and curved forceps and ligated with cotton thread
- Once one fossa is dry, other fossa is inspected and hemostasis is achieved.

Hemostasis is carried out by pressure of the gauze. A long, straight and curved artery forceps may be required to apply a ligature, which sloughs off in a few days. If bleeding persists, pillars may be sutured with a gauze kept at the tonsillar bed. Rarely, one may require to ligate the external carotid artery in the neck.

After the hemostasis, pack around the tube is removed and gag is also removed. The patient is put in tonsillectomy position.



Figures 77.5A to C Steps of tonsillectomy

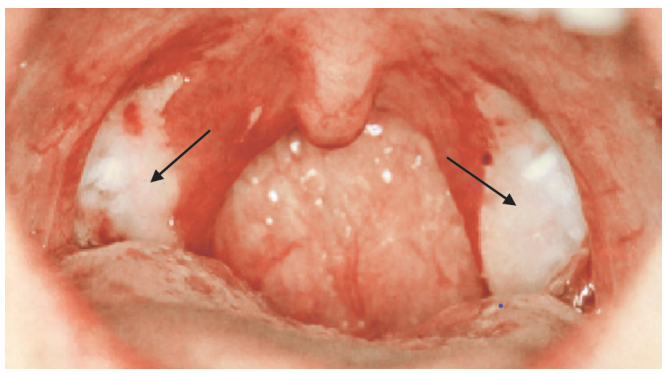


Figure 77.6 Post tonsillectomy throat appearance

Electrocautery

Technique may be used although not very commonly.

Coblation Tonsillectomy (Cold Method)

- Coblation means controlled ablation
- It is done using a bipolar probe to generate radiofrequency leading to bloodless tonsillectomy operation
- It uses radiofrequency to convert saline solution into precisely focused plasma causing plasma-mediated cold ablation in which protons are energized to break molecular bonds between tissues
- It gives minimal pain to the patient.

Monopolar or bipolar diathermy technique: In this, an electrosurgical needle is inserted in the tonsil and diathermy applied for minute, causing subsequent fibrosis of tonsil thus reducing its size. In monopolar, two electrodes are used one is a dispersal electrode and other is operating electrode, where as bipolar involves two proximally placed electrodes for transfer of energy to cut or coagulate.

Postoperative Care

1. *Position:* Following surgery, the patient is kept in tonsillar position, where head is kept low and the patient lies in lateral position to prevent aspiration of blood
2. Nil orally for 6 hours
3. Strict watch is kept over the temperature, pulse and respiration every hour for first 4 to 5 hours.
4. A rising pulse, pallor or bluish and vomiting of blood are signs of impending danger is a sign of hemorrhage. Swallowing movements over anterior part of neck indicate that the blood is being swallowed.
5. *Antibiotics:* Broad-spectrum antibiotics are given for 5-7 days.
6. *For pain:* Injection fortwin or novalgin SOS
7. Feeding as advised
   a. First 48 hours—cold things such as ice cream, ice cubes, cold drinks without gas/soda
   b. After 48 hours—lukewarm diet, the patient must start eating normal diet without chillies or condiments as early as possible
8. *Gargles:* Weak hydrogen peroxide gargles or Condy's gargles are advised after every feed for 5 to 7 days.
9. *Post Tonsillectomy throat:* Dirty white membrane starts forming in the fossa from third to fifth day onwards which continues until it falls off nearly on 10th day (**Figure 77.6**).

Complications

Mortality 1 in 25,000 cases due to anesthesia, hemorrhage or airway obstruction.

Immediate

1. **Hemorrhage (2–4%):** Primary hemorrhage is controlled on the table by gauze pressure or ligation. Excessive bleeding may occur due to trauma to an aberrant vessel or paratonsillar vein or due to underlying infection, hypertension or bleeding disorder.
2. **Trauma:** Common over lips, teeth, tongue, tonsillar pillar, uvula and soft palate. Rarely cervical injury may occur.

Delayed

1. *Hemorrhage:*
   i. **Reactionary hemorrhage** (incidence 0.5-1%) can occur within 48 hours. It is due to:
      - Postoperative rise in BP.
      - Dislodgement of clot.
      - Slipping of ligature.
      - Failure to control primary hemorrhage.
      - Effect of adrenaline goes resulting in dilatation of blood vessels.

      Management:
      - Vital parameters are assessed.
      - If blood loss is considerable, intravenous fluids and blood transfusion may be required.
      - Tonsillar fossa is inspected under good illumination.
      - If the clot is small or dry, no active surgical intervention is required.
      - However, if the clot is wet and progressing, the patient is shifted to operation theater and bleeding is controlled in the same way as primary hemorrhage.
      - Clot formation is discouraged as it hampers muscle contraction and retraction of blood vessels like in uterus in postpartum hemorrhage (PPH). In all other areas clot formation is encouraged.

   ii. **Secondary hemorrhage** (incidence 1%) It usually occurs on 5th to 7th day and is mainly due to infection. Tonsillar fossa may show unhealthy slough.

      Management:
      - Broad-spectrum parenteral antibiotics and coagulants
      - Patient is admitted to the hospital
      - Blood replacement and intravenous fluids to maintain complete hydration
      - Local pressure
      - Stitching of anterior and posterior pillars.
      - Ligation of feeding blood vessel or external carotid artery rarely required.
2. *Pulmonary complications:* If blood or a piece of tonsillar tissue is inhaled into the tracheobronchial tree, collapse of a lung or its segment with infection can follow
3. *Change of voice:* Excessive damage to soft palate and its fibrosis leads to nasal twang and nasal regurgitation. Blowing of balloons is a good exercise to stretch the palate.
4. Otalgia
5. Intubation granuloma (due to endotracheal intubation)
6. Nightmares
7. Chronic granular pharyngitis
8. Lingual tonsillitis.
9. Tympanic membrane (TM) joint dislocation
10. Injury to teeth, uvula and lips.
11. Aspiration such as of tooth or sponge or a blood clot.

Key Points

1. Four most **important indications for tonsillectomy** are—recurrent attacks of tonsillitis, quinsy, bilateral chronic suppurative otitis media (CSOM), when it acts as a septic focus and early suspected tonsillar growth.
2. **Hot tonsillectomy** is when it is done immediately after evacuation of peritonsillar abscess and cold or interval tonsillectomy is done after an interval of 6 weeks.
3. **Tonsillectomy is contraindicated** in polio epidemics because of the fear of developing bulbar poliomyelitis.
4. The **various methods of doing tonsillectomy** are dissection method, guillotine method, electrocautery, cryotonsillectomy, by LASER and the latest being coblation tonsillectomy.
5. **Secondary hemorrhage** which occurs after 5th day is usually because of infection and is treated by change of antibiotics, local pressure, by stitching of anterior and posterior pillars and blood transfusion, if required.
6. **Cold drinks and icecream** are given for first 24 hours as the nerve endings are exposed causing cold anesthesia.
7. **Warm liquids** are started after 24 hours as the inflammation starts and warmth is always soothing for the inflammation.
8. **H_2O_2 gargles** are helpful, because when it comes in contact with slough, there occurs release of nascent oxygen which helps in the contraction of blood vessels expelling small clots thereby causing closure of mouth of blood vessel thus stopping bleeding.
9. **Average blood loss** in tonsillectomy is 100 to 130 mL.

Chapter 78 Tracheostomy

What Students Must Know!

- **Introduction**
- **Applied Anatomy of Trachea**
  - Complications of Endotracheal Intubation
- **Types of Tracheostomy**
  - Indications
- **Anesthesia**
  - Steps of Operation
  - Sequelae/Problems After Tracheostomy
  - Postoperative Care
- **Complications**

Surgery is a team work which divides the task and doubles the success.

INTRODUCTION

- The term Tracheostomy was coined by Heister in 1718.
- Tracheostomy is an operation in which an opening is made in the anterior wall of trachea, which is brought to the skin by inserting a tube.
- First documented tracheostomy was done in **1546 by Antonius Musa Barsavola**.
- Although the technique was standarized by Chevalier Jackson in 1932.
- It is a life saving procedure in critically ill patients that has been used for many years, its origin have been lost in the mist of antiquity. From the legendry period a story comes that Alexander the great saved the life of one of his soldier who was choking on a bone by incising the trachea with the tip of his sword.
- **Tracheotomy** means making an opening in the anterior wall of the trachea to secure an airway, while tracheostomy is actually exteriorizing the trachea to the cervical skin making a stoma.
- **Laryngotomy** means making an opening in the cricothyroid membrane, but because of stenosis the procedure has been very rarely used.

APPLIED ANATOMY

- Trachea is the most anteriorly placed in the midline and is covered by skin, subcutaneous tissue, superficial and deep fascia
- It has 7 to 8 rings in the neck out of total 16 to 20 rings of trachea
- The thyroid isthmus covers the 2nd and 3rd tracheal rings (Ideal location for tracheotomy)
- On each side of trachea are thyroid lobes and other major vessels and nerves of the neck
- Posteriorly lies the esophagus and recurrent laryngeal nerves
- Trachea is normally very superficial and in the midline
- Anterior jugular vein comes in the way during the procedure and in children, a high innominate artery may be seen.

To maintain this position, one must keep the chin, suprasternal notch and symphis is pubis in the straight line.

TYPES OF TRACHEOSTOMY

1. Depending upon the urgency with which tracheostomy is done, it can be classified into:
   i. **Emergency tracheostomy:** It is done, when there is acute laryngeal obstruction demanding an urgent relief. It is advisable, if endotracheal intubation is done to tide over the emergency in most of the cases.

   Emergency airway management
   - Traumatic
     - Face injury: Intubation/Mini tracheotomy
     - Larynx injury: Tracheostomy
     - No injury.
     - Patient unconscious: Intubation/Tracheostomy.

- Nontraumatic
  - Intubation or tracheostomy.

ii. **Elective tracheostomy:** It is a planned surgery, when the patient and the surgeon both are not in a hurry. It can also be classified into temporary or permanent.
   a. **Temporary tracheostomy:** When it is done only for some time to overcome the crisis.
   b. **Permanent tracheostomy:** When it is done forever, in which the tracheal stump is brought to the surface and stitched to the skin. The various indications for this type are bilateral abductor palsy, laryngectomy, and laryngeal stenosis.

2. **Depending on the position,** it can be classified into the following.
   i. **High tracheostomy:** Performed above the isthmus of thyroid gland (above the 2nd tracheal ring). It is indicated in carcinoma larynx, when laryngectomy is anticipated.
   ii. **Mid tracheostomy:** Performed at the level of thyroid isthmus (2nd, 3rd and 4th tracheal ring), which is an ideal location and is usually done.
   iii. **Low tracheostomy:** Performed below the level of thyroid isthmus (5th and 6th tracheal ring). Indicated in laryngeal papillomatosis to avoid implantation.
   Most satisfactory type is that when it is performed immediately below the thyroid isthmus.
3. Tracheostomy can also be classifed into the following:
   i. **Therapeutic tracheostomy:** When it is done to relieve respiratory obstruction.
   ii. **Prophylactic tracheostomy:** When it is done to guard against anticipated respiratory obstruction or aspiration in extensive oral or neck surgeries.

Other Types

i. **Percutaneous tracheostomy (Figure 78.1):**
   a. It is an attractive and elegant, alternative to standard surgical tracheotomy procedure that can be performed at the bed side by even non-surgical personnel
   b. First described by Toye and Weinstein (1969), but it gained acceptance in 1980s owing to the development of graded tracheal dilators.
   c. The procedure may be done under local or general anesthesia.
   d. In most of the methods, Seldinger's guidewire technique is used to ensure correct placement of teflon dilators.
   e. The tracheostomy tube is then advanced into trachea after removal of guide wire and dilator.
   f. A small caliber flexible bronchoscope with a camera may be passed through endotracheal tube to see the needle, guide wire and dilator
   g. A high incidence of tracheal stenosis has been reported as a postoperative sequelae.

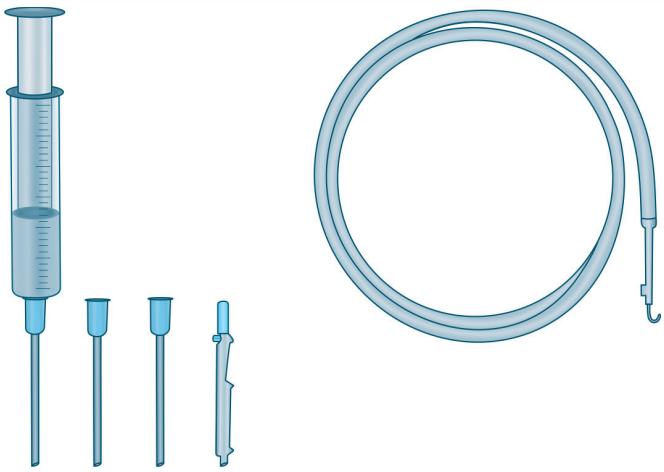


Figure 78.1 Insruments for percutaneous tracheostomy

Contraindications
- Children younger than 12 years
- Anatomic abnormality of trachea
- Pulsating blood vessels over the site of tracheostomy
- Active neck infection
- Occluding thyroid mass in the neck
- Short or obese neck
- Bleeding disorder
- History of difficult intubation

ii. **Mini tracheostomy (Figures 78.2 and 78.3):** First described by Mathews and Hopkins in 1984. In this method, a 4 mm cannula is introduced through an incision in the cricothyroid membrane. Procedure is mainly done to remove chest secretions or to treat respiratory failure with a high frequency jet ventilator.

iii. **Chemical tracheostomy:** It is the term used when maximum permissible dose of sterioids are given to relieve respiratory obstruction due to inflammatory edema.

iv. **Needle ventilation:** A needle of 14 G bore is put through cricothyroid membrane to give temporary ventilation in emergency situations only.

Other procedures for management of airway

- Endotracheal intubation
- Transtracheal jet ventilation through cricothyroid membrane
- Oropharyngeal and nasopharyngeal airways
- Laryngeal mask—a device which fits directly over the laryngeal inlet
- Jaw thrust in which jaw is lifted forward and neck is extended to improve the airway, which is commonly done by anesthetist after the surgery.

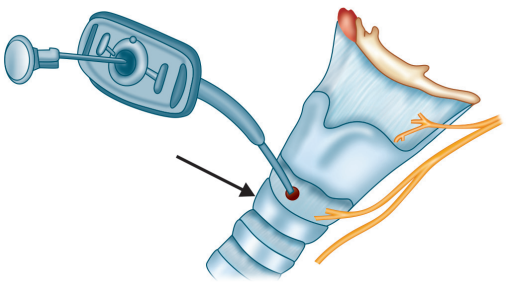


Figure 78.2 Cricothyrotomy cannula

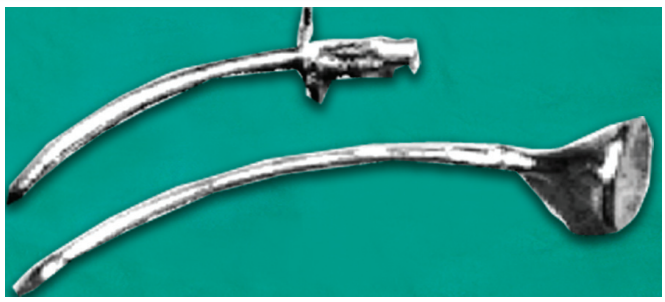


Figure 78.3 Mini tracheostomy tube

COMPLICATIONS OF ENDOTRACHEAL INTUBATION

- Improper tube placement
- Pulmonary edema
- Laryngeal stenosis
- Tracheoesophageal fistula
- Recurrent laryngeal nerve injury
- Sinusitis.

INDICATIONS

For the Relief of Upper Respiratory Obstruction

Congenital Causes

- Laryngeal web
- Bilateral choanal atresia
- Laryngeal cysts
- Tracheoesophageal anomalies.

Traumatic Causes

- Blows to larynx
- Gunshot wound
- Cut throat wounds
- Foreign bodies
- Swallowing of corrosives.

Infective Causes

- Acute laryngotracheobronchitis
- Diphtheria
- Ludwig's angina.

Tumors

- Malignancy of tongue, pharynx, larynx, thyroid and trachea
- Edema of radiotherapy
- Before surgery.

Bilateral Nerve Palsies

- After thyroidectomy
- Bulbar palsy.

Miscellaneous Causes

- Angioneurotic edema
- Hemophilia
- Obstructive sleep apnea (OSA) syndrome.

Protection of Tracheobronchial Tree

Through the tracheostomy tube, aspiration can be done easily and if needed, cuffed tube can also be used, such as in cases of:

- Bulbar poliomyelitis
- Polyneuritis
- Tetanus
- Coma
- Myasthenia gravis
- Drug overdosage
- Cervical cord lesions
- Burns of face and neck
- Multiple fractures of mandible.

Treatment of Conditions Leading to Respiratory Insufficiency

- Chronic emphysematous bronchitis
- Postoperative pneumonia
- Severe chest injuries
- Neuromuscular incoordination, causing conditions requiring artificial or intermittent positive pressure ventilation.

Five Most Common Indications

- Head injury with coma
- Acute infective conditions of larynx and tracheobronchial tree
- Cancer larynx

- Tetanus
- Laryngeal diphtheria.

Advantages or Functions of Tracheostomy

- Decreases dead space in tracheobronchial tree by 30% to 50%
- Decreses airflow resistance and hence increases total compliance
- Upper airway obstruction is bypassed
- Prevents aspiration, thus protecting the airway
- Good for tracheobronchial toilet
- Humidification can be given
- Patient can swallow without reflex apnea
- Intermittent positive pressure respiration (IPPR) can better be given with tracheostomy than with intubation.

Disadvantages of Tracheostomy

- Loss of phonation
- Loss of olfaction
- Loss of physiological humidification and filtration
- Difficulty in swallowing
- Loss of coughing mechanism
- Prone to atelectasis due to draining of secretions.

ANESTHESIA

Anesthesia can be done under local or general anesthesia. Type will depend upon the type of emergency. If the patient comes as an emergency requiring immediate tracheostomy, local anesthesia is enough; but if there is no emergency, then general anesthesia is better.

Local anesthesia (2% xylocaine with adrenaline) is given in the neck in the shape of rhomboid.

Position

Supine position with extension of the neck and head by placing a sandbag below the shoulders.

By this, the trachea becomes more superficial and the distance between the chin and suprasternal notch increases.

Instruments

Instruments required for tracheostomy is given in **Figure 78.4A**.

- Blood pressure (BP) handle with knife
- Artery forceps
- Right angle retractors
- Allis tissue forceps
- Tracheostomy tube
- Suction tips
- Tracheal wound dilator
- Portex tube (**Figure 78.4B**)
- Cricothyroidotomy cannula.

STEPS OF OPERATION

1. Skin → Deep Fascia → Strap muscles → Isthmus of thyroid → Pretracheal Fascia → Trachea.

   An incision may be vertical or transverse is given. Vertical is 4 cm long, in midline, extending from the lower border of cricoid cartilage. Horizontal incision is 5 cm long, approximately 2 finger-breadths above the sternal notch.
2. In elective tracheostomy, horizontal incision is preferred as it is more acceptable giving an invisible scar.
3. Advantages of vertical incision is easy dissection and collection of secretions does not take place as there is no inferior flap.

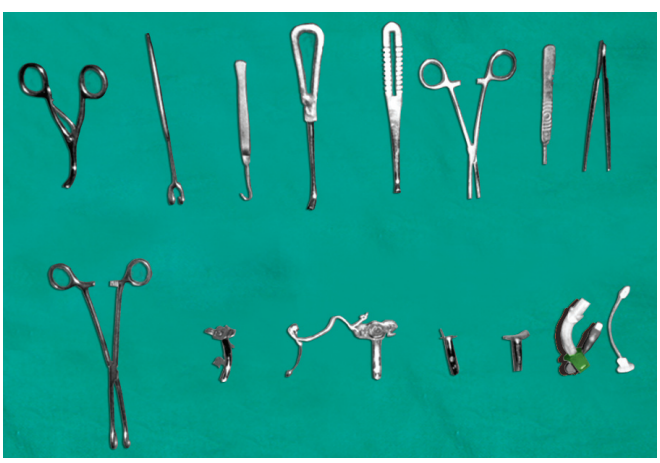


Figure 78.4A Instruments for tracheostomy

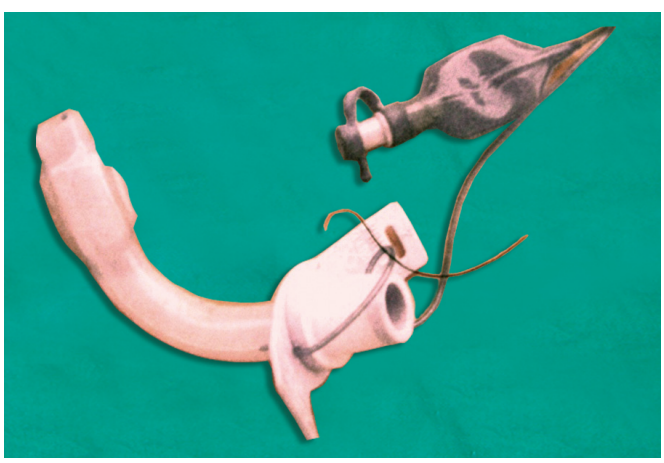


Figure 78.4B Portex tube

4. *Dissection:* Skin incision is deepened until strap muscles are reached. Strap muscles are separated vertically in the midline and retracted laterally, thus exposing the pretracheal fascia which covers the trachea and isthmus of thyroid gland. Isthmus may be retracted superiorly to avoid transecting it.
5. *Incision of tracheal wall:* Air is aspirated for confirmation and then 4 percent xylocaine is injected to avoid severe coughing.

   Vertical incision is given at the level of 3rd ring of trachea. Incision is opened with a hemostat and tracheostomy tube is inserted.
6. Suturing of skin incision should not be very tight to avoid complications such as subcutaneous emphysema, pneumothorax.

Sequelae/Problems after tracheostomy

- Swimming is not permitted with tracheostomy
- Showerbath is to be avoided
- Speech is not possible, as the larynx is bypassed
- Smell is lost (anosmia), as the patient is not breathing through the nose
- Swallowing becomes difficult, because of lack of laryngeal lift
- Weight lifting becomes difficult.
- Difficulty in straining like micturition, constipation or childbirth.

POSTOPERATIVE CARE

1. Due attention is given for selecting the proper size of tube and securing it with ribbon gauze around the neck.
2. Regular cleaning of the tube is important as secretions are deposited on the tube which dry up to form crusts.
3. If cuffed tube is being used, it should be deflated for 5 minutes per hour to prevent necrosis and tracheal stenosis.
4. Suction should be done regularly, every half an hour or as and when required. Injury to the tracheal mucosa is avoided by applying suction only, when the catheter is being withdrawn. Instillation of a few drops of 5 percent sodium bicarbonate causes thinning of the secretions.
5. Humidification of the inhaled air prevents crusting. This can be achieved by placing a moist thin layer of gauze over the outer opening of the tube. A boiling water kettle kept in the room provides humidified air to such patients. Better gadgets like a humidifier or a steam tent are also available.
6. A call bell should always be made available by the bedside. For the patients, who are not bedridden, a card must hang around their neck reading 'I breathe through my neck'.

COMPLICATIONS

Immediate

- Bleeding should be controlled before incising the trachea or else the patient may inhale it
- Injury to the surrounding structures like esophagus leading to tracheoesophageal fistula or dome of the pleura may be injured in children or even the major vessels of neck
- Apnea due to sudden washout of CO_2 which was acting as a respiratory stimulant. Treatment in such condition is to give carbogen (95% oxygen and 5% carbon dioxide)
- Air embolism, as sometimes a major vessel is cut and large volume of air gets sucked in which may pass into the right atrium leading to cardiac tamponade
- Cardiac arrest mainly due to three main reasons:
  - Increased adrenaline production as the patient is anxious
  - Increased pH of blood due to retained CO_2
  - Hyperkalemia due to respiratory alkalosis.

Delayed

- Hemorrhage which could be reactionary or secondary and is to be controlled depending upon its cause
- Tracheoesophageal fistula may form as a result of pressure of the tracheostomy tube. It usually heals with Ryle's tube feeding and inserting tracheostomy tube of proper size
- Pneumothorax may occur due to the injury to the dome of pleura
- Surgical emphysema may develop extensively, which could be taken care of by removing the sutures or giving multiple incisions over the emphysematous area
- Accidental decannulation can occur, if there is improper opening in the trachea, improper size of the tube or because of formation of a false passage
- Obstruction of the tracheosotmy tube
- Tracheal erosion and hemorrhage
- Atelectasis
- Hypercapnia
- Septicemia.

Late

1. Tracheal stenosis may occur due to perichondritis of cricoid cartilage, necrosis caused by the cuff of the tube or due to a badly performed surgery.
2. Tracheomalacia may occur, if a large area of trachea has been excised.
3. Persistent tracheostomy fistula, which may require surgical closure.
4. Sometimes fatal hemorrhage may occur due to erosion of great vessels by the tube end.
5. Tracheal granulations.
   Difficult decannulation: Removal of the tracheostomy tube is called decannulation. It should be done as early as possible or else the patient gets accustomed to breathing without resistance thorugh the tracheostomy tube. Decannulation at times becomes difficult in children as they have no airway reserve.

   During decannulation, the tracheostomy tube is partially blocked which is increased progressively. The patient is closely monitored and if he tolerates it for 24 hours, then decannulation can be performed safely.
   Factors causing difficult decannulation are:
   - Persistence of the condition that necessitated tracheostomy
   - Granulations around stoma
   - Subglottic stenosis.
7. Problems of tracheostomy scar.

Summary of Complications of Tracheotomy

Intraoperative

- Damage to great blood vessels
- Damage to tracheoesophageal wall
- Pneumothorax
- Pneumomediastinum.

Early Postoperative

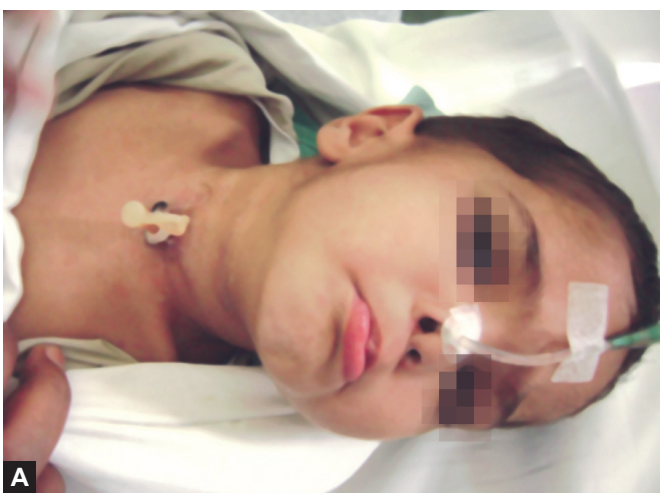
- Tracheostomy tube obstruction
- Tracheostomy tube displacement
- Pulmonary edema
- Sepsis/Infection.

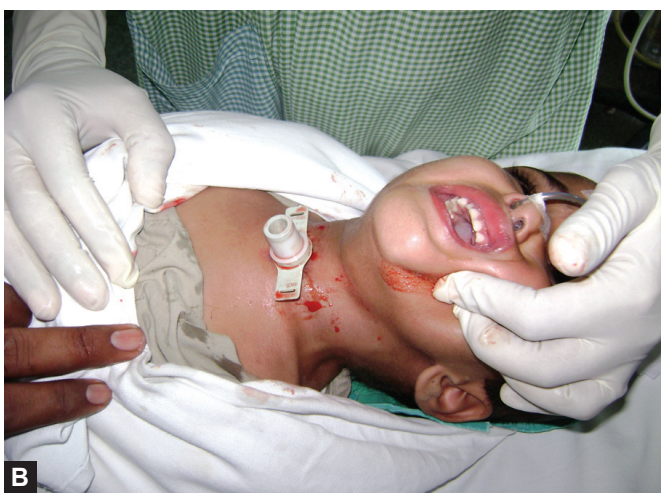
Late

- Tracheal stenosis
- Granulation tissue
- Difficult decannulation.

TRACHEOSTOMY IN INFANTS AND CHILDREN

- Most important indication for tracheostomy in infants is subglottis hemangioma and stenosis while in children it is acute laryngotracheobronchitis and acute epiglottitis (**Figures 78.5A and B**)
- Avoid tracheostomy, if endotracheal tube can serve the purpose
- Avoid low tracheostomy
- Avoid excision of tracheal cartilage
- Avoid too deep incision in the tracheal lumen
- Remember apical pleura, great vessels of neck and innominate artery may be easily damaged
- Decannulation problems are more seen in children due to psychological dependence.





Figures 78.5A and B Tracheostomy in children

Key Points

1. **Laryngotomy (cricothyrotomy)** is an emergency lifesaving procedure in which airway is achieved through cricothyroid membrane
2. **High tracheostomy** is not done at 1st or 2nd tracheal ring due to high incidence of tracheal stenosis. Midtracheostomy is done at 3rd or 4th ring. Low tracheostomy is done below 4th ring.
3. Main **advantages of tracheostomy** are to bypass the upper airway obstuction, reduces dead space by 30 to 50 percent, helps in positive pressure ventilation, reduces air flow resistance and protection of lower respiratory tract against aspiration.
4. **Five most important indications** for tracheostomy are foreign bodies, malignancy of larynx, head injury, acute laryngotracheobronchitis and tetanus.
5. Various types of **tracheostomy tubes** are:
   - Chevalier Jackson trachestomy tube (size 8–44).
   - Fuller bivalved tracheostomy tube.
   - Portex tracheostomy tube (size 3-10 in the increment of 0.5)
   - Durham tube (has an adjustable flange and is good for short fat neck)
   - Radcliff tracheostomy tube (right angled tube useful for short fat neck)
   - Salpekar double cuffed tracheostomy tube and is good for comatose patients on a ventilator.
6. The **most common problems** of patient following tracheostomy include inability to speak, he/she cannot swim or take a shower/bath, unable to lift heavy weights, difficulty in straining especially in constipation or passing urine, inability to smell due to bypassing of nose.
7. **Best tube for tracheostomy** during radiotherapy is portex tube which is non-reactive and that is the reason for not using the metallic tube.
8. In case of cuffed tracheostomy tube, **cuff pressure should not exceed 25 mm Hg** (or capillary perfusion pressure), otherwise there will be mucosal ischemia resulting in tracheal stenosis
9. **Elective tracheostomy** is always done below the cricoid cartilage.
10. Most common **intraoperative complication** in pediatric tracheostomy is hemorrhage and postoperative is blockage of the tube and decannulation.
11. **Coniotomy** is making a stab incision in the cricohyoid membrane through which a 4 mm endotracheal tube is passed.
12. **Low tracheostomy** in children can cause injury to innominate artery and dome of pleura.
13. Most common **indications of tracheostomy in children** are acute laryngotracheobronchitis, epiglottitis diphtheria, laryngeal edema, multiple papillomas and neck traumas.
14. **Endotracheal intubation** is an immediate alternative to tracheostomy.
15. **German silver** is an alloy of siver, copper and phosphorus, while Portex is the name of the company.
16. **Normal dead space is 150 mL** and tracheostomy reduces dead space by 30 to 50%.
17. Normal **pressure of gases** is—pO_2 90 to 95 pascal and pCO_2 is 40 to 45 pascals.
18. **Disadvantages** of metallic tube is that:
   - No cuff, so no **intrathoracic positive pressure respiration (IPPR)** possible
   - Erosion of anterior tracheal wall can occur
   - RT cannot be given.
19. Functions of tracheostomy—**remember mneumonic: VIP BAR:** V: **V**entilation; I: **I**PPR; **P**: Protects the airways; B: **B**reathing; A: **A**dminister anesthesia; R: **R**emoval.

Chapter 79 Direct Laryngoscopy

What Students Must Know!

- **Direct Laryngoscopy (DL)**
  - Advantages of D/L over IDL Examination
  - Types
  - Indications
  - Contraindications
  - Prerequisites for Direct Laryngoscopy
  - Anesthesia
  - Steps
  - Complications
- **Microlaryngoscopy**
- **Fiberoptic Laryngoscopy**
- **Stroboscopy**

DIRECT LARYNGOSCOPY

- In direct laryngoscopy (DL) procedure the larynx is visualized directly with the help of a rigid direct laryngoscope
- Manuel Garcia (1854) a singing teacher tried to see his vocal cords by using two mirrors, hence was called the father of laryngology
- The procedure of DL was developed in 1856 by Turck and Czemark in Vienna.

Advantages of direct laryngoscopy over indirect laryngoscopy examination

- False sense of depth perception as seen on indirect laryngoscopy (IDL) is not there
- All hidden areas of larynx such as anterior commissure, ventricle and subglottis can be seen on DL
- Epiglottis overhang is not a problem in DL
- There is no anteroposterior reversal of the structures of larynx in DL
- No foreshortening of vertical axis of larynx in DL
- Exact size of lesion of larynx is seen in DL examination
- Both diagnostic and therapeutic procedures can be undertaken in direct laryngoscopy examination.

Types

- Rigid type
- Flexible type.

Indications

Diagnostic Indications

- For proper visualization of various lesions in diseases of larynx.
- For taking a smear or biopsy from lesions of laryngopharynx.
- For finding out the nature and extent of growth larynx.
- For assessment of laryngeal trauma.
- As a part of panendoscopy in hidden primary with cervical lymph node metastasis.
- In vocal cord paralysis to see the position of vocal cords.
- In infants and children with noisy breathing.

Therapeutic Indications

- Foreign body removal
- Removal of benign lesions such as nodule, cyst, polypi or stripping of vocal cords
- Insertion of laryngeal stent
- Teflon paste injection in vocal cord palsy
- Dilatation of subglottic stenosis
- For endotracheal intubation
- As a part of bronchoscopic procedure
- For medialization/lateralization of vocal cords.

Contraindications

- Diseases of cervical spine like caries or fractures and dislocations for fear of quadriplegia

- Severe trismus, stridor or laryngeal spasm
- General contraindications such as hypertension, heart diseases, diabetes
- Acute corrosive poisoning
- Aneurysm of arch of aorta
- Severe stridor.

Prerequisites for Direct Laryngoscopy

- IDL examination
- Rule out caries, loose teeth
- Patient fasting
- Rule out diabetes/hypertension
- Radiological examination.

Position of Patient

The patient lies supine, a pillow may be placed under both shoulders.

Boyce's position, i.e. flexion of cervical spine and extension at atlanto-occipital joint, so that vertical axis becomes more horizontal and horizontal axis becomes vertical and therefore, oral cavity and larynx lie almost in the same plane for easy introduction of instruments. The position can be achieved if head, neck and shoulders project beyond the edge of the operation table and head is supported by an assistant.

Instruments Required

Instruments required for direct laryngoscopy is given in **Figure 79.1**.

- Laryngoscope with light carrier
  - Straight blade type
  - Anterior commissure type
- Laryngeal forceps
- Suction tubes.

Anesthesia

Direct laryngoscopy may be done under local or general anesthesia, which provides enough time for diagnostic or therapeutic procedures on larynx.

Steps

- Upper teeth are protected with a rubber sponge or thick gauze piece
- Laryngoscope, held in right hand, is introduced gently into the oral cavity, passed along the side of tongue till epiglottis is visualized (**Figures 79.2 and 79.3A to D**)
- Tip of epiglottis is lifted using tip of laryngoscope to see the inlet of larynx and now one can see the vestibule, false and true cords, anterior and posterior commissures
- Any diagnostic or therapeutic procedure is carried out.

Complications

- Trauma to lips, teeth and tongue, arytenoid or vocal vords
- Laryngeal spasm may occur causing cyanosis and death (Laryngocardiac reflex)
- Damage to cervical spine, especially, if it is already diseased. Bradycardia, syncope, cardiac arrest and arrhythmias

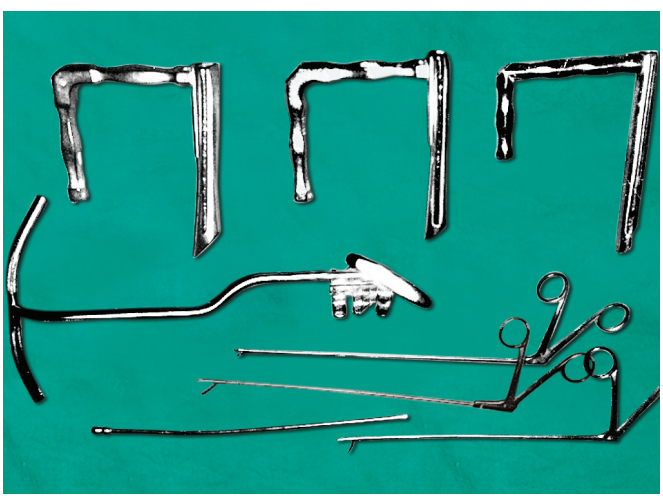


Figure 79.1 Instruments for direct laryngoscopy

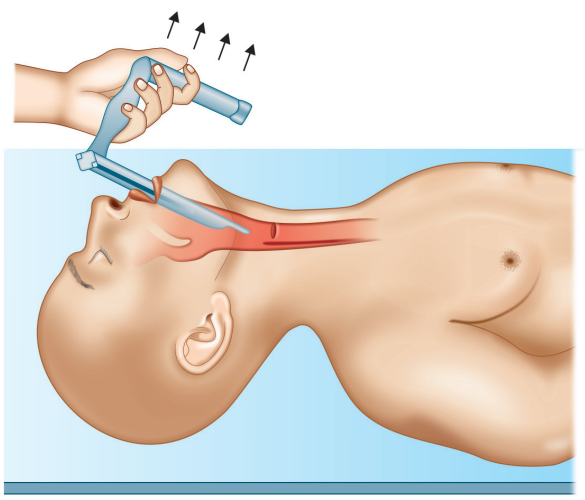


Figure 79.2 Direct laryngoscopy (diagrammatic)

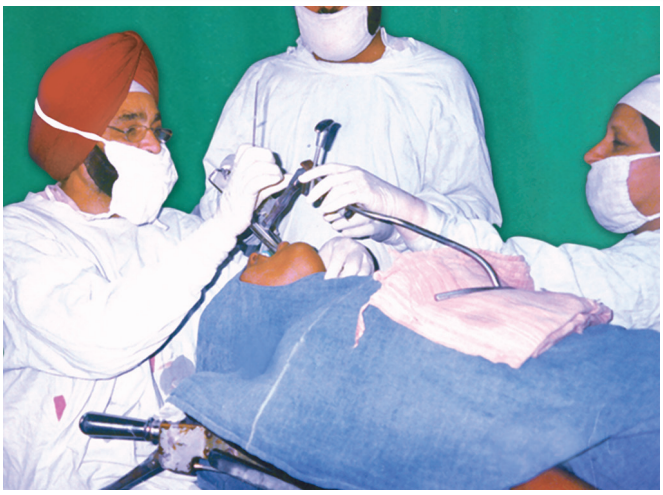


Figure 79.3A Suspension laryngoscopy in progress—examination

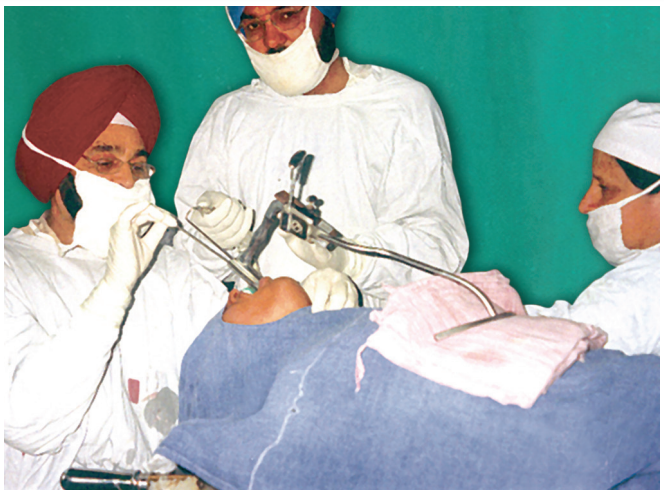


Figure 79.3B Suspension laryngoscopy—surgical manipulation being done

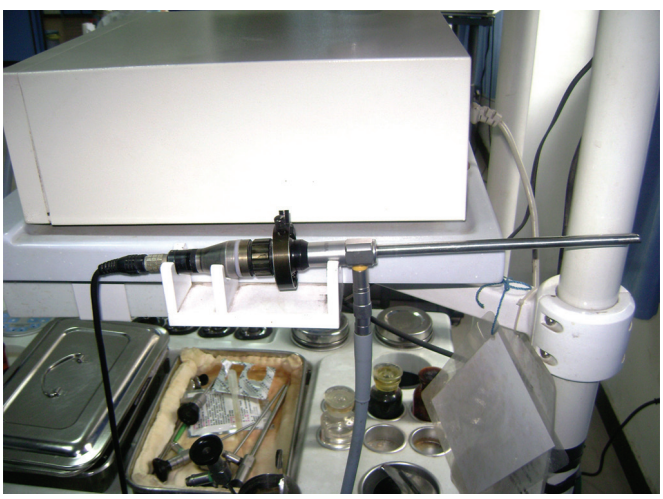


Figure 79.3C 90 degree endoscope for laryngoscopy

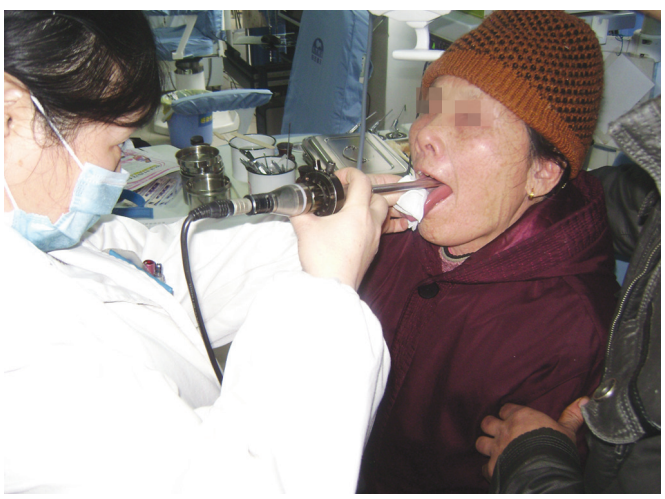


Figure 79.3D Endoscopy with 90 degree endoscope

- Anesthesia complications like respiratory and cardiac arrest due to vagal stimulation may take place.

MICROLARYNGOSCOPY (KLEINSASSER 1968)

Microlaryngoscopy is a better procedure than direct laryngoscopy because of the following reasons:

- It provides magnification due to use of microscope
- Both hands are free for manipulation
- Surgeon gets adequate time for any procedure
- Photography and video recording can be done
- Teaching to students can be done by the side tube
- Laser, cryo or ultrasound can be performed.

Indications as well as contraindications are same as that for direct laryngoscopy.

FIBEROPTIC LARYNGOSCOPY

A flexible fiberoptic laryngoscope is passed through the nose to the larynx via nasopharynx in sitting position in the outpatient department (OPD) set up. It is useful where the patient is unconscious, has trismus or difficult IDL/DL cases.

Advantages are:

- Better visualization of movements of both cords
- Photography
- Provides magnification
- Can be done in the OPD also.

STROBOSCOPY

- Stroboscopy was described by Oertel in 1908.
- The instrument allows to observe the cyclical movements of objects depending on the rate of flashes such as that of vocal cords.
- Any rotating body when flashes of light are given, slows down the movements of that object, which can be seen in slow motion
- Its digital display can be recorded.
- Pulse of light can be synchronizing or asyncronizing.

Stroboscope consists of microphone, light source, control unit, paddle to adjust the magnitude of pulse.

Key Points

1. **Hidden areas of larynx** which are not seen with indirect laryngoscopy like anterior commissure, ventricles and subglottis are visualized better with direct laryngoscopy.
2. IDL gives inverted **2D image** whereas DL scopy provides **3D** direct visualization of larynx.
3. Some important **indications for DL** are for biopsy; finding the nature and extent of growth; removal of benign lesions of vocal cords; foreign bodies' removal and endotracheal intubation.
4. **Suspension laryngoscopy** is used for performing therapeutic surgery on vocal cords like removal of polypi, nodules, papilloma.
5. **Fiberoptic flexible laryngoscopy** is an OPD procedure and is done in patients with trismus; difficulty in IDL and in uncooperative children.
6. Supine position with extension of head and flexion of the neck is called **Boyce's position (Barking dog position)**.
7. **Laryngocardiac reflex**—pressure on the larynx occasionally produces bradycardia or cardiac arrest.
8. Suspension laryngoscopy is also called **autostatic laryngoscopy**.
9. Laryngoscope was conceived by **Gustave Killian**.
10. Position for laryngoscopy is also called **sniffing the morning air position**.
11. **Jet ventilation** can lead to pneumothorax.
12. **Stroboscopy** is done to see the movements of vocal cords.

Chapter 80 Bronchoscopy

What Students Must Know!

- ❖ **Bronchoscopy**
- ❖ **Introduction**
  - Indications
  - Contraindications
  - Instruments
  - Anesthesia
  - Position of Patient
  - Complications of Bronchoscopy

"Surgery is easy to watch, difficult to do"

INTRODUCTION

- **Gustave Killian of Freiburg** is called the father of bronchoscopy
- Bronchoscopy is a procedure used for endoscopic examination of tracheobronchial tree.

Types of Bronchoscopy

- Bronchoscopy may be **rigid bronchoscopy** (open) or **flexible bronchoscopy** (closed type)
- Rigid reaches up to 3rd generation bronchioles while flexible reaches up to 5th generation and is good for diagnosis and biopsy.

Indications

Diagnostic

- Tracheobronchial foreign bodies
- For taking a biopsy from suspected lesion of tracheobronchial tree
- For cases of sputum cytology for tuberculosis (TB) or malignancy or bronchoalveolar lavage
- To see the spread of carcinoma from esophagus or thyroid
- In cases of stridor, hemoptysis wheeze and chronic cough to find out the cause
- In tracheoesophageal (TO) fistula, to see the dye in tracheobronchial tree
- Unexplained chronic cough in a smoker

Therapeutic

- For removal of tracheobronchial foreign bodies
- For excision of suspected benign lesions, e.g. papillomas, polypi, granulomas
- Aspiration of secretion from tracheobronchial tree in pulmonary collapse or coma patients
- For dilatation of tracheal stenosis
- For difficult intubation
- For bronchography
- For radioactive brachytherapy.

Contraindications

Emergency bronchoscopy has no contraindication, as it may be a life-saving procedure.

Elective bronchoscopy may have the following contraindications:

- General contraindications such as hormone therapy (HT), diabetes mellitus (DM), bleeding disorders
- Active infections
- Trismus
- Aortic aneurysm
- Cervical spine problems
- Active recent massive hemoptysis
- Metastatic involvement of cervical spine
- Pulmonary hypertension
- Inability to oxygenate the patient
- Recent myocardial infarction (MI) or unstable angina.

Figure 80.1 Instruments for bronchoscopy

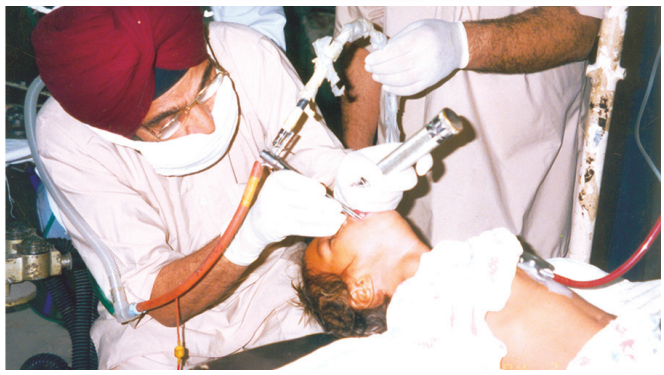


Figure 80.2 Bronchoscopy procedure

Preoperative Investigations

- X-ray chest and tomograms
- Computed tomography (CT) scan
- Bronchography
- Sputum for acid fast bacilli (AFB)/cytology
- Usual investigations as for Georgia association (GA).

Instruments

- Bronchoscopes (Jackson's type)
  - — Adults (40 cm × 7 mm)
  - — Child (30 cm × 5 mm)
  - — Infant (25 cm × 3.5 mm)
- Long biopsy forceps and foreign body forceps
- Suction tubes (**Figure 80.1**).

ANESTHESIA

General anesthesia is preferred always. The ventilation is done with a jet instrument known as **Venturi** which gives oxygen at a high pressure or by connecting the bronchoscope with anesthetic machine. The patient must be hyperventilated for at least 3 minutes before passing the scope.

Position of Patient

Boyce position as in direct laryngoscopy.

TECHNIQUE

1. Rigid bronchoscope is passed along the tongue to the epiglottis which is lifted. Bronchoscope is turned 90° so that one can pass easily through the anteroposterior axis of vocal cords to avoid damage. Bevelled end should face posteriorly.
2. Bronchoscope enters the trachea as seen by rings and blast of air during expiration. Carina is an important landmark, where bifurcation of trachea into right and left bronchus takes place.
3. After flexing the head, it is turned to opposite side say left side to pass the scope into right principal bronchus. Primary bronchi and openings of secondary branching are visualised.
4. During removal, the scope is turned through 90° at the glottis so that bevelled end faces the vocal cord to avoid damage (**Figure 80.2**).

Flexible Fiberoptic Bronchoscopy

- Commonly used than rigid bronchoscopy because of better illumination and magnification
- Permits examination up to 5th subsegmental bronchii
- Easily used in patients with neck and jaw anamolies
- Procedure can be done under topical anesthesia in poor risk patients
- Good for aspiration of secretions or small foreign bodies and biopsy.

Complications of Bronchoscopy

- Complications of anesthesia:
  - – Cardiac arrhythmias
  - – Vasovagal shock
  - – Hyper or hypotension.
- Cardiorespiratory arrest
- Damage to lips, teeth, tongue or vocal cords
- Dislocation of arytenoid resulting in fixation of vocal cord
- Subglottic edema
- Dislocation of cervical spine
- Tear of tracheobronchial areas
- Difficultly in removing a foreign body.

Key Points

1. The **length of trachea is 10 to 12 cm** and extends from C6 to T5 with carina at the bifurcation of trachea occurring at 25 cm from upper incisor.
2. Bronchoscopy has **absolute indications** such as unexplained cough, hemoptysis, stridor and wheeze.
3. **Jackson Dictum**—If you suspect a foreign body in the tracheobronchial tree, it is safer to perform bronchoscopy rather than withholding the endoscopy.
4. Bronchoscopy is always done under general anesthesia. The machine used is called **venturi**, which provides oxygen under pressure by a jet.
5. Cardiac arrest and respiratory arrest are the most **dreaded complications** of this procedure.
6. **Mediastinoscopy** is performed by suprasternal incision.
7. In **bilateral vocal cord palsy** bronchoscopy should not be done as later on edema may cause life threatening air way obstruction.

Chapter 81 Esophagoscopy

What Students Must Know!

- **Introduction**
  - Types of Esophagoscopy
  - Indications
  - Contraindications
  - Anesthesia
  - Position
  - Steps
  - Complications

INTRODUCTION

- It is rightly said that many skillful operators are not good surgeons
- Endoscopic examination of the esophagus is called esophagoscopy
- Adolph Kussmaul of Freiburg (1868) was the first to look into esophagus with reflected light after understanding the technique of sword swallowing (Father of esophagoscopy).

ENDOSCOPIC EXAMINATION OF ESOPHAGUS

Types of Esophagoscopy

Esophagoscopy of two types, rigid and flexible.

Advantages of Rigid Esophagoscopy

- Deep biopsy can be taken
- Foreign body removal
- Use of endoscopic laser
- Easy maintenance
- Better visualization.

Advantages of Flexible Esophagoscopy

- GA is not required
- Mucosal lesions are better examined
- Endoscopic photography
- Better flexibility in anatomically difficult areas.

Indications

Esophagoscopies are diagnostic and therapeutic.

Diagnostic

To visualize:

- Any suspected foreign body
- Stricture esophagus
- Growth in the food pipe
- Esophageal varices
- Unknown primary with metastasis
- Unilateral vocal cord palsy
- To visualize esophagitis gastroesophageal reflux disease (GERD)
- In caustic burns of food pipe.

Therapeutic

- To remove foreign body
- Dilatation of stricture with bougie
- Injection of sclerosing agent for varices
- Benign tumor of esophagus can be dealt with esophagoscopy
- Souttar tube, in terminal cases of esophageal cancer, can be inserted with the help of esophagoscope
- Treatment of cardiac achalasia/hypopharyngeal pouch

- Treatment of diverticulae
- For brachytherapy.

Contraindications

- Aortic aneurysm
- Cervical spine deformity
- Trismus
- Mediastinal growth
- Systemic diseases like hormone therapy (HT) and diabetes mellitus (DM) should be controlled first.

Instruments Required

1. a. Hypopharyngoscope (Esophagus speculum)
   b. Esophagoscope
2. Light source and light carrier
3. Biopsy punch
4. Suction apparatus (**Figure 81.1**).

Anesthesia

General anesthesia is preferred but can be done under local anesthesia also.

Position

Boyce's Position

The patient lies supine with ring below the head. The neck is flexed and the head is extended at the atlanto-occipital joint. A piece of gauze is kept over the upper jaw for protection of teeth and upper lip is retracted. Surgeon's left hand steadies, protects and controls the upper jaw.

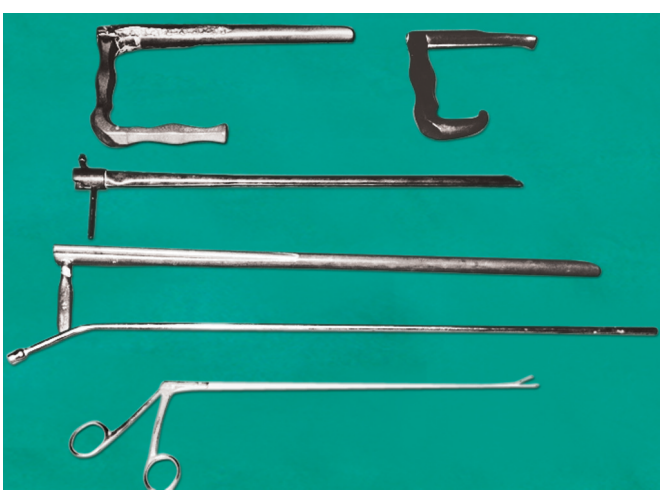


Figure 81.1 Instruments for esophagoscopy

Steps

- Esophagoscope is held by right hand like a pen and inserted in the oral cavity from the right angle of mouth till one sees the uvula and both valleculae
- The epiglottis is seen and the esophagoscope is brought to the midline
  - Both the pyriform sinuses are examined
  - Cricopharynx is visualized. It is slit like and after a little pause, when the crico-pharyngeal sphincter relaxes, the scope is passed into the esophagus with very gentle movement taking care of anatomical curves of the esophagus
  - Lumen is visualized for any pathological abnormality and lumen acts as a guide to proceed downwards.
- The scope is then passed down slowly till it reaches the lower end of esophagus
- Withdrawal of scope is done in the same manner, examining the lumen of esophagus once again.

Flexible Fiberoptic Esophagoscopy

- Outpatient department (OPD) procedure
- No anesthesia required
- Can be under taken in anatomically abnormality of spine and jaw patients
- All areas of upper gastrointestinal tract (GIT) can be seen
- Better illumination and magnification permits better visualization of lesions
- Injection of sclerosing agents can be done.

Complications

1. Esophageal perforation is one of the dreaded complications. It can result if the scope is inserted forcibly or an attempt is made to remove foreign body without knowing its nature and position or when foreign bodies are impacted.

Esophageal perforation is characterized by
- Rising pulse
- High fever
- Severe pain radiating to the back between the blades of two scapulae
- Dysphagia associated with pyrexia
- Subcutaneous surgical emphysema in the neck
- Under general anesthesia, a crunching sound heard over the precordium (Hamman's sign).

2. Injury to teeth, lips, tongue and cervical spine
3. Aortic aneurysm may rupture
4. Undue force may dislocate the cervical spine vertebrae if affected with disease, e.g. caries spine
5. Tracheal compression.

Key Points

1. The **most important indications** for esophagoscopy are to see and remove a foreign body, to see the extent and take biopsy from the growth, dilatation of benign stricture, excision of benign tumor and injection of sclerosing agent for varices.
2. **Absolute contraindication** to esophagoscopy is **caries cervical spine**.
3. In **Boyce position** the neck is flexed and head is extended at atlanto-occipital joint.
4. **Most dangerous complication** of esophagoscopy is esophageal perforation, which is characterized by rising pulse, severe pain radiating to the back between the two scapulae, high rise of temperature and emphysema of the neck.
5. The most important part of treatment of **esophageal perforation** is nil orally, Ryle tube feeding, good IV antibiotics and rarely repair of the tear by thoracotomy.
6. Esophagus has a **greater propensity to rupture** than any other site in the alimentary tract because it has no serosal layer and because of negative intra-thoracic pressure
7. **Alkaline substance** causes more damage and perforation of esophagus.
8. **Esophagoscope in stomach** is indicated by appearance of rouge and gastric secretions.
9. **Esophageal dilators** includes Gum elastic, Hurst (Filled with mercury), Maloney and Chevalier Jackson.
10. Esophagus extends from **C6 to T11 vertebrae level**.

Section 11 Instruments

Chapter 82 Instruments for ENT Examination

What Students Must Know!

- **Why Important?**
- **ENT Examination Instruments**
  - Head Mirror
  - Bull's Eye Lamp
  - Thudicum's Nasal Speculum
  - Eustachian Tube Catheter
  - Laryngeal Mirror
  - Siegle's Pneumatic Speculum
  - Otoscope
  - Jobson Horne's Aural Probe and Ring Curette
  - Tuning Fork (Hartmann's or Gardiner Brown)
  - Posterior Rhinoscopic Mirror

WHY IMPORTANT?

- It is important to learn the name of the instrument.
- How to handle it correctly.
- In which surgical procedure or examination this instrument is used.
- Further, the viva questions related to the instrument or the operation, where the instrument is used are usually asked.

ENT EXAMINATION INSTRUMENTS

ENT Outpatient Department Set Up Trolley

- ENT set up trolley is a modern set up of outpatient department (OPD) for examination of patients, available in good hospitals
- In this set up besides examination instruments, suction facility, good illumination, endoscopic set up along with camera and monitor for recording the findings is available (**Figure 82.1**)
- It is excellent for teaching purposes
- But it is a very costly set up.

Head Mirror with Adjustable Head Band

- Avery in 1840 invented the perforated head mirror
- It is used to focus the light from the light source for examination of the patient
- The mirror is concave with a focal length of 23 cm, diameter of mirror is 9 cm and size of hole is 2 cm diameter
- The hole of mirror comes in front of pupil of right eye and light is focussed with closed left eye to have a binocular vision

Approximate distance between mirror and lamp is one feet and may be adjusted to have a sharp light both hands are free to carry out any procedure (**Figure 82.2**).

Clar's Head Light

Clar's head light is an electric head light, handy, more useful and gives strong light for examination or for operations (**Figure 82.3**).

Bull's Eye Lamp

Bull's eye lamp is a source of light with a 100 watt milky bulb and a convex lens with focal length of 45 cm, through which light passes on to the mirror. Lamp is kept close to the left shoulder of the patient (**Figure 82.4**).

Thudicum's Nasal Speculum

- The speculum is named after Johann Ludurig Wilhelm Thudicum (1829–1931)
- It is used for doing anterior rhinoscopy for examination or operations on the nasal cavity
- Correct method of holding nasal speculum is in the left hand suspended over the crooked left index finger

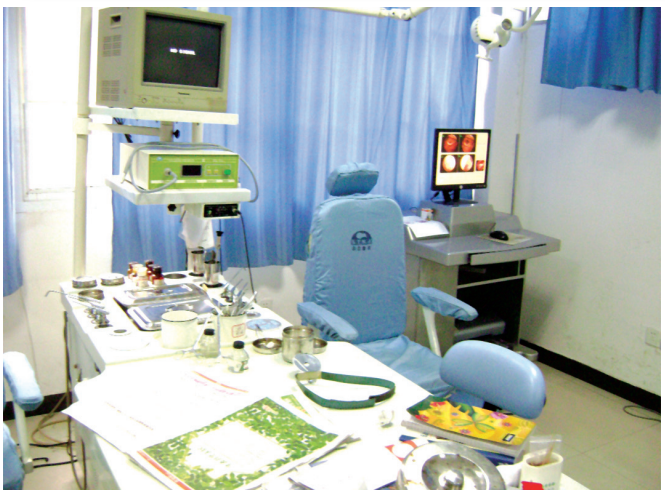


Figure 82.1 ENT outpatient department set up trolley

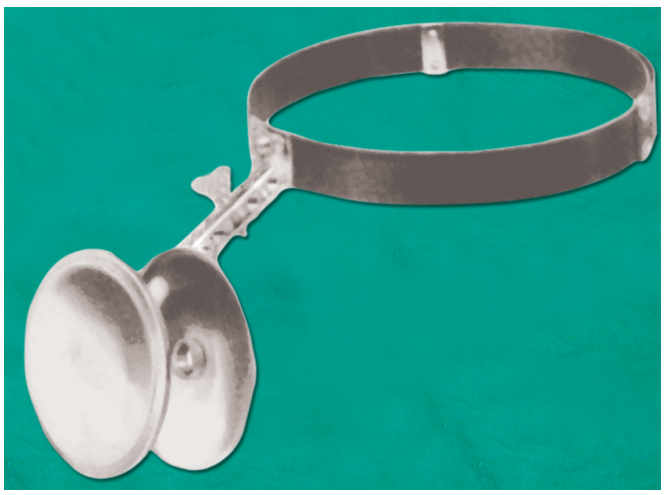


Figure 82.2 Head mirror

Figure 82.3 Head light

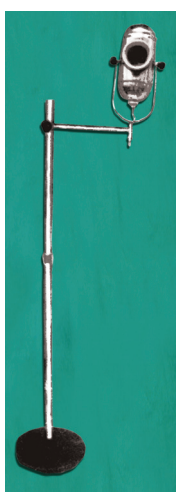


Figure 82.4 Bull's lamp

- Fixed with the thumb and putting middle and ring fingers on the sides of two prongs (**Figure 82.5**).

Lack's Tongue Depressor

Lack tongue depressor is used to:

- Examine the oral cavity
- Oropharynx
- Posterior pharyngeal wall
- To test nasal patency
- To test gag reflex and for posterior rhinoscopy
- Only middle part of the tongue is pressed because touching the posterior part of tongue causes gag reflex (**Figure 82.6**)
- Alternatively disposable wooden spatulas may be used.

Eustachian Tube Catheter (Rose's)

- Eustachian tube catheter is wide bore beaked metallic cannula 12 to 15 cm in length
- It is used for catheterization or insufflation of eustachian tube
- Removing foreign body from the nose
- To instill medication into the middle ear
- It may also be used for suction
- Ring on the proximal end indicates the direction of the tip of the catheter (**Figure 82.7**) after it is in the nasopharynx.

Laryngeal Mirror

- A Spanish music teacher Manuel Garcia (1855) hit the idea, when he saw sunlight reflected from a window

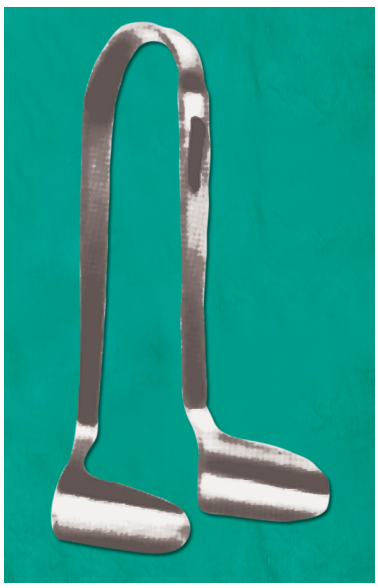


Figure 82.5 Nasal speculum

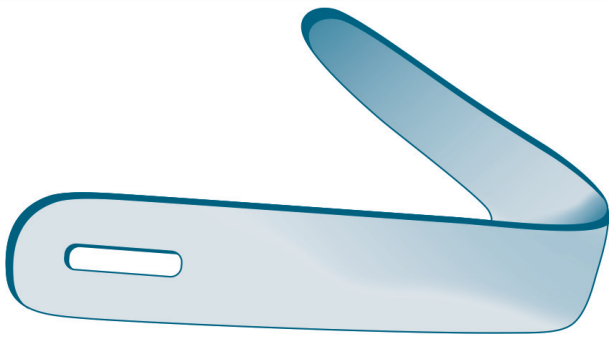


Figure 82.6 Tongue depressor

Figure 82.7 Eustachian tube catheter

glass and by using a mirror saw his own larynx. Shaft of the laryngeal mirror is straight while that of posterior rhinoscopic mirror is bayonet-shaped.

- It is a plane mirror with infinite focal length (Diameter 10–30 mm) available in size 1 to 5, used for indirect laryngoscopic (IDL) examination of hypopharynx, which makes it possible to see.
- Base of tongue (BOT), valleculae, true and false cords, anterior and posterior commissures, subglottis, aryepiglottic (AE) fold and pyriform sinus.
- Areas which cannot be seen on IDL are postcricoid, apex of pyriform sinus, ventricles and laryngeal surface of epiglottis.
- Remember mirror surface is warmed to prevent fogging and metal surface is always tested on the dorsum of hand so that it does not cause burn or discomfort to the uvula (**Figure 82.8**).

Local Anesthetic Sprayer

Local anesthetic sprayer is used to spray 10 percent xylocaine on to various areas such as nose, throat and pharynx for examination or minor surgical procedures (**Figure 82.9**).

Siegel's Pneumatic Speculum

The speculum has a angulated lense, which is parallel to the tympanic membrane with an ear speculum to fit into the canal, which is attached to a rubber tube and a bulb for applying suction or pressure on the drum (**Figure 82.10**).

Various uses of Siegel's speculum

- Magnification (2X)
- Mobility of tympanic membrane (TM)
- Medicine insufflation
- Suction of discharge
- Fistula test
- Gelle's test
- Browne's sign
- D/D of healed perforation and adhesive otitis media.

Otoscope

Otoscope is a handy battery-operated instrument used to examine the meatus, tympanic membrane and middle ear. It has convex lens, which gives magnification of 2X and also gives good illumination. It is especially useful for examination of bedridden patients and children (**Figure 82.11**).

Jobson Horne Aural Probe with Ring Curette

Jobson Horne's aural probe with ring curette is used to remove wax with ring curette and debris, discharge or foreign bodies from external auditory meatus by the other serrated end (**Figure 82.12**).

Simpson's Aural Metallic Syringe

- Simpson aural metallic syringe is a large metallic (stainless steel) syringe with a conical nozzle
- It has a capacity of 150 mL

Figure 82.8 Laryngeal mirror

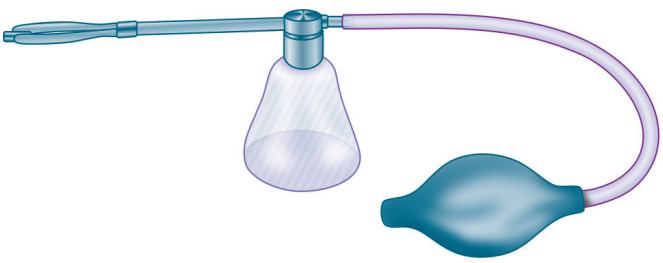


Figure 82.9 Anesthetic sprayer

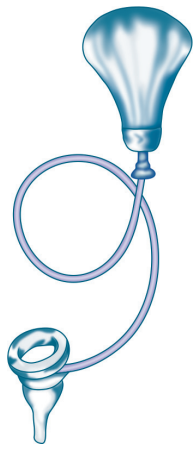


Figure 82.10 Siegel's speculum

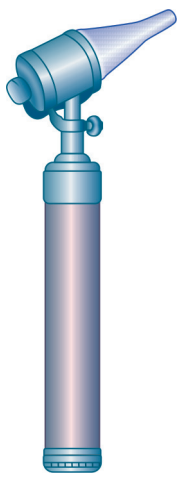


Figure 82.11 Otoscope

Figure 82.12 Aural probe

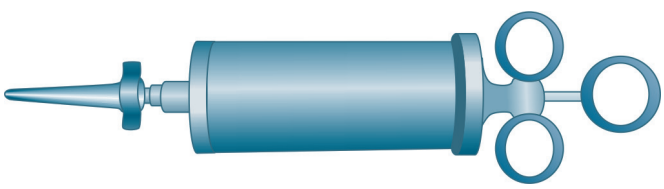


Figure 82.13 Aural syringe

- Though not used these days but was extensively used in the past for removal of wax, debris or foreign bodies from external auditory meatus
- Water at body temperature (37°C) should strike the wall of the meatus and not the wax or foreign body
- Complications may be injury to tympanic membrane, vasovagal attack, vertigo and otitis externa (**Figure 82.13**)
- This instrument is not used if there is suspected or confirmed tympanic membrane perforation or in case of hygroscopic foreign body and in cerebrospinal fluid (CSF) otorrhea or recent injury cases.

Tongue Tie Spatula

Tongue tie spatula is used to cut the frenulum of tongue in small infants with tongue tie (**Figure 82.14**).

Tuning Fork (Hartmann's or Gardiner Brown)

- Various tuning forks are 128 Hz, 256 Hz, 512 Hz, 1024 Hz, 2048 Hz, 4056 Hz
- These are used for testing
  - The type of hearing loss, whether conductive or sensorineural hearing loss (SNHL)
  - Also to judge roughly the amount of hearing loss by using various tuning forks.
- Mostly 512 Hz tuning fork is used because it falls in mid speech frequency and its sound lasts longer because of its slow decaying and it produces minimal overtones.
- Tuning fork has a base, stem and two prongs and when struck lightly, produces a pure tone which is a single frequency tone (**Figure 82.15**).
  - Forks of lower frequency causes overtones
  - Forks of higher frequency—shorter decay time.

Figure 82.14 Tongue tie spatula

Figure 82.15 Tuning fork

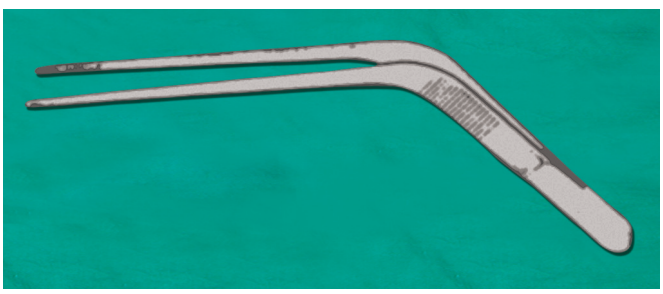


Figure 82.16A Nasal dressing forceps

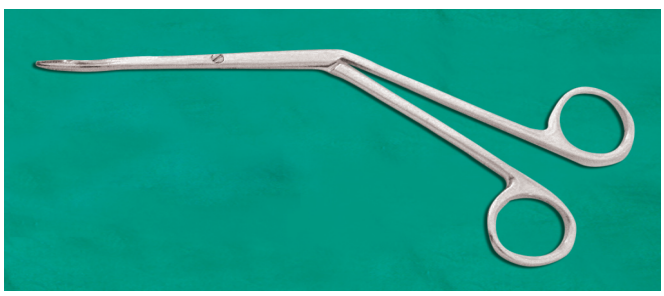


Figure 82.16B Tilley's nasal dressing forceps

Nasal Dressing Forceps

Nasal dressing forceps are used for nasal dressing or for inserting and removal of packs or for removal of foreign bodies from nasal cavity (**Figure 82.16A**).

Tilley Nasal Dressing Forceps

Tilley nasal dressing forceps are also used for nasal dressing and also for packing of gauge dressings or removal of a foreign body or other manipulation in the nasal cavity (**Figure 82.16B**).

Aural Speculum (Toynbee's)

Aural speculum is used for examination or operations in the external ear, tympanic membrane and middle ear. It should be introduced gently by rotation by pulling the pinna upwards, backwards and outwards in aduls and downward and outward in children to straighten the meatus (**Figures 82.17A and B**).

Posterior Rhinoscopy Mirror (St Clair-Thomsons)

- Posterior rhinoscopy mirror is an angled plane mirror for doing posterior rhinoscopy to examine the nasopharynx

- **By this examination one can see:**
  - The posterior end of nasal septum and choanae
  - Posterior end of inferior and middle turbinates
  - Roof of nasopharynx
  - Opening of eustachian tube
  - Fossa of Rosenmüller (**Figure 82.18**).
  - Bayonet shaped allows a clear view of the areas
  - It is smaller in size than IDL mirror
  - Available in size from 0-5
  - Mirror is plane with no magnification.

Figures 82.17A and B Aural specula

Figure 82.18 Posterior rhinoscopy mirror

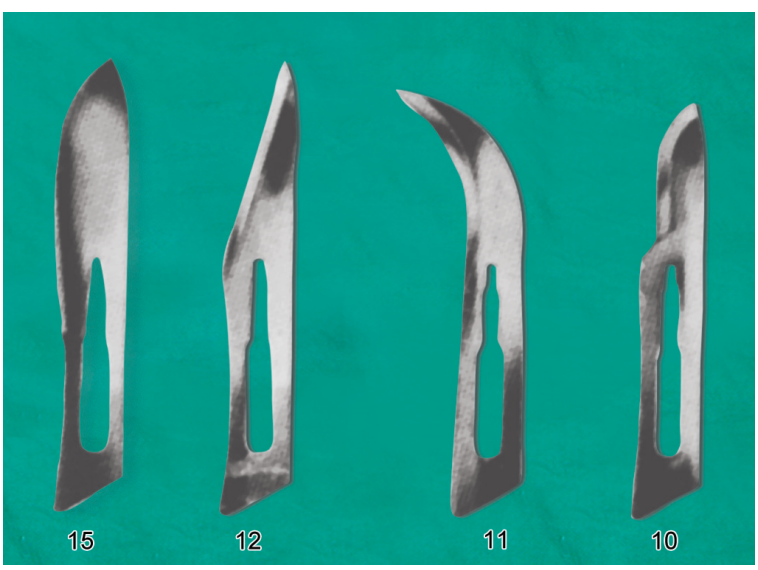


Figure 82.19 Various surgical blades

Surgical Blades

Surgical blades are used for surgical incisions (**Figure 82.19**).

- Blade number 10 — for submucous resution (SMR) or septoplasty incision, submandibular gland and thyroid surgery.
- Blade number 11 — for stab incision in I and D.
- Blade number 12 — for tonsillar resection.
- Blade number 15 — for general surgery.

Key Points

1. **Bull's eye lamp** is a source of light with a 100 watt milky bulb and a convex lens
2. **Head mirror is concave** with a focal length of 9", diameter of mirror is 3½" and size of hole is ¾" diameter.
3. Eustachian tube catheter is used for catheterization or insufflation of eustachian tube besides removing foreign body from the nose
4. **Laryngeal mirror** is a plane mirror (Diameter 10-30 mm) and one can see on indirect laryngoscopy—base of tongue, valleculae, true and false cords, anterior and posterior commissures, subglottis, AE fold and pyriform sinus.
5. **Siegel's pneumatic speculum** uses are:—Magnification (2X)/—test mobility of TM/Insufflation of medicine/Suction of discharge/Fistula test/Gelle'stest/Browne's sign/differential diagnosis of healed perforation and adhesive otitis media.
6. Otoscope has a convex lens which gives **magnification of 2X**
7. **Tuning fork 512 Hz is used** because it falls in mid speech frequency and its sound lasts longer, its slow decaying and minimal overtones.

Chapter 83 Ear Surgery Instruments

What Students Must Know!

❖ **Ear Instruments**
- Otoendoscopes
- Self-retaining Mastoid Wound Retractor
- Mastoid Gouge
- Macewen's Scoop with Cell Seeker
- Lempert's Mastoid Curette
- Myringotomy Knife
- Bone Nibbler
- Aural Snare
- Crocodile Fine Forceps
- Zollner's Knife
- Stack's Guide

INSTRUMENTS USED FOR EAR SURGERY

Otoendoscopes

Otoendoscopes are the latest addition to the examination of ear. Advantages are better illumination at the sight and is the best aid for teaching and for keeping future records as well (**Figure 83.1**).

Ear Speculum with Cut (Tumarkin)

Ear speculum with cut is used to inspect the external auditory meatus (EAM) and tympanic membrane (TM) in cases of tympanoplasty, tympanotomy and stapedectomy operations. Its black color prevents reflection of light (**Figure 83.2**).

Ear Speculum with Handle

Ear speculum with handle is useful in ear surgery, when the canal is very narrow, especially the cartilaginous part of meatus (**Figure 83.3**).

Self-retaining Mastoid Wound Retractor and Hemostat (Mollison)

- Mollison self-retaining mastoid wound retractor is used to retract the wound, i.e. soft tissue after elevation of flaps in operations like mastoidectomy, tympanoplasty.
- It also acts as a hemostat due to stretching of wound.
- It may also be used in:
  - External ethmoidectomy,
  - Laryngofissure
  - Burr hole operations
  - Optic nerve decompression (**Figure 83.4**).
  - Other retractors are Jenkin's, Oyher's and House's.

Mastoid Gouge (Jenkin's)

- Mastoid gouge is used for removal of bone overlying mastoid antrum in mastoidectomy operation, Caldwell-Luc (CWL) operation and removal of osteoma.
- Caldwell-Luc removes sleeves of bone and is held at acute angle to the surface of bone and bone is cut from behind forward and above downwards. If it slips, may cause injury to dura, sinus and facial nerve. Hammer used is Godler's mallet which weighs 28 to 30 oz. Now, this instrument is not used and has been replaced by electric burr machine (**Figure 83.5**).

> Remember osteotome is beveled on both sides, a chisel is beveled on one side only and a mastoid gouge is beveled on one side with a curved edge.

Macewen's Scoop with Cell Seeker (Sir William Macewen of Glasgow 1848-1924)

Macewen's scoop with cell seeker is useful in mastoid surgery to scoop various cells and intervening septa and also to confirm the aditus ad antrum. Drawback is that it may dislocate the incus (**Figure 83.6**).

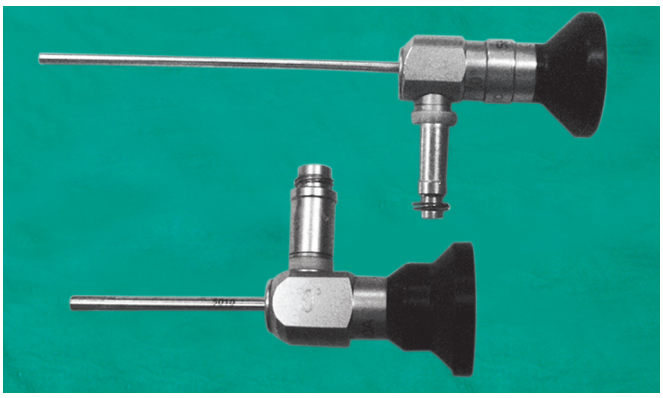


Figure 83.1 Otoendoscopes

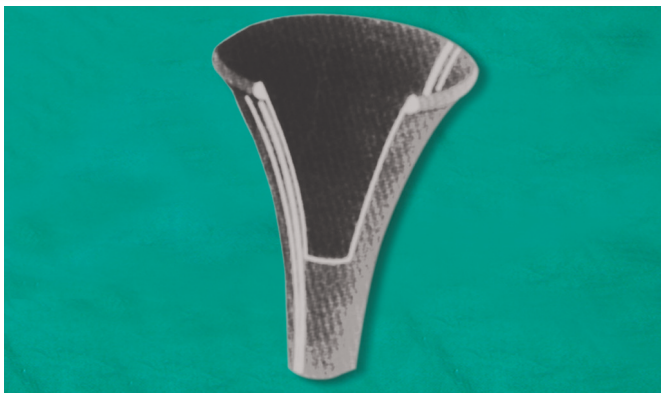


Figure 83.2 Ear speculum with cut

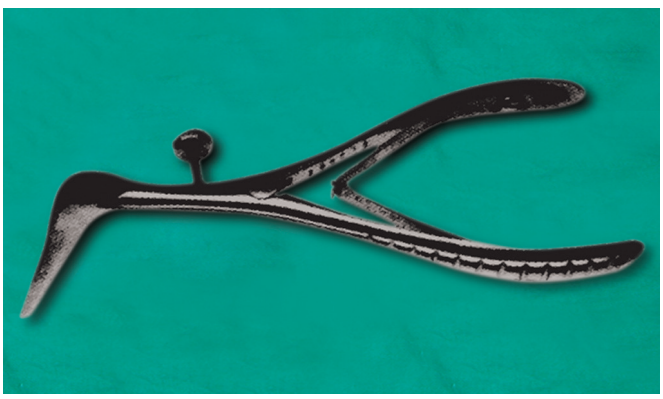


Figure 83.3 Ear speculum with handle

Figure 83.4 Mollison's retractor

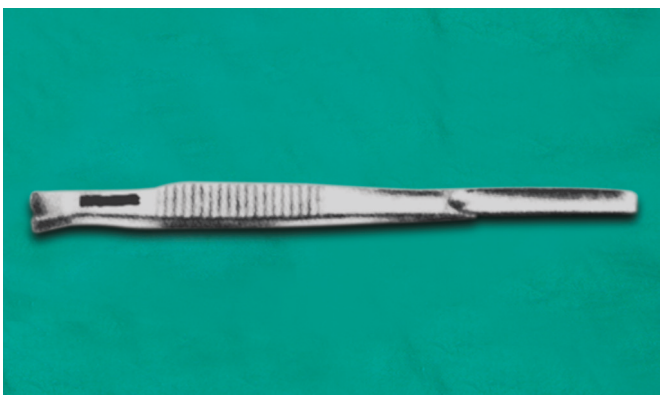


Figure 83.5 Mastoid gouge

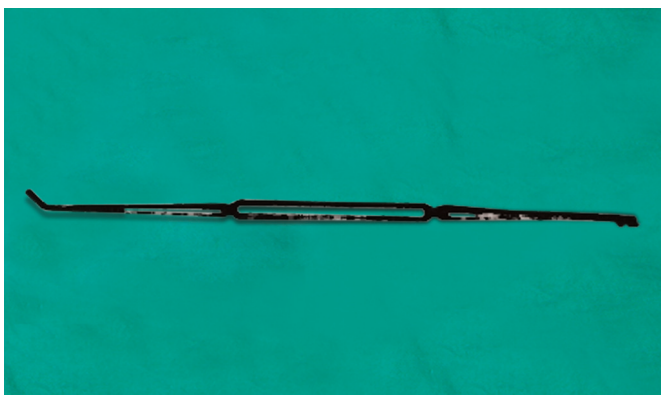


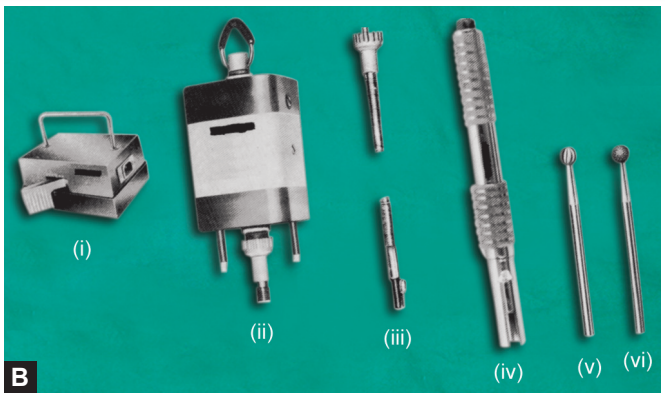
Figure 83.6 Macewen's scoop with cell seeker

Lempert's Mastoid Curette

Useful for removal of granulation tissue and diseased cells in mastoidectomy, ethmoidectomy, stapes surgery and CWL operations (**Figure 83.7A**).

Hanging Motor Complete/Electric Drill

Hanging motor is an electric motor with various parts, very useful for drilling bone and diseased cells in mastoidectomy, removal of osteoma, for drilling posterior canal wall to



Figures 83.7A and B (A) Lempert's mastoid curette; (B) Hanging motor or electric drill machine
(i) Foot handle;(ii) Motor; (iii) Cable; (iv) Handle; (v) Cutting burr; (vi) Polishing burr

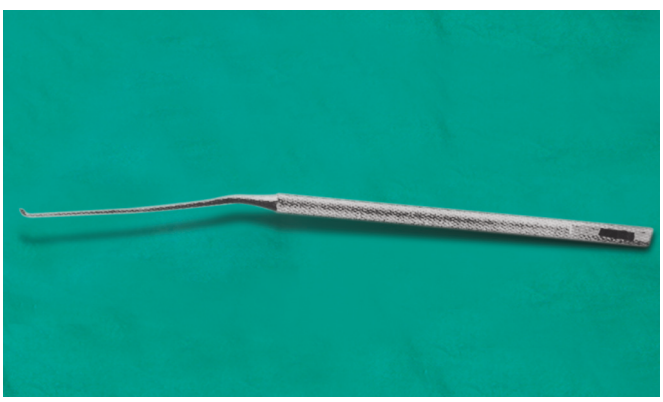


Figure 83.8 Circular knife

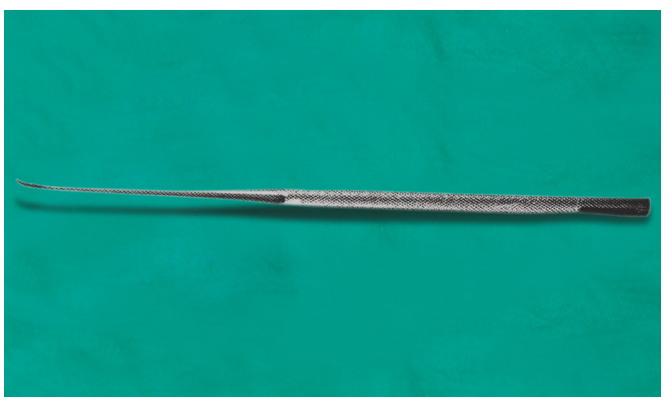


Figure 83.9 Myringotomy knife

expose footplate of stapes in stapedectomy and facial nerve decompression (**Figure 83.7B**).

It has been replaced by more sophisticated and compact electric drill with more resolution per minutes (RPMs).

Circular Knife

Circular knife is used to cut the deep meatal skin in cases of tympanoplasty and stapedectomy operations (**Figure 83.8**).

Myringotomy Knife

- Myringotomy knife is used to give a cut in TM in secretory otitis media and acute suppurative otitis media (ASOM)
- This instrument is also used in uncinectomy operation in functional endoscopic sinus surgery (FESS) (**Figure 83.9**)
- In ASOM cut is given in posteroinferior segment
- In secretory OM cut is given in anteroinferior segment.

Fine Curette

Fine curette is used to curette the granulation tissue and diseased cells in the narrow crevices during mastoidectomy operation (**Figure 83.10**).

Bone Nibbler

Bone nibbler has been used to nibble the bone in mastoid surgery, but it has now been replaced by burr machine (**Figure 83.11**).

Bayonet Knife

Used in secretory otitis media and ASOM for giving incision in TM (**Figure 83.12**).

Fine Curette (House's)

House's fine curette works to curette granulation tissue and diseased cells in mastoidectomy operation on both ends

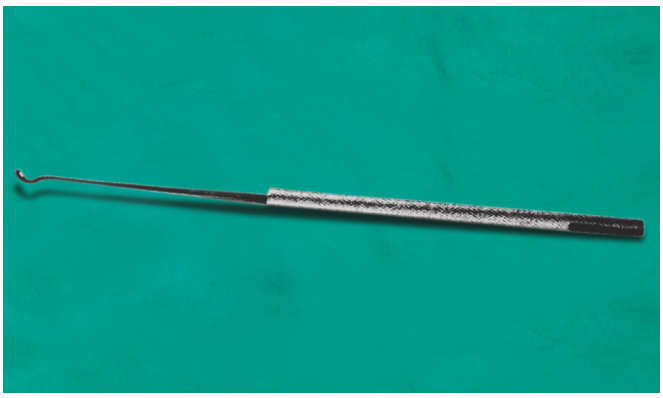


Figure 83.10 Fine curette

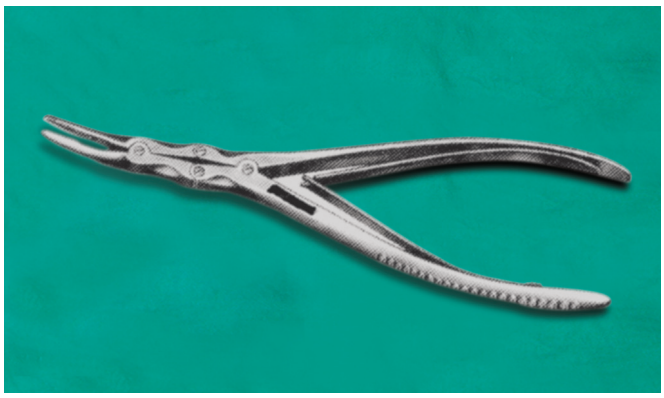


Figure 83.11 Bone nibbler

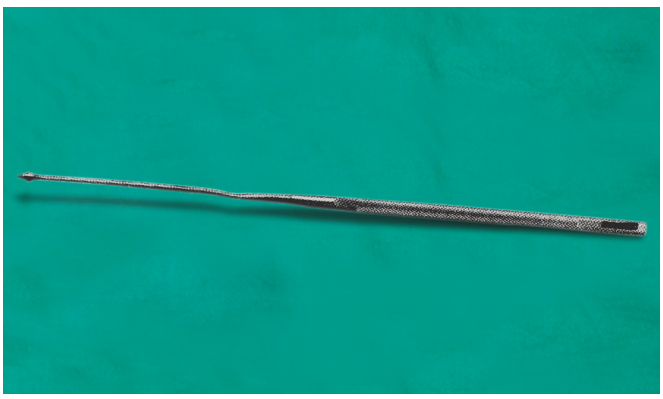


Figure 83.12 Bayonet knife

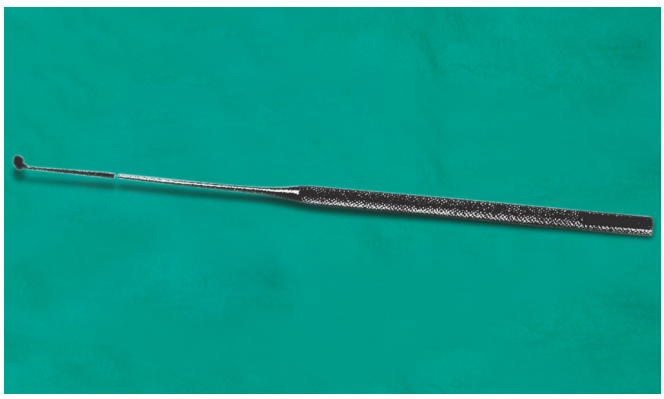


Figure 83.13 Fine curette (House's)

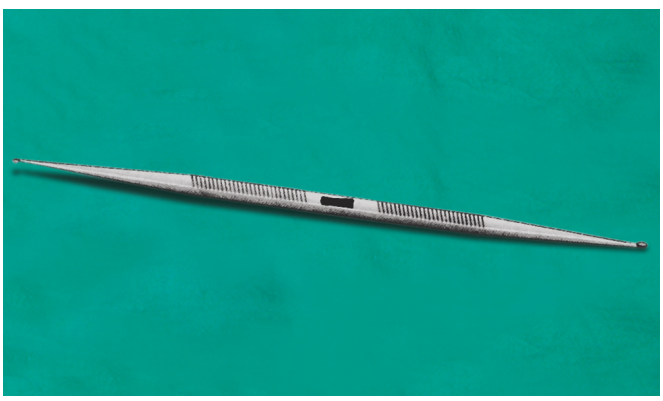


Figure 83.14 Double ended fine curette

(**Figure 83.13**). A similar action double ended fine curette is also shown in **Figure 83.14**.

Angled Fine Elevator

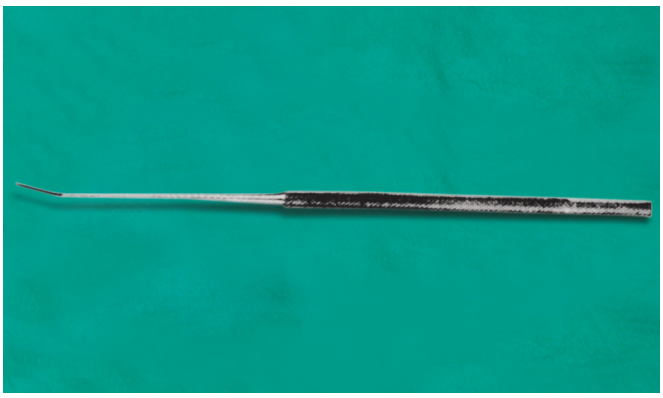
Angled fine elevator is used to lift the tympanomeatal flap from the annulus in cases of tympanoplasty and stapedectomy operations (**Figure 83.15**).

Straight Fine Elevator

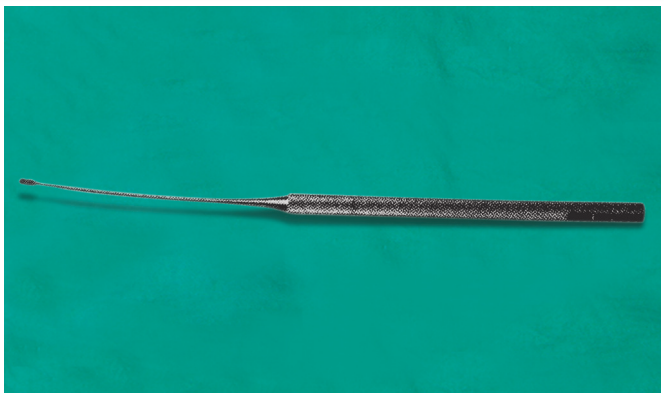
Straight fine elevator works same as fine curette (**Figure 83.16**).

Aural Snare (Ballance's)

- Aural snare is a small snare of cutting type used for aural polypectomy
- Polyp should not be avulsed as it may be attached to ossicles, labyrinth, facial nerve or drum remnant causing irreversible damage to these structures (**Figure 83.17A**).



Figures 83.15 Angled fine elevator



Figures 83.16 Straight fine elevator

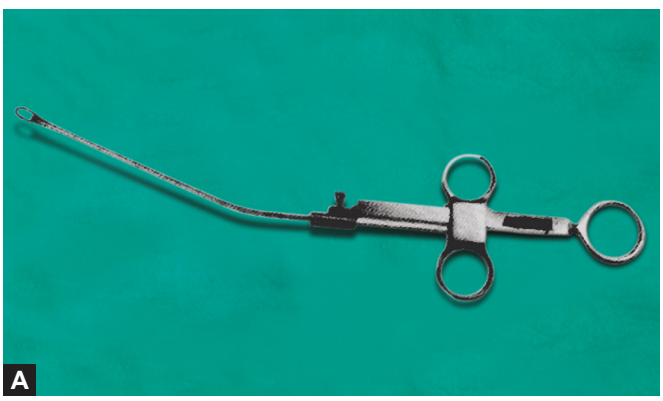


Figure 83.17A Aural snare

Figure 83.17B Crocodile fine forceps

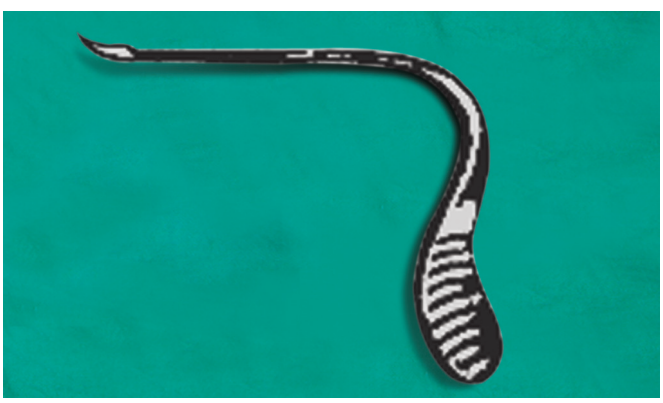


Figure 83.18 Zollner's knife

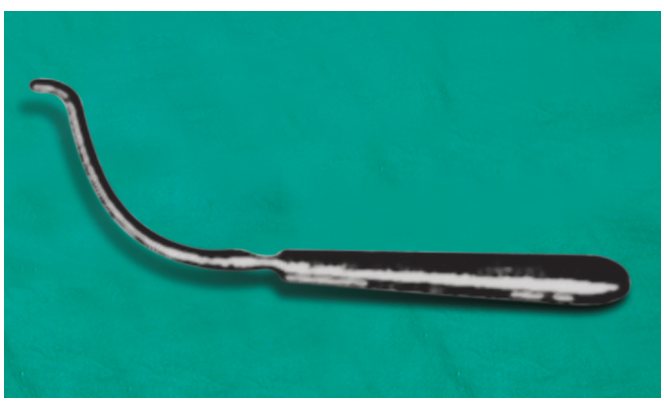


Figure 83.19 Stack's guide

Crocodile Fine Forceps

Crocodile fine forceps opens like the jaws of a crocodile and is used to remove the disease like granulations, cholesteatoma flakes in mastoidectomy operations and also in tympanoplasty and stapedectomy operations (**Figure 83.17B**).

Zollner's Knife

Zollner's knife is named after Zollner, a pioneer of tympanoplasty along with Wullstein. It is used to give cut in the deep meatal skin for making tympanomeatal flap and in stapedectomy operation (**Figure 83.18**).

Stack's Guide

Stack's guide also called facial nerve protector.

The tip of the instrument is kept in aditus before removing the bridge to protect the facial nerve and incus. It is not used these days because of better understanding of anatomy of facial nerve and refined techniques (**Figure 83.19**).

Key Points

1. **Mollison's self-retaining mastoid wound retractor** is used to retract the wound in operations like mastoidectomy; tympanoplasty. It also acts as a hemostat.
2. **Mastoid gouge (Jenkin)** is used for removal of bone overlying mastoid antrum in mastoidectomy operation, CWL operation and removal of osteoma.
3. **Myringotomy knife** used to give a cut in tympanic membrane in secretory otitis media and ASOM, and also in uncinectomy operation in FESS.
4. **Aural snare** is of cutting type used for aural polypectomy. Polyp should not be avulsed as it may be attached to ossicles, labyrinth and facial nerve.

Chapter 84 Nasal Surgery Instruments

What Students Must Know!

- **Nose Instruments**
  - Nasal Speculum with Handle
  - Luc's Forceps
  - Ballenger's Swivel Knife
  - Killian's Nasal Gouge
  - Tilley's Lichtwitz Antrum Trocar with Cannula
  - Antral Rasp
  - Antral Harpoon
  - Glegg's or Krause's Nasal Snare
  - Asch's Forceps
  - Walsham's Forceps
  - Sinuscope (Hopkins Nasal Endoscope)

NOSE INSTRUMENTS

Nasal Speculum with Handle

Killian speculum is a self-retaining type of speculum used for:

- Submucous resection (SMR)
- Septoplasty
- Polypectomy
- Anterior nasal packing.

It is useful in narrow nasal cavities for better exposure (**Figure 84.1**). The self retaining mechanism allows less strain on the surgeon while operating.

Long-bladed Nasal Speculum (St Clair-Thompson)

Long-bladed nasal speculum also gives better exposure due to long blades and is useful for all types of nasal surgeries (**Figure 84.2**). Being long bladed, it can only be used after anesthetizing the nasal cavity.

Raspatory (Killian's Elevator)

Raspatory is used for SMR operation to lift the muco-perichondrial and mucoperiosteal flaps. It is available both for left and right nasal cavities with a thumb rest on top. Concave surface of raspatory should be towards nasal septum to find the side of right or left raspatory (**Figure 84.3**).

Luc's Forceps

1. Luc's forceps is a cutting type of instrument with a screw type joint and blades are fenestrated and cup shaped with sharp edges to cut the tissues and is used in:
   - SMR, septoplasty
   - Caldwell-Luc (CWL)
   - Polypectomy
   - To remove adenoid tags
   - May be used to hold the tonsil or
   - To take a biopsy from growth.
2. It differs from tonsil holding forceps, which is of holding nature and has lower large ring over which lies the little smaller upper ring.
3. In Luc's forceps, both rings are of equal size and it is not as stout as the tonsil holding forceps (**Figure 84.4**).
4. Joints in both the instruments are also different.

Mucoperichondrium Double Ended Elevator (Freer)

Freer's elevator is used to lift mucoperichondrium and muco-periosteum in SMR, septoplasty and also in cleft palate repair (**Figure 84.5**).

Ballenger's Swivel Knife

- Swivel means rotation around an axis thus performing function of knife in every direction

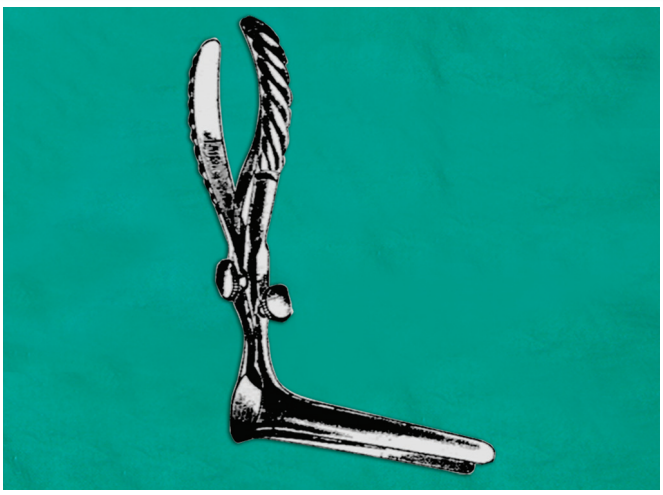


Figure 84.1 Killian's nasal speculum

Figure 84.2 Long-bladed nasal speculum

Figure 84.3 Raspatory

Figure 84.4 Luc's forceps

Figure 84.5 Mucoperichondrium elevator

Figure 84.6 Ballenger's swivel knife

- It cuts only cartilage in all directions in SMR and septoplasty operations
- The knife can rotate 360° around an axis between the two bars (**Figure 84.6**).

Killian's Nasal Gouge

Killian's nasal gouge is a fish tailed (bayonet shaped) nasal gouge used to remove spur of maxillary crest and palatine bone in SMR or septoplasty operations (**Figure 84.7**). Hammer used in SMR operation weighs 13 oz.

Tilley Lichtwitz Antrum Trocar with Cannula

- Tilley Lichtwitz antrum trocar is used for doing proof puncture through inferior meatus or through canine fossa in chronic maxillary sinusitis.
- It is not entered through the middle meatus due to risk of injury and scarring of natural ostium and more chances of injury to orbit.
- Direction of trocar should be towards the outer canthus of same eye to avoid complications (**Figure 84.8**).

Figure 84.7 Killian's nasal gouge

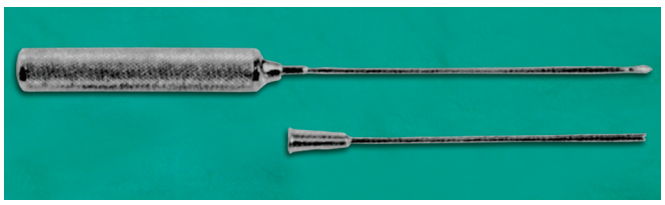


Figure 84.8 Tilley Lichtwitz's trocar with cannula

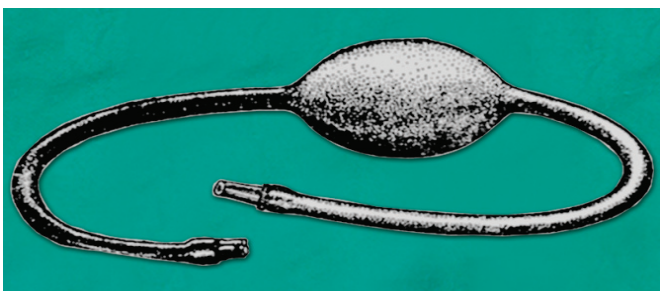


Figure 84.9 Higginson's syringe

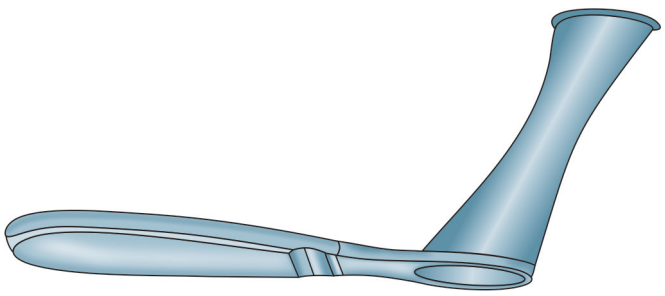


Figure 84.10 Nasopharyngeal speculum

Higginson's Syringe

Higginson's syringe is used to inject warm saline water at body temperature through the cannula to wash the maxillary antrum. Its capacity is 30 to 50 mL. Rubber balloon should not be compressed forcefully as it may lead to air embolism (**Figure 84.9**).

Nasopharyngeal Speculum

Yankauer's nasopharyngeal speculum is used to inspect or to take a biopsy from the nasopharynx after introducing through the oral cavity. All areas including eustachian tube can be visualized through it (**Figure 84.10**).

Antral Rasp and Myle's Nasoantral Perforator

Antral rasp and Myle nasoantral perforator is used for antrostomy through the inferior meatus. When it is withdrawn, it brings out bony chips along with it, making the opening regular. Antral rasp is used for smoothening the edges of hole made in the antral wall (**Figures 84.11A and B**).

Antral Burr (Tilley)

Antral burr is used to smoothen and enlarge the hole of antrostomy (**Figure 84.12**).

Antral Harpoon (Tilley)

Antral harpoon is also used to make opening in the inferior meatus (**Figure 84.13**).

Citelli's Bone Punch

Citelli's bone punch is used in CWL operation and antrostomy to widen the bony margins (**Figure 84.14**).

Glegg or Krause Nasal Snare

1. Nasal snare is of avulsion type used for removal of polypi along with cells of ethmoidal labyrinth.
2. Guage of the wire is 30 Fr.
3. It is not used commonly, instead Luc's or tonsil holding forceps in used to remove the multiple polypi (**Figure 84.15**).
4. Microdebrider is the latest addition to the management of nasal polypi.

Asch's Forceps

Asch's forceps is used to treat fractures of nasal septum in cases of frontal injuries to nose. It is similar to Walsham's forceps except that its beak is bent laterally and is longer (**Figure 84.16**). Both the blades are inserted on either side of the septum to elevate and straighten it.

Walsham's Forceps

Walsham's forceps has a beaked tip. It is used to disimpact and reduce the nasal bone fractures due to lateral injury in which one nasal bone gets impacted under the other and also in rhinoplasty operation (**Figure 84.17**). The larger blade covered with a rubber guard is kept in the skin of the nose and the other blade is introduced into the cavity just under the nasal bones.

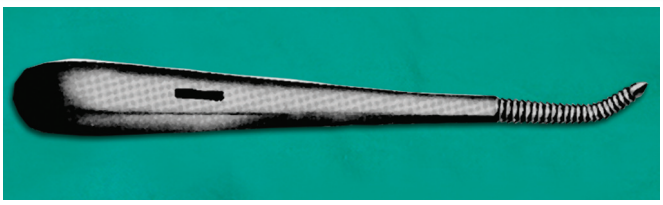


Figure 84.11A Antral rasp

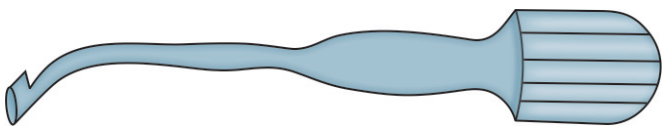


Figure 84.11B Nasoantral perforator

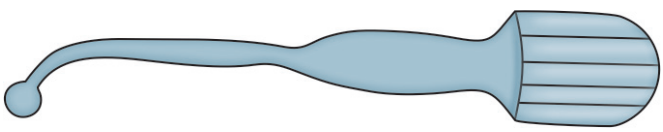


Figure 84.12 Antral Burr

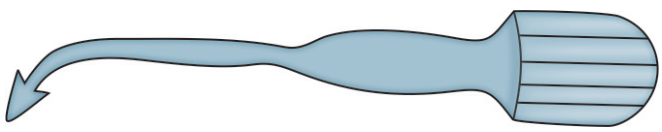


Figure 84.13 Antral Harpoon

Figure 84.14 Citelli's bone punch

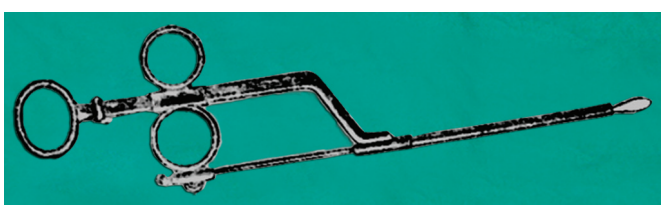


Figure 84.15 Glegg's nasal snare

Figure 84.16 Asch's forceps

Figure 84.17 Walsham forceps

Sinuscope (Hopkins Nasal Endoscope)

1. Sinuscope is used for doing diagnostic or functional endoscopic sinus surgery (DESS or FESS) in cases of:
   - Chronic sinusitis
   - Nasal polypi
   - Cerebrospinal fluid (CSF) rhinorrhea.
2. It is also available in 30°, 45° and 70° and these degrees indicate the angle of lens.
3. It does not provide any magnification, but only very good illumination of areas (**Figure 84.18**).
4. The outer diameter of the adult size is 4 mm and of the child size is 2.7 mm.
5. Illumination is by a 481 C miniature light source and 610 xenon light for photo documentation.

Sickle Knife

Sickle knife is used to give incision for doing uncinectomy in chronic maxillary sinusitis, opening up a concha bullosa or for removing a spur with endoscope (**Figure 84.19**).

Weil Blakesley's Straight Forceps

Used in functional endoscopic sinus surgery (FESS) to remove various diseased ethmoidal cells, polypi and uncinate process (**Figure 84.20**).

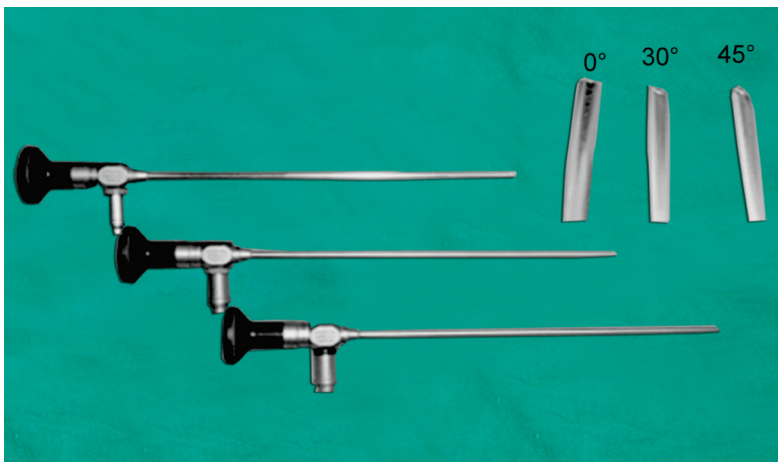


Figure 84.18 Hopkins sinuscope

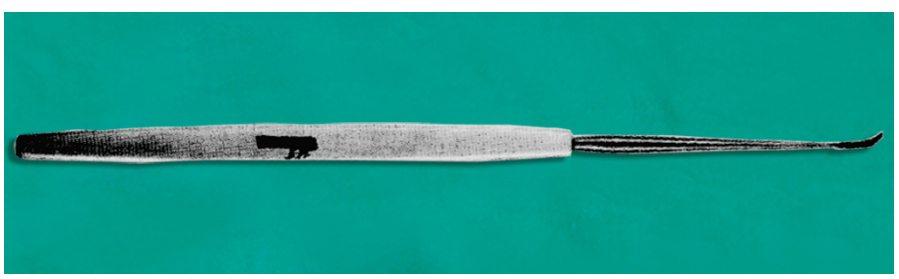


Figure 84.19 Sickle knife

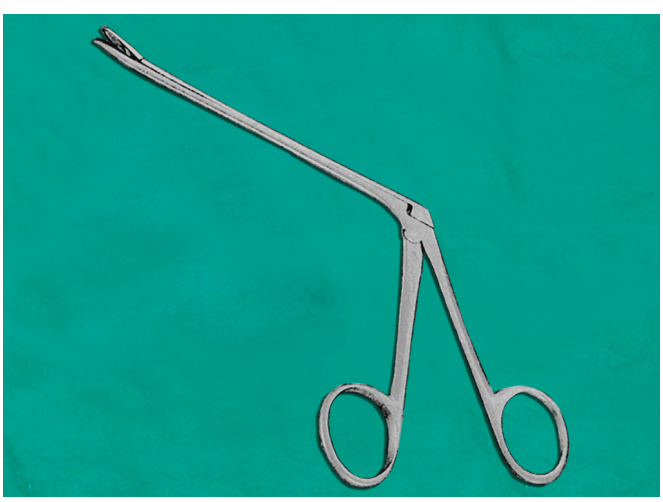


Figure 84.20 Weil Blakesley's straight forceps

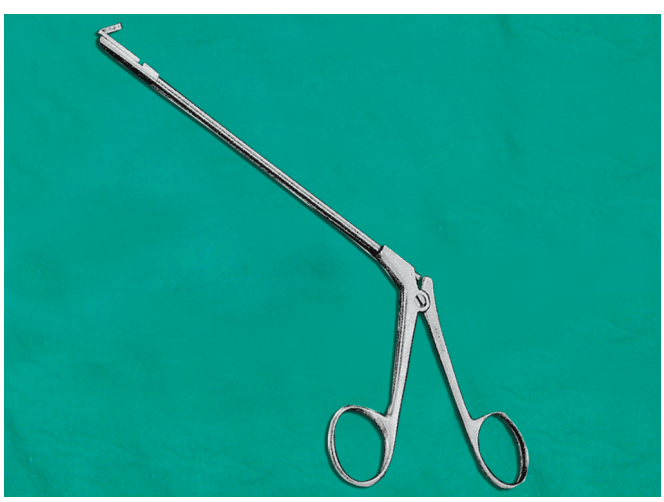


Figure 84.21 Blakesley's angled forceps

Weil Blakesley's Angled Forceps

Used in functional endoscopic sinus surgery (FESS) for approaching deeper areas to remove diseased tissue (**Figure 84.21**).

Microdebrider

Microdebrider is used for removal of soft tissue like polyps and not the bone tissue. It consists of a power unit, foot switch, handpiece and disposable blades.

Key Points

1. **Luc's forceps** is a cutting type of instrument with a screw type joint and blades are fenestrated and cup shaped used in SMR, septoplasty, CWL,polypectomy.
2. **Ballenger's swivel knife** cuts only cartilage in all directions in SMR and septoplasty operations.The knife can rotate 360° around an axis between the two bars.
3. **Tilley's Lichtwitz antrum trocar with cannula** is used for doing proof puncture through inferior meatus or through canine fossa in chronic maxillary sinusitis.
4. **Higginson's syringe** is used to wash the maxillary antrum. Its capacity is 30 to 50 mL.
5. **Glegg's or Krause's nasal snare** is of avulsion type used for removal of polypi along with cells of ethmoidal labyrinth. Guage of the wire is 30 **FrIt**.
6. **Asch's forceps** is used to treat fractures of nasal septum in cases of injuries to nose.
7. **Walsham's forceps** has a beaked tip used to disimpact and reduce the nasal bone fractures and also in rhinoplasty operation.
8. **Sinuscope (Hopkins nasal endoscope)** is used for doing diagnostic or functional endoscopic sinus surgery in chronic sinusitis, nasal polypi and CSF rhinorrhea.

Chapter 85 Throat Surgery Instruments

What Students Must Know!

❖ **Instruments Used in Throat Surgery**
- Boyle-Davis Mouth Gag
- Denis Browne's Tonsil Holding Forceps
- Negus Knot Tier and Thread Adjuster
- Eve's Tonsillar Snare
- Jenning's Mouth Gag
- Doyen's Mouth Gag
- Quinsy Knife
- Ballenger's Tonsillar Guillotine
- Adenoid Curette with Guard

INSTRUMENTS USED IN THROAT SURGERY

Boyle-Davis Mouth Gag with Tongue Depressor Blade

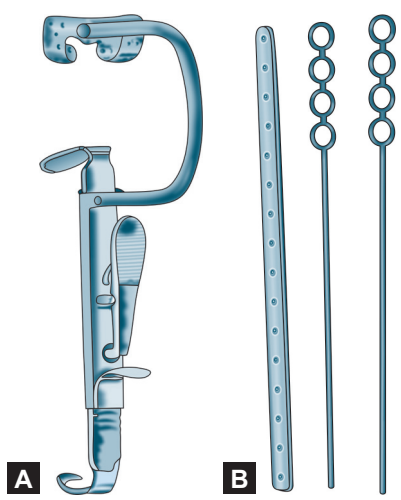
1. The part, which retracts the tongue blade is called Boyle's and the fixed part or jaw piece, which rests on the teeth of patient is called Davis gag.
2. It is used for opening mouth in:
   - Tonsillectomy
   - Adenoidectomy
   - Cleft palate
   - Pharyngoplasty uvulopalatopharyngoplasty (UPPP)
   - Oral approach for antro-choanal polyp and angio-fibroma (**Figure 85.1A**).
3. Other mouth gags are:
   - Doyen's mouth gag
   - Jening's mouth gag: Advantage of this mouth gag over Doyen's mouth gag is that it can be used in edentulous patients.
   - Mcivor's mouth gag.

Draffin Bipod

Draffin bipod is used to hold the Boyle-Davis mouth gag in place. Two rings of bipod are brought in apposition and made to stand on the sides of the chest and curved tip of mouth gag is passed thru the both opposed rings (**Figure 85.1B**).

Denis Browne Tonsil Holding Forceps

- Denis Browne is used to hold the tonsil in tonsillectomy operation and may also be used in nasal polypectomy
- It should not be confused with Luc forceps where as
  - Luc's forceps has a screw joint
  - Blades are fenestrated and cup like and sharp edges for cutting.



Figures 85.1A and B (A) Boyle-Davis mouth gag; (B) Draffin's bipod

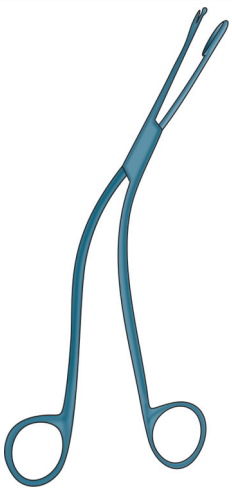


Figure 85.2 Tonsil holding forceps

Figure 85.3 Anterior pillar retractor

Figure 85.4 Negus knot tier

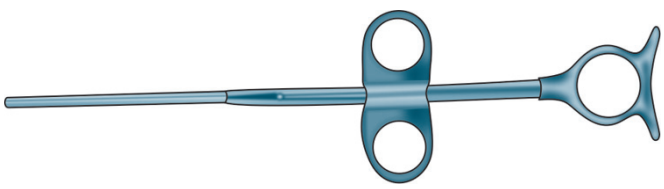


Figure 85.5 Eve's tonsillar snare

- Tonsil holding has an alligator type of joint and forceps does not have sharp jaws and small upper jaw sits in large lower jaw (**Figure 85.2**).

Mollison's Anterior Pillar Retractor with Blunt Dissector

Dissector part is used to separate the tonsil from its bed in tonsillectomy by dissection method. Retractor is used to retract anterior pillar for seeing any bleeding vessel for ligature (**Figure 85.3**).

Negus Knot Tier and Thread Adjuster

It is used to ligate or tie the knot after adjusting the thread over the curved artery forceps after tonsillectomy operation. Forked blunt ends help to slip the ligature downward on the bleeding vessel (**Figure 85.4**).

Eve's Tonsillar Snare (Dr Curtis C Eves 1910)

- The snare is of crushing and cutting type for achieving hemostasis at the lower pole of tonsil
- It crushes the pedicle of lingual tonsil along with lingual blood vessels. Thus choking the blood supply and releasing tissue thromboplastin helping in blood coagulation
- If it is not available or the wire breaks, the pedicle can be crushed with a long artery forceps
- The wire in the snare is 18 to 27 gauge stainless steel and loop of the wire withdraws completely inside the snare (**Figure 85.5**)
- Piano wire may be used in tonsillar snare.

Straight Artery Forceps (Birkett's)

Straight artery forceps is used for catching the bleeding vessel after tonsillectomy operation to achieve hemostasis. It may be used in general surgery for similar purposes (**Figure 85.6**).

Jenning's Mouth Gag

Jenning mouth gag is useful in edentulous patients because the blades rest on alveolar margins. It is used in tonsillectomy, adenoidectomy, pharyngoplasty or other operations in oral cavity (**Figure 85.7**).

Doyen's Mouth Gag

Used for surgery in oral cavity and oropharynx. It can be used only in dentulous patients as the blades rest only on teeth (**Figure 85.8**).

Quinsy Knife (St Clair-Thompson) or Quinsy Forceps

Quinsy knife can be used for draining peritonsillar abscess. Sharp tip is entered with closed blades and opened after entering the abscess (**Figure 85.9**). Shoulder prevents deep entry of sharp blades in the tissues.

Ballenger's Tonsillar Guillotine

1. The word Guillotine was derived from a mechanism, which was used to chop off the neck of prisoners of French revolution.
2. It is not used these days because disadvantages are that fibrosed tonsils cannot be removed, incomplete removal is common and it is difficult to achieve hemostasis (**Figure 85.10**).

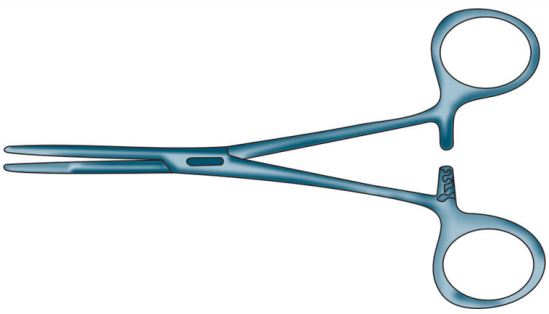


Figure 85.6 Straight artery forceps

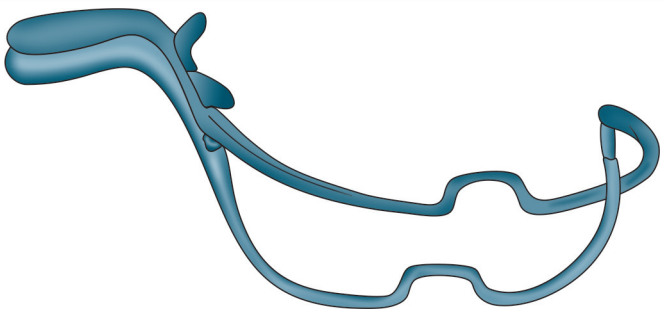


Figure 85.7 Jennings mouth gag

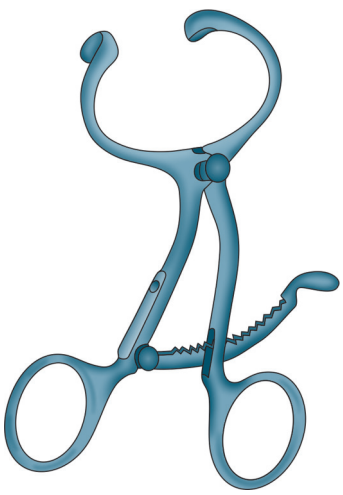


Figure 85.8 Doyen mouth gag

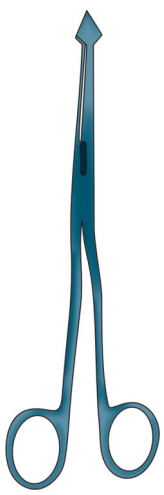


Figure 85.9 Quinsy knife

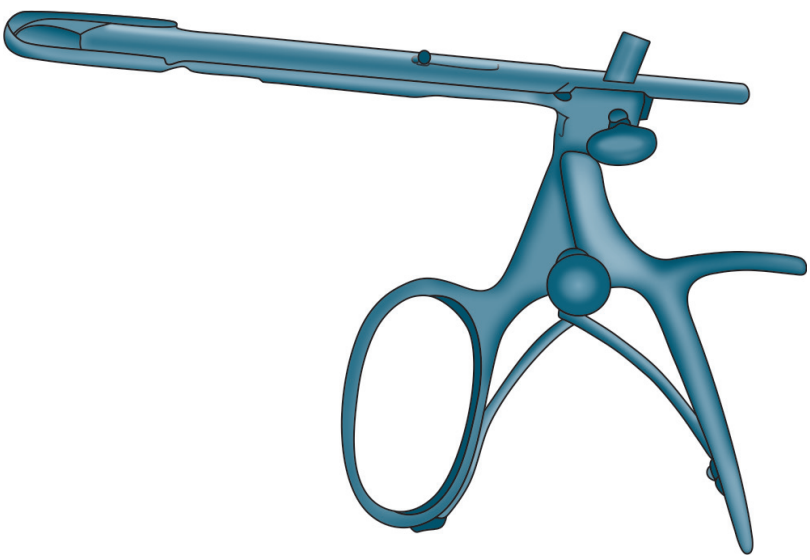


Figure 85.10 Tonsillar guillotine

Tonsillar Fossa Compression Forceps (Yorke's)

Tonsillar fossa compression forceps is used to control secondary hemorrhage. The flat blade rests outside on the mandible, while circular part presses the gauze pad in the tonsillar fossa. It should be kept for about 15 to 20 minutes (**Figure 85.11**).

Curved Artery Forceps

Curved artery forceps is used for achieving hemostasis after the bleeding vessel has been caught with a straight artery (**Figure 85.12**).

Adenoid Curette with Guard (St Clair-Thomson)

- It is used to shave off the adenoid mass in the nasopharynx
- It has a sharp straight blade with a cage and fangs so as to stop pieces of adenoids from slipping downwards
- It is held like a dagger holding position
- Movement, which is given is downward and forward shaving movement
- The guard is detachable and its function is to hold the adenoid mass thus preventing it from falling into nasopharynx and hypopharynx forming a foreign body (**Figure 85.13**).

Adenoid Curette without Guard

1. Adenoid curette without guard is used to remove the left out adenoid mass, since it is blunt, hence causes less trauma in the nasopharynx (**Figure 85.14**).
2. Also used to remove adenoid tissue close to eustachian tube opening. Available in 8,10,12,14,16 and 18 mm blade size.

Adenotome

Adenotome is also used for the removal of adenoids, but now it has been replaced by adenoid curette with guard (**Figure 85.15**).

Yankauer's Oropharyngeal Suction Cannula

Oropharyngeal suction cannula is used for suction in the throat during tonsillectomy, adenoidectomy or pharyngoplasty operation. It has a long length and is bent, hence surgeon's view is not obstructed (**Figure 85.16**).

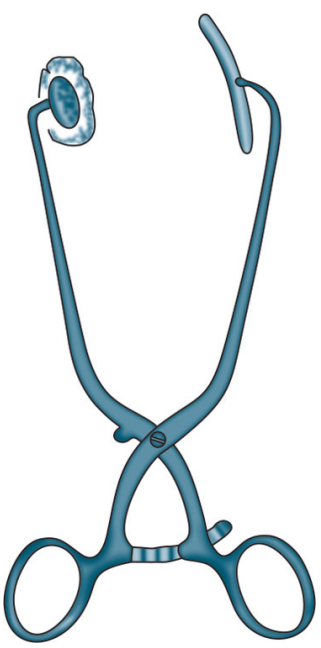


Figure 85.11 Tonsillar fossa compression forceps

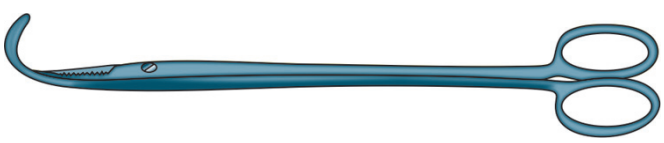


Figure 85.12 Curved artery forceps

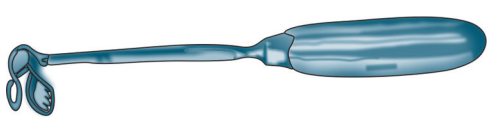


Figure 85.13 Adenoid curette with guard

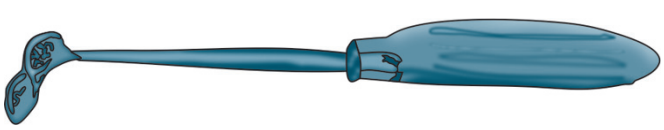


Figure 85.14 Adenoid curette without guard

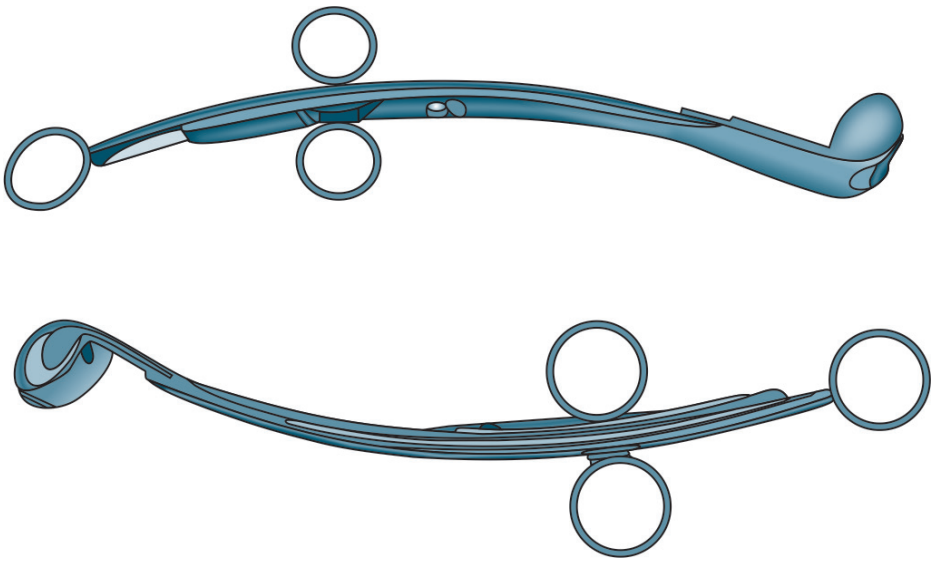


Figure 85.15 Adenotome

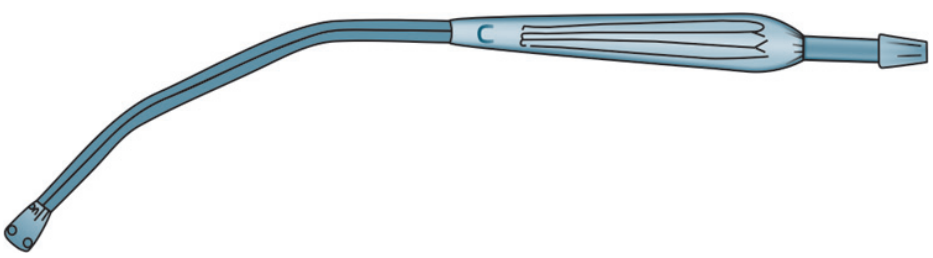


Figure 85.16 Oropharyngeal suction cannula

Key Points

1. **Boyle-Davis mouth gag with tongue** depressor blade—the part which retracts the tongue is called Boyle's blade and the fixed part or jaw piece which rests on the teeth of patient is called **Davis gag**.
2. **Denis Browne's tonsil holding** should not be confused with Luc's forceps where as it has a screw joint, blades are fenestrated and cup like and sharp edges.
3. **Eve's tonsillar snare** is of crushing and cutting type the wire in the snare is 18-27 gauge stainless steel.
4. **Ballenger's tonsillar guillotine** - word guillotine was derived from a mechanism which was used to chop off the neck of prisoners of **French Revolution**.
5. **Adenoid curette with guard (St. Clair-Thomson)** is held like a dagger holding position with downward and forward shaving movement.
6. **Adenoid curette without guard** is used to remove the left out adenoid mass, to remove adenoid tissue close to eustachian tube opening.

Chapter 86 Endoscopic Instruments

What Students Must Know!

- **Endoscopic Instruments**
  - Chevalier Jackson Laryngoscope
  - Anterior Commissure Laryngoscope
  - Rigid 90° Endo Laryngoscope
  - Hypopharyngoscope
  - Fibre Optic Flexible Hypopharyngoscope
  - Chevalier Jackson Bronchoscope
  - Esophagoscope

ENDOSCOPIC INSTRUMENTS

Chevalier Jackson Laryngoscope

- It is used for direct laryngoscopy (**Figure 86.1**) for diagnostic as well as therapeutic purposes.

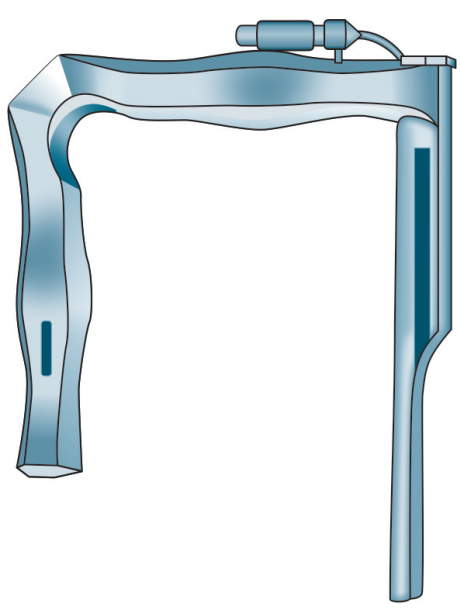


Figure 86.1 Laryngoscope

- It has better illumination due to presence of light sensor at distal end. This gives a less bright light and there may be fogging due to secretions. It is narrow so easy to insert.
- It is mainly useful for:
  - Localization and removal of foreign body
  - To see the site and extent of growth
  - To take a biopsy
  - To remove a benign lesion.

Anterior Commissure Laryngoscope

It is used for direct laryngoscopy especially to see blind or hidden areas of larynx such as anterior commissure, subglottis and laryngeal ventricles (**Figure 86.2A**).

Rigid 90° Endolaryngoscope

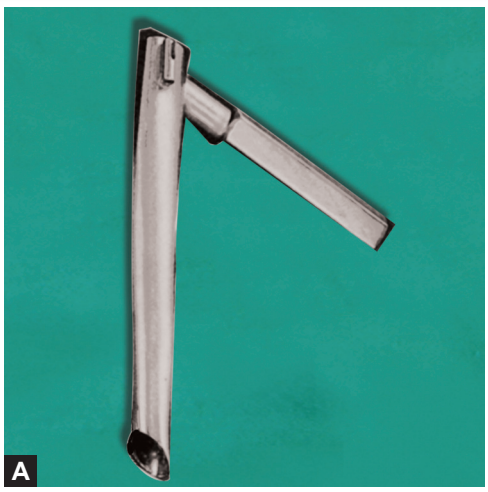
It is excellent aid for visualization of larynx for diagnostic, therapeutic and teaching purposes (**Figure 86.2B**).

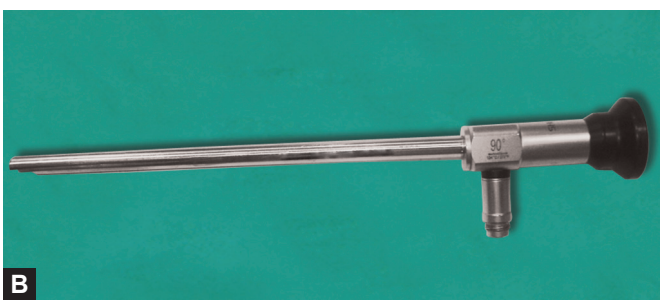
Light Source

It gives light which is picked up by fiberoptic cable and is delivered to endoscope through a light carrier (**Figure 86.3**).

Negus Laryngoscope

This laryngoscope has proximal twin lighting system, which gives a bright light and clear view so fogging is unlikely. It is





Figures 86.2A and B (A) Anterior commissure laryngoscope; (B) Rigid 90° endolaryngoscope

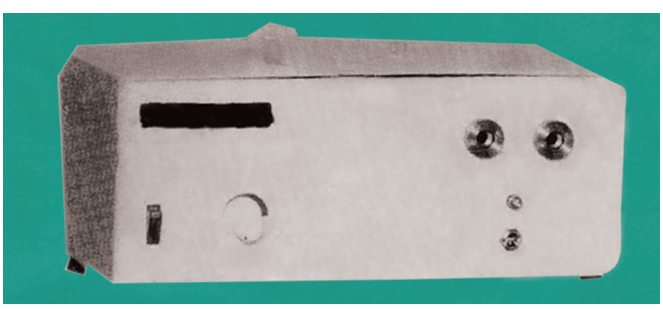


Figure 86.3 Light source

broader, so it gives a better view, but is bulky and difficult to sterilize (**Figure 86.4**).

Microlaryngoscope or Kleinsasser Laryngoscope

- Kleinsasser suspension laryngoscope system is used best with an operating microscope with 400 mm lens.
- This procedure is called microlaryngoscopy.
- The instrument is of matte black finish to reduce glare and back reflection from microscope, has a broader lumen for better view and the suspension laryngoscope allows both hands of the surgeon to be free for using the instruments.

Figure 86.4 Negus laryngoscope

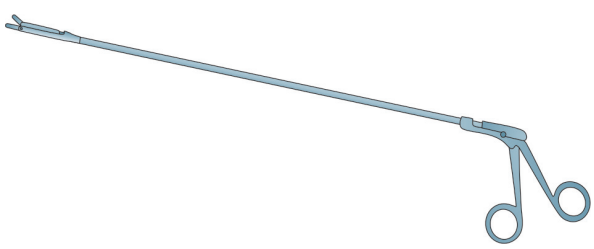


Figure 86.5 Laryngeal crocodile forceps

Laryngeal Crocodile Forceps

Laryngeal crocodile forceps is used to remove any foreign body or to take biopsy from hypopharynx (**Figure 86.5**).

Coin Holding Forceps

Coin holding forceps is used to remove the coin from the hypopharynx. Serrated edges of the instrument hold the coin firmly (**Figure 86.6**).

Hypopharyngoscope (Esophageal Speculum)

Hypopharyngoscope (esophageal speculum) is used to examine the hypopharynx and upper end of esophagus for therapeutic and diagnostic purposes (**Figure 86.7**).

Fiberoptic Flexible Hypopharyngoscope and Endoscopes

Fiberoptic hypopharyngoscope is a fiberoptic device to examine the upper and lower aerodigestive system. It gives

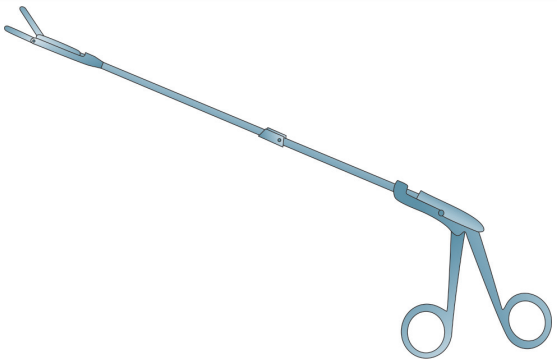


Figure 86.6 Coin holding forceps

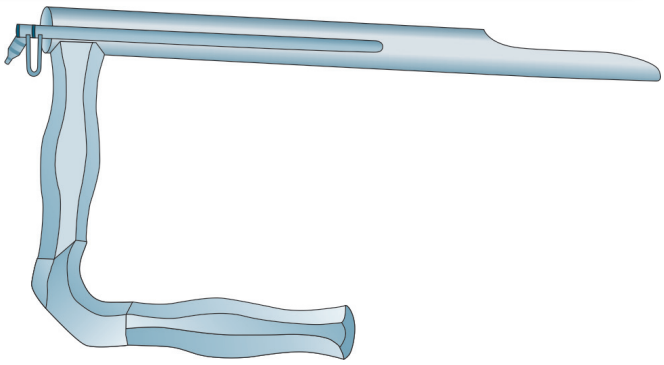


Figure 86.7 Hypopharyngoscope

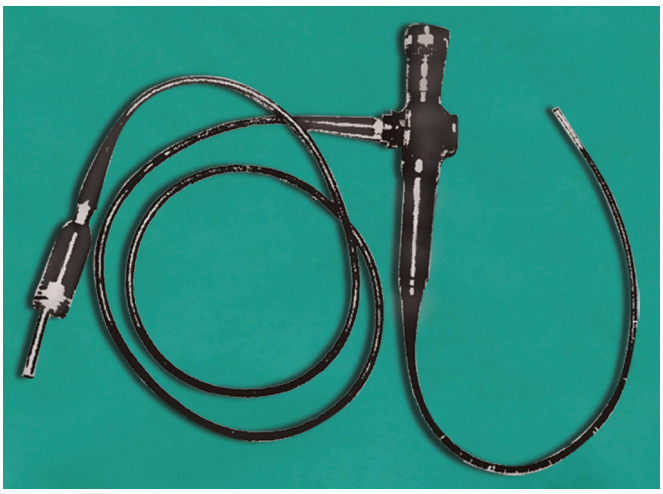


Figure 86.8 Fiberoptic hypopharyngoscope

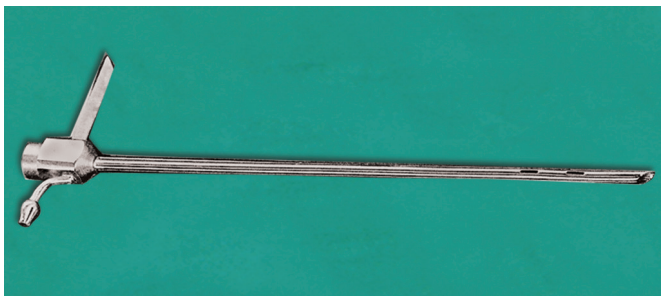


Figure 86.9 Bronchoscope

less discomfort to the patient as compared to rigid instruments (**Figure 86.8**).

Fiberoptic flexible endoscopes such as esophagoscpe and brochoscope are now widely used because these give no discomfort and procedure may be performed as an OPD procedure, but are very costly and very large foreign bodies cannot be removed.

Chevalier Jackson Bronchoscope

- It is a hollow rigid tube 40 to 45 cm with a bevelled end.
- Handle of the instrument is used for balancing and manipulating the bronchoscope during the procedure.
- It is used for examination of trachea and bronchi for diagnostic as well as therapeutic purposes.
- It differs from oesophagoscope by having two holes (vents) on each side of the bronchoscope for aeration of the other side bronchi when inserted into major bronchus by remaining above the carina level (**Figure 86.9**).
- Sizes available are adults 6.5, 7.5 and 8.5 mm pediatrics 2.4, 3.5 and 4.5 mm lumen size and length varies between 30 to 40 cm.
- A Negus type of bronchoscope with proximal illumination and flexible firberoptic bronchoscopes are also available.

Esophagoscope

- Esophagoscope is 40 to 45 cm long, rigid and hollow tube with diameter of 16 to 20 mm
- It is used for diagnostic as well as therapeutic purposes in suspected lesions of esophagus such as:
  - Taking a biopsy
  - To see extent of tumor
  - To remove benign lesions
  - Dilatation of stricture
  - Removal of foreign bodies.
- Two types are in use, Negus and Jackson.
- Negus has markings on it, tapers distally and has proximal

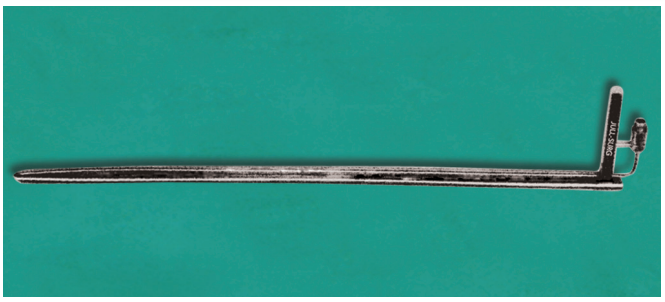


Figure 86.10 Esophagoscope

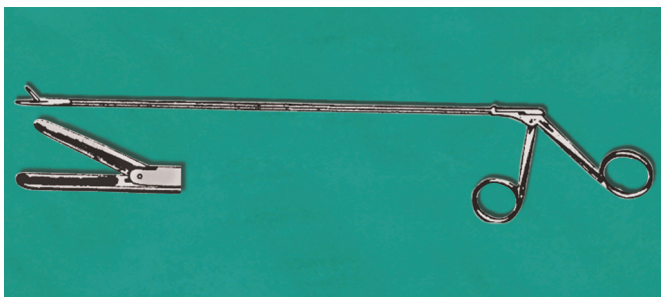


Figure 86.11 Long crocodile forcep

illumination, whereas Jackson type in contrast has distal illumination, not marked and does not taper distally (**Figure 86.10**).

- Since it does not have side holes and so in emergency a bronchoscope can be used for doing esophagoscopy, but oesophagoscope cannot be used for bronchoscopy.

Long Crocodile Forceps

Long crocodile forceps is used for taking biopsy or to remove foreign body from esophagus (**Figure 86.11**).

Key Points

1. **Chevalier Jackson laryngoscope** is used for direct laryngoscopy for localization and removal of foreign body and to see the site and extent of growth.
2. Rigid 90 degree endolaryngoscope is excellent aid for visualization of larynx for diagnostic, therapeutic and teaching purposes
3. **Chevalier Jackson Bronchoscope** is rigid tube of 40-45 cm length and differs from esophagoscope by having two holes (vents) on each side of the bronchoscope.
4. **Esophagoscope** is 40-45 cm long, rigid and hollow tube with diameter of 16-20 mm.
5. **Esophagoscope** does not have side holes and so in emergency a bronchoscope can be used for doing esophagoscopy but esophagoscope cannot be used for bronchoscopy.

Chapter 87 Tracheostomy Instruments

What Students Must Know!

- **Tracheostomy Instruments**
  - Chevalier Jackson's Tracheostomy Tube
  - Fuller's Bivalve Tracheostomy Tube
  - Portex Tracheostomy Tube
  - Tracheostomy Wound Dilator
  - Double Hook Retractor

INSTRUMENTS FOR TRACHEOSTOMY

Chevalier Jackson Metallic Tracheostomy Tube

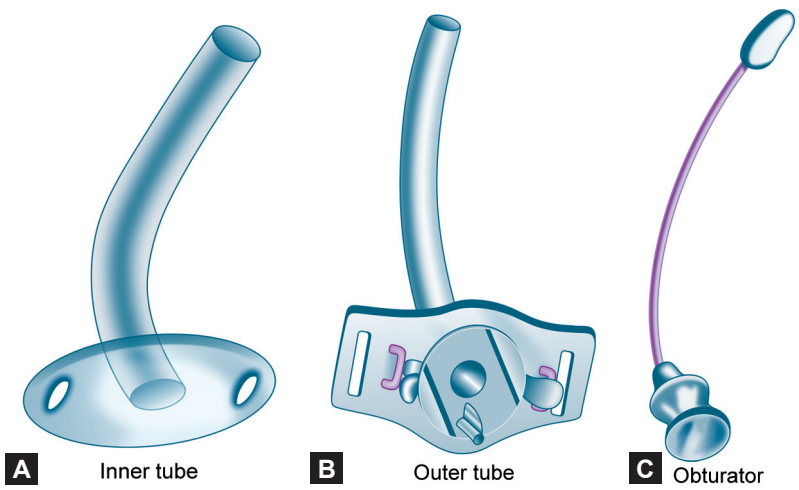
1. It has 3 parts:
   - An inner tube
   - An outer tube
   - An obturator.
2. Inner tube of Jackson tracheostomy tube is longer than outer tube (by 2–3 mm) and gets blocked by tracheobronchial secretions, which can be removed, cleaned and reinserted. when the inner tube is removed, the outer tube remains in place and so airway remains patent (**Figures 87.1A to C**).
3. Outer tube has a shield and lock for the inner tube.
4. Obturator, also called pilot or introducer has a blunt olive tip. It is used for non-traumatic insertion of tube as it converts the hollow of outer tube into a solid conical mass with the result introducing the tube into the hole made in the tracheal wall becomes easy.
5. It is made of German silver, (non irritant) which consists of Copper (60%), Zinc (20%) and Nickel (20%) –developed by a German scientist-EA Geitner in 19th century.
6. Only disadvantage of this tube is that, it cannot be used during radiotherapy as it may become radioactive by irradiation and byproducts of the metal may be toxic to the tissues and patient cannot phonate when the tube is in place.
7. A speaking valve can be used with the inner tube.
8. It is available from 8 to 44 sizes in only even numbers. Normal adult male size is 34 to 36 and in female size used is 32 to 34.

Fuller's Bivalve Tracheostomy Tube

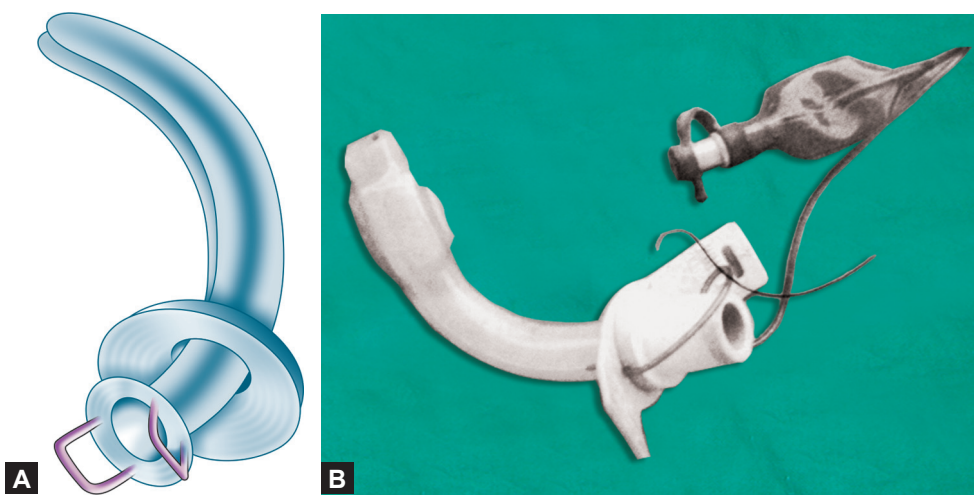
- Fuller's bivalve tracheostomy tube has two tubes—inner and outer
- The outer tube has two prongs for insertion into tracheostome, which are weak, may break and cause trauma, while inserting
- While, inner tube has a hole on the posterior wall for breathing or speaking purpose after closing the opening of tracheostomy tube with finger
- The opening also allows the use of normal passages and helps the patient to use normal passages during decannulation (**Figure 87.2A**)
- The hole also gives the patient a chance to breathe from the larynx when tube is blocked at its outer end
- It cannot be used during radiotherapy as it may become radioactive by irradiation.

Portex Tracheostomy Tube

- Portex tracheostomy tube may be cuffed (**Figure 87.2B**). Cuff is present in tubes of size more than 5.5 and the capacity of cuff is 2 to 3 cc of air. The cuff has a pilot bulb outside, to know if it is inflated and an obturator as a guide and Portex tube may be non-cuffed (**Figure 87.3**)
- It is made of non-irritable Portex material
- Also remember that Portex is the name of company
- It is the most commonly used tube in tracheostomy operation
- It has no inner tube. Thickness of the portex tube is 0.7 to 1.2 mm and sizes available are from 3 to 10 in increment of 0.5, Normal adult, male size is 9 or 10 and female size is 8 to 9



Figures 87.1A to C Chevalier Jackson's tracheostomy tube



Figures 87.2A and B (A) Bivalve tracheostomy tube; (B) Portex tracheostomy tube cuffed

- There is a blue line impregnated with barium to make the tube radiopaque
- It has advantages over other tubes like:
  - It is less irritant
  - Non-traumatic
  - The cuff when inflated prevents aspiration, keeps the tube *in situ* and allows positive pressure ventilation and general anesthesia
- Cuff must be deflated every 2 hours for 5 minutes to prevent tracheal damage
- Approximate size of tracheostomy tube can be calculated by the following formula:
  - Under 12 years of age = [(Age/ 4 + 4. 5) × 4] + 2
  - For more than 12 years = Adult male: size 30 to 38
  - Adult female = Size 34 to 38.

Tracheostomy Wound Dilator (Trousseau's)

Tracheostomy wound dilator is used when the tracheostomy tube is to be inserted. It opens up the tracheostomy wound for reinsertion of the tube (**Figure 87.4**). It resembles a curved artery forceps, but is stouter, with blunt tips without the catch and has cross action blades, which open the tip when opposed.

Double Hook Retractor

Double hook retractor is a blunt instrument used in tracheostomy operation to retract the soft tissue such as strap muscles, fascia, etc (**Figure 87.5**).

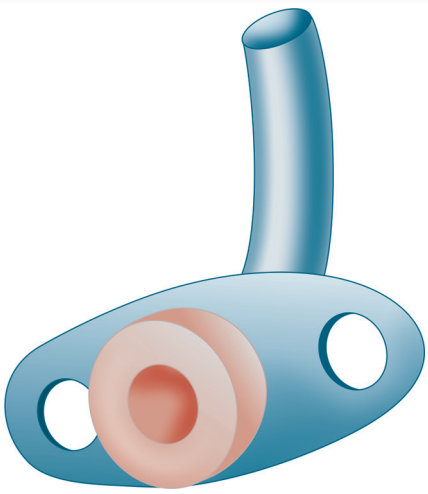


Figure 87.3 Tracheostomy tube–non-cuffed

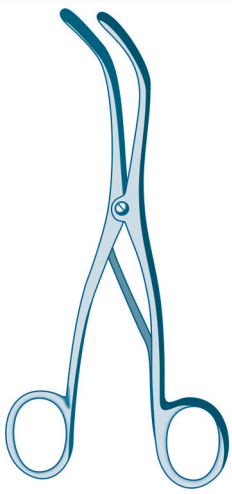


Figure 87.4 Tracheal wound dilator

Figure 87.5 Double hook retractor

Tracheal Hook (Single)

Tracheal hook may be sharp or blunt. The sharp hook retracts the cricoid cartilage to stabilize the trachea before incision and the blunt tracheal hook helps to retract the isthmus of the thyroid gland.

Key Points

1. **Chevalier Jackson's metallic tracheostomy** tube is made of German silver which is a mixture of copper, zinc and nickel.
2. Only **disadvantage of metallic tube** is that it cannot be used during radiotherapy.
3. **Metallic tube** is available from **8-44 sizes** in only even numbers.
4. Normal adult tube in **male size is 34-36** and in **female size is 32-34**.
5. **Fuller's bivalve tracheostomy tube** while, inner tube has a hole on the posterior wall for breathing or speaking purpose and cannot be used during radiotherapy.
6. **Portex tracheostomy tube** is a blue line in the cuff's impregnated with barium to make the tube radiopaque and advantages over other tubes — it can be used during radiotherapy.

Appendices

APPENDIX 1: CLINICAL METHODS

HOW TO PRESENT A LONG CASE?

Learn to see, hear, smell and feel that is what is clinical methods!

Biodata of Patient

- Name
- Age and sex
- Occupation
- Address

Chief Complaints with Duration

Symptom which occurred first must be recorded first.

1. _____
2. _____
3. _____

History of Presenting Illness

- Write down details of above chief complaints in patient's own words.
- Explore all the symptoms thoroughly, especially in relation to the duration, severity, progression, aggravation and relieving factors.
- Regarding any complaint, enquire about the severity, duration, type of onset, progression, whether the problem is unilateral or bilateral, known aggravating or suppressing factors, any treatment taken and its effects.
- Any other problem if present should be noted.
- Ask some leading questions to help you in making out a final diagnosis.
- Any treatment taken for the present ailment and the results of the treatment.
- Enquire specific problems pertaining to specific complaints besides above, such as in an ear case: These may be:

A. *Ear discharge:*
   - Nature and color of ear discharge
   - Consistency
   - Smell
   - Blood stained
   - Quantity (whether profuse or scanty)
   - Flow (continuous or intermittent)
   - Pulsatile discharge
   - Relation of discharge to seasons or upper respiratory catarrh
   - Effect of treatment on the discharge
   - Whether the discharge is associated with improvement in hearing or not
   - Any pain or discomfort associated with discharge.

B. *Hearing loss:*
   - Any history of trauma
   - Duration of hearing loss
   - Partial or complete unilateral or bilateral
   - Any operation
   - Drug intake
   - Amount of disability
   - Progression of hearing loss—whether slow or sudden onset
   - Any history of noise trauma
   - Whether associated with tinnitus or vertigo, drugs intake or septicemia.

C. *Vertigo:* History of trauma, drugs, associated features such as tinnitus and hearing loss, duration and frequency of vertigo, any relation to changes in posture.
D. *Tinnitus:* Type of sound whether hissing, whistling, escaping of steam, ringing of bells; whether continuous or intermittent; associated hypertension, diabetes, old age, trauma; unilateral or bilateral; severity of tinnitus so as to cause disturbances of sleep; any history of anxiety neurosis.
E. *Earache:* History of upper respiratory catarrh (URC), trauma, fever, swelling or some operation; unilateral or bilateral, severity—mild, moderate or severe; whether associated with any cause in the oral cavity, oropharynx and hypopharynx should be enquired (referred otalgia).
F. *Associated features* such as headache, vomiting facial nerve palsy, eye symptoms or any swelling around the ear must be recorded which indicates complications.

Similarly, details of the complaints regarding a nose and throat case such as nasal obstruction, discharge, sneezing, postnasal drip, headache, pain in the throat, cough, fever, change in voice, difficulty in swallowing or a mass in the neck should be enquired as given in the relevant chapters.

Past History

- History of similar problems in the past
- History of tuberculosis (TB), diabetes mellitus (DM), hypertension (HTN) or any infectious disease
- History of drug intake or trauma
- History of allergy to any medication
- History of any operation.

Family History

- History of similar complaints in the family
- History of TB, syphilis, bleeding disorder, malignancy, allergic disorder, DM or hypertension.

Personal Cum Social History

History of smoking, drinking, food habits and exact nature of work including his education and employment.

Examination of the Patient

- Before examination a good hello and a warm handshake serves to produce a lot of confidence between doctor and patient
- If the patient is a female it is ideal to examine in the presence of a female nurse or an attendant
- Also remember examination of the patient begins as soon as the patient enters clinic.

General Physical Examination

- Conscious, orientation to time, place and person
- Built and nourishment
- Anemia, jaundice, cyanosis, orodental hygiene
- Neck examination—trachea central, thyroid enlargement if any, jugular venous pressure (JVP), lymphadenopathy, if present is to be described in detail
- Pulse rate, regularity, volume and blood pressure
- Gait of the patient and nystagmus if present.

Systemic Examination

- Respiratory, cardiovascular system (CVS), abdomen and central nervous system (CNS) systems should be evaluated; and if any abnormality is present, it should be described in detail.
- Cranial nerves especially III, IV, VI, VII, and VIII should be described in detail.

Local Examination in an Ear Case

Pinna

a. *Inspection:* For size, shape, position; swelling, preauricular sinus, change in color; congenital abnormality like malformed pinna, if any; vesicles in concha; any operative scar on or around the pinna.
b. *Palpation:* For temperature rise; tenderness; tragus sign or circumduction sign; thickening of tissue; any fluctuation; swelling of pinna, if any needs to be described.

Preauricular and Postauricular Region

a. *Inspection:* Any swelling; sinus; scar mark; fistula.
b. *Palpation:* Tenderness over mastoid or cymba concha, postauricular sulcus (shallow or full), tip of mastoid to be palpated for tenderness.

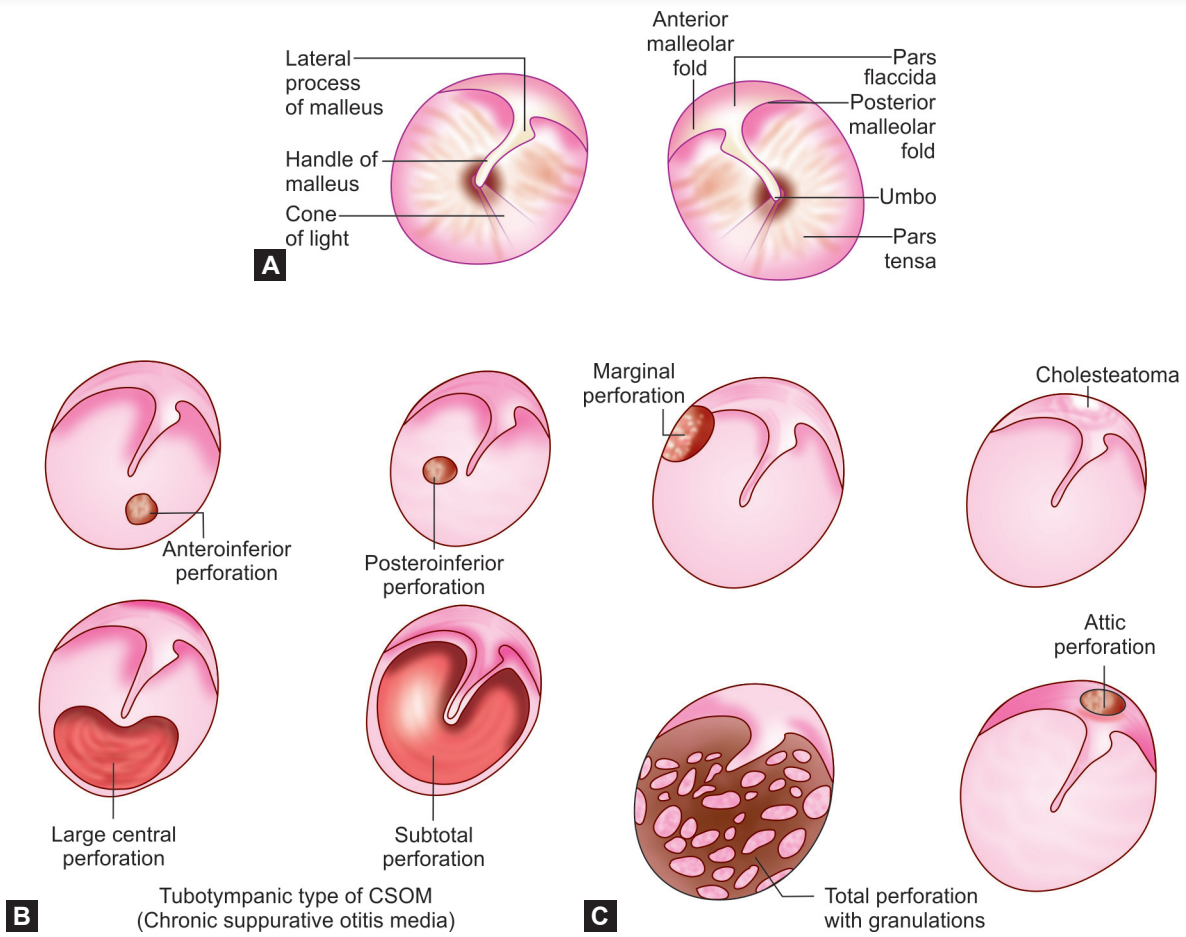
External Auditory Meatus (With or Without Speculum)

- *Size of meatus:* Narrow/wide or stenosed
- *Contents of meatus:* Wax/debris; discharge; foreign body or polypoidal mass
- *Walls of meatus:* Swelling; sagging of posterior meatal wall if present, to be described in details
- Tympanic membrane
- Color, position; mobility; surface; retraction/bulge; tympanosclerotic patches or any perforation
- *Perforation:*
  - Site, size, shape
  - Central/marginal, quadrant involved
  - Whether oval, round or kidney-shaped
  - Subtotal or total
  - Single or multiple
  - Dry or wet, margins of perforation (**Figures A-1A to C**)
  - Condition of middle ear structures if visible through a large central perforation, i.e. ossicles, whether necrosed or completely normal; handle of malleus; incus and its joint with stapes if seen
  - Mucosa over the promontory whether normal, congested or polypoidal
  - Polyp whether pale or red, probe test, bleeds on touch, facial twitching or vertigo on probing
  - Oval (size 3.25 × 1.75)/and round window (1.5 × 1.3) if visible
  - Opening of eustachian tube; any polyp; granulation tissue or cholesteatoma
  - Condition of rest of pars tensa and pars flaccida
  - Mobility of tympanic membrane (TM) if there is no perforation.
- Facial nerve
- Any loss of nasolabial fold; creases of forehead; closure of eyelids; showing of teeth and deviation of angle of mouth be specifically mentioned.

Functional Tests in an Ear Case

Auditory Functions

- *Finger snapping test:* Positive or negative
- *Speech test:* Normal whisper heard at 6 meters
  - Normal conversation heard at 12 meters
  - Mild loss—Whisper not heard (26–40 Hz)
  - Moderate loss—Conversation not heard (41–70 Hz)
  - Severe loss—Clapping not heard (71–90 Hz)
  - Profound—Shouting is just heard (> 90 Hz)
  - Total loss—Even shouting not heard.



Figures A-1A to C (A) Normal tympanic membranes; (B) Tubotympanic type of pathology (safe ear); (C) Atticoantral type of pathology (unsafe ear)

- *Tuning fork tests:*
  1. *Rinne's test:* (with 256/512/1024/2048 Hz)
     - — Negative means bone conduction (BC) is greater than air conduction (AC)
     - — Positive means AC is greater than BC
     - — False negative Rinne is seen in unilateral sensorineural hearing loss (SNHL).
  2. *Weber test:*
     - — Lateralized to worse ear: In conductive loss
     - — Lateralized to better ear: Sensorineural deafness
  3. *Schwabach test:* Bone conduction of patient lengthened in conductive deafness and shortened in SNHL.
  4. *Absolute bone conduction test (ABC test):*
     - — Bone conduction of the patient and examiner is equal—Normal or conductive deafness
     - — Bone conduction of the patient shortened—Sensorineural deafness.

Rinne	*Weber*	*Conditions*
Positive both ears	Central	No deafness or equal SNHL in both ears
Positive both ears	Lateralized to left ear	SNHL in right ear; left normal
Positive both ears	Lateralized to right ear	SNHL in left ear; right normal
Negative right ear	Lateralized to right ear	Conductive deafness right ear
Negative both ears	Lateralized to left ear	Conductive loss in both; left is worst
Negative both ears	No lateralization	Equal loss in both ears

- *Eustachian tube function:* Tests can be done by following methods:
  - Valsalva and politzerization.
  - Putting eardrops (Chloromycetin); in the perforated ear and feeling the bitter taste in the mouth.
  - Eustachian tube catheterization
  - By instilling some dye if perforation is present or injecting it through normal tympanic membrane and taking X-rays
  - Impedance audiometry.
- *Facial nerve function:*
  - *Clinical tests:* Water drinking test
  - Bell's phenomenon
  - Nerve excitability test
  - Maximal stimulation test
  - Electroneuronography (ENOG)
  - Electromyography (EMG).
- *Vestibular function tests:*
  - Tests for nystagmus
  - Fistula test
  - Gait test/finger nose test
  - Caloric test.

Investigations in an Ear Case

- Blood for hemoglobin (Hb), bleeding time (BT), clotting time (CT)
- Urine for sugar, albumin, pus cells
- Culture and sensitivity of ear discharge
- Examination under microscope
- Pure tone audiometry
- X-rays both mastoids lateral oblique view
- Computed tomography (CT) scan wherever required.

Provisional Diagnosis is made based on the symptoms and signs on examination and the points in favor of the diagnosis made are memorized because examiner will certainly be interested to know the salient points of the disease.

Management

- In case of safe ear (tubotympanic type) the management is conservative in the form of aural toilet, antibiotics, nasal decongestants and treatment of the underlying cause followed by repair of the tympanic membrane perforation (Myringoplasty) to improve the hearing.

  In case of unsafe ear (atticoantral disease) the management is mastoid exploration, which includes atticotomy, atticoantrostomy or modified or radical mastoidectomy depending upon the extent of disease.
- Similarly if it is a case of nose, oral cavity, oropharynx, nasopharynx or larynx, history and examination of patient should be done as per the norms.
- The details of how to examine a nose or pharynx and neck case has been described in the appropriate sections.

APPENDIX 2: MODEL TEST PAPERS (I-VI)

Model Test Paper–I
Subject: ENT

Question No.	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Total
Marks distribution	10	14	14	14	14	14	80
Marks obtained							
Signature of Evaluator							

All parts of question to be answered together. Time 3 Hrs
Draw suitable diagrams wherever required.

1. Attempt 20 multiple choice questions on a separate sheet provided to you. 10 marks
2. Describe etiopathogenesis, clinical features and complete management of atticoantral disease of ear? 14 Marks
3. Discuss types, causes, clinical features and treatment of nasal polypi? 14 Marks
4. Discuss etiopathogenesis, clinical features and management of nasopharyngeal fibroma? 14 marks
5. Write short notes on following:
   - Peritonsillar abscess
   - Parapharyngeal space
   - Osteomeatal complex
   - Complications and management of adenotonsillectomy operation 14 marks
6. Write short notes on following:
   - Differential diagnosis of Meniere's disease and acoustic neuroma
   - Types advantages and disadvantages of tracheostomy operation
   - Impedance audiometry
   - Anatomy of Waldeyer's ring. 14 marks

Model Test Paper–II
Subject: ENT

Question No.	Q.1	Q.2	Q.3	Q.4	Total
Marks distribution	20	20	20	40	100
Marks obtained					
Signature of Evaluator					

All parts of question to be answered together.
Draw suitable diagram wherever required.

1. Describe etiopathogenesis, clinical features and complete management of chronic maxillary sinusitis? 20 Marks
2. Discuss types, causes, clinical features and treatment of Meniere's disease ? 20 Marks
3. Describe etiology and clinical features with management of Ludwig's angina ? 20 marks
4. Write short notes on following: (Marks 10 × 4 =40)
   - TNM classification of carcinoma maxilla
   - Differential diagnosis and management of tubotympanic and glue ear
   - Lateral wall of nose
   - Management of ethmoidal polypi
   - Adenoid facies
   - Types, advantages and complications of tympanoplasty operation
   - Faucial diphtheria
   - Pure tone audiometry
   - Anatomy of scala media
   - Spaces of larynx.

Model Test Paper–III
Subject: ENT

Question No.	Q.1	Q.2	Q.3	Q.4	Total
Marks distribution	20	20	20	40	100
Marks obtained					
Signature of Evaluator					

All parts of question to be answered together.
Draw suitable diagram wherever required.

1. Describe etiopathogenesis, clinical features and complete management of chronic suppurative otitis media? 20 Marks
2. Discuss types, causes, clinical features, diagnostic features and treatment of acoustic neuroma? 20 Marks
3. Describe causes, clinical features with management of parapharyngeal abscess? 20 marks
4. Write short notes on following: (Marks 10 × 4 =40)
   - TNM classification of carcinoma maxilla
   - Differential diagnosis and management of discharging ear
   - Lateral wall of nose
   - Malignant otitis externa
   - Secondary hemorrhage after tonsillecomy
   - Types, advantages and complications of tracheostomy operation
   - Plummer-Vinson's syndrome
   - Impedance audiometry
   - Anatomy of eustachian tube
   - Muscles and nerve supply of larynx.

Model Test Paper–IV
Subject: ENT

Question No.	Q.1	Q.2	Q.3	Q.4	Total
Marks distribution	20	20	20	40	100
Marks obtained					
Signature of Evaluator					

All parts of question to be answered together.
Draw suitable diagram wherever required.

1. Describe etiopathogenesis, clinical features and complete management of chronic suppurative otitis media? 20 Marks
2. Discuss types, causes, clinical features, diagnostic features and treatment of otospongiosis? 20 Marks
3. Describe causes, clinical features with management of quinsy ? 20 marks
4. Write short notes on following: (Marks 10 × 4 =40)
   - TNM classification of carcinoma larynx
   - Differential diagnosis of discharging ear
   - Osteomeatal complex of nose
   - Malignant otitis externa
   - Secondary hemorrhage after tonsillecomy
   - Types, advantages and complications of mastoidectomy operation
   - Plummer-Vinson's syndrome
   - BERA
   - Anatomy of eustachian tube
   - Muscles and nerve supply of larynx.

Model Test Paper–V

Max Marks–40

Part–A

1. Discuss the surgical anatomy of nasal septum, its blood and nerve supply. Enumerate the differences between septoplasty and submucous resection of septum operation. 4+3
2. Write short notes on:
   a. Osteomeatal complex
   b. Complications of tonsillectomy operation
   c. Anosmia 3+2+2
3. Draw the labeled diagrams of:
   a. Left tympanic membrane
   b. Indirect laryngoscopy 3+3

Part–B

1. Enumerate the causes of hoarseness of voice. Write in detail management of juvenile laryngeal papillomatosis. 4+4
2. Write short notes on:
   a. FESS
   b. CSF rhinorrhea
   c. Lateral sinus thrombosis 2+2+2
3. Write short notes on (any three):
   a. Cortical mastoidectomy
   b. Stages of acute suppurative otitis media
   c. TNM classification of carcinoma larynx
   d. Bithermal caloric tests 2+2+2

Model Test Paper–VI

Max Marks–40

Part–A

1. Discuss the surgical anatomy, blood and nerve supply of middle ear. Enumerate the differences between safe and unsafe ear. 4+3
2. Write short notes on:
   a. Indications and complications of tracheostomy operation.
   b. Indications of adeno-tonsillectomy operation
   c. Clinical features and management of nasopharyngeal fibroma. 3+2+2
3. Draw the labeled diagrams of:
   a. Facial nerve
   b. Scala media 3+3

Part–B

1. Enumerate the causes, clinical features and management of chronic maxillary sinusitis. 4+4
2. Write short notes on:
   a. Ludwig's angina
   b. LASER in ENT
   c. Management of hemorrhage after tonsillectomy 2+2+2
3. Write short notes on (any three):
   a. Types of tympanoplasty
   b. Adhesive otitis media
   c. TNM classification of carcinoma nasopharynx
   d. Recruitment tests 2+2+2

Multiple Choice Questions

EAR

1. **Which is the most commonly involved ossicle in CSOM....**
   a. Malleus
   b. Stapes
   c. Incus
   d. All of the above
2. **Which is the most common site of congenital cholesteatoma in middle ear**
   a. Posterior superior part of middle ear
   b. Attic
   c. Attic and antrum
   d. Anterosuperior part of middle ear
   e. All of the above
3. **What are the typical findings seen in tuberculous otitis media**
   a. Foul smelling discharge with posterior perforation
   b. Blood stained discharge with granulation, no perforation
   c. Persistent otorrhea, multiple perforations with granulations
   d. All of the above
4. **What is the angle of eustachian tube with horizontal in infants and adults**
   a. 10 degree and 45 degree
   b. 20 degree and 55 degree
   c. 0 degree and 70 degree
   d. None of above
5. **Which type of epithelium mainly lines the middle ear**
   a. Ciliated columnar
   b. Nonciliated cuboidal
   c. Ciliated cuboidal
   d. None of above
6. **MRI is preferred over CT in CSOM when**
   a. Disease is confined within the middle ear
   b. Disease involves inner ear
   c. Disease spreads beyond temporal bone
   d. All of the above
7. **Blue mantles of Manasse are typically seen in**
   a. Ménière's disease
   b. Otospongiosis
   c. Acoustic neuroma
   d. Glomus tumor
8. **What forms Oort's anastomosis....**
   a. Anastomosis between superior vestibular and cochlear nerve
   b. Anastomosis between inferior vesticular nerve and superior vestibular nerve
   c. Anastomosis between saccular branch of inferior vestibular and cochlear nerve
   d. None of above
9. **Grade IV atelectasis means....**
   a. Wrapping of tympanic membrane to ossicles
   b. Tympanic membrane touches the promontory
   c. Adhesions form between TM and promontory of middle ear
   d. None of above
10. **Porus acusticus is the....**
    a. Medial end of external auditory meatus
    b. Medial end of internal acoustic meatus
    c. Lateral end of internal acoustic meatus
    d. None of above
11. **Bill's bar is a bony land mark which separates....**
    a. Superior vestibular from inferior vestibular nerve
    b. Cochlear and facial from superior and inferior vestibular nerve
    c. Cochlear nerve from facial nerve
    d. None of above
12. **Luc's abscess in otitis media means....**
    a. Pus at the tip of mastoid process
    b. Pus fistulises the external auditory meatus
    c. Pus tracks between sternocleidomastoid and digastric muscle
    d. None of the above
13. **A 10-year-old boy is diagnosed as having posterosuperior retraction pocket with cholesteatoma, management will include all except....**
    a. Pure tone audiometry
    b. Tympanoplasty
    c. Mastoid exploration
    d. Myringoplasty
14. **Carhart's notch in otosclerosis is a bone dip seen at....**
    a. 0.5 kHz
    b. 2 kHz
    c. 3 kHz
    d. All of above

15. Fistula test will be positive in all except....
a. Hypermobile stapes footplate
b. After fenestration
c. Labyrinthine fistula
d. Dead ear

16. All is true about Ramsay Hunt syndrome except....
a. Viral etiology
b. Spontaneous recovery
c. 7th and 8th nerve palsies
d. Vessicular eruptions

17. Bleeding from bone can be controlled by all except....
a. Using a cutting drill
b. By using diamond burr
c. By bone wax
d. With bipolar cautery

18. Cough while cleaning ear wax is mediated through....
a. By innervation through C1 and C2
b. Through 5th nerve
c. 10th nerve
d. 7th nerve

19. Aldermen's nerve is a branch of....
a. Glossopharyngeal nerve
b. Vagus nerve
c. Trigeminal nerve
d. None of above

20. Jacobson's nerve is a branch of....
a. Trigeminal nerve
b. Glossopharyngeal nerve
c. Vagus nerve
d. None of above

21. A case of Bell's palsy shows no improvement with steroids after 2 weeks, next step in treatment should be....
a. Continue steroids
b. Electrophysiological testing
c. Physiotherapy and electrical stimulation
d. Use of vasodilators and ACTH

22. In collumellar type of tympanoplasty graft is placed against....
a. Stapes footplate
b. On the incus
c. On head of stapes
d. Against malleus

23. Baffle's effect tympanoplasty means....
a. Graft in contact with incus
b. Graft on head of stapes
c. Making a window in HSCC
d. Graft placed against mobile footplate of stapes

24. When any substance enters inner ear, it can cause....
a. Meningitis
b. Labyrinthitis
c. Endolymphatic hydrops
d. SNHL
e. All of above

25. Which is the smallest segment of facial nerve....
a. Horizontal segment
b. Vertical segment
c. Labyrinthine segment
d. None of above

26. Which is called nerve of Wrisberg....
a. Motor root of facial nerve
b. Tympanic branch of glossopharyngeal nerve
c. Sensory root of facial nerve
d. Greater auricular nerve

27. Greater superficial petrosal nerve is secretomotor to...
a. Parotid gland
b. Submandibular gland
c. Lacrimal gland
d. All of above

28. Geniculate ganglion lies....
a. Anterior to processus cochleariformis
b. Just below processus cochleariformis
c. Above processus cochleariformis
d. Posterior to processus cochleariformis

29. Direction of cartilaginous meatus is....
a. Medial, downwards and forwards
b. Medially, upwards and backwards
c. Upwards and medially only
d. None of above

30. Pinna is innervated by....
a. Greater auricular nerve
b. Lesser occipital nerve
c. Auricular branch of vagus
d. Auricular branch of glossopharyngeal nerve
e. All of above

31. Notch of Rivinus is a deficiency in....
a. Superior part of bony annulus
b. Between cartilaginous and bony meatus
c. Medial wall of middle ear
d. None of above

32. Shrapnell membrane is also called....
a. Secondary tympanic membrane
b. Pars flaccida
c. Reissner's membrane
d. Tectorial membrane

33. Anterior and posterior malleolar folds are attached to....
a. Handle of malleus
b. Lateral process of malleus
c. Neck of malleus
d. All of above

34. Footplate of stapes is held in oval window by....
a. Middle ear mucosa
b. Annular ligament
c. Middle ear pressure
d. All of above

35. Stapedius muscle develops from....
a. Ist arch
b. 2nd arch
c. Ist and 2nd arch
d. None of above

36. Facial recess is bounded laterally by....
a. Facial nerve
b. Chorda tympani nerve
c. Short process of incus
d. Ponticulus

37. Length of eustachian tube cartilaginous and bony part is....
a. 12 mm and 24 mm
b. 24 mm and 12 mm
c. 12 mm and 12 mm
d. 16 mm and 20 mm

38. Structures of ear fully formed at birth are all except....
a. Middle ear
b. Ossicles
c. Inner ear
d. External ear

39. Advantage gained by middle ear transformer mechanism is....
a. 14 x 1.3 = 18 times
b. 14 x 1.4 = 19.6 times
c. 16 x 1.5 = 24 times
d. 14 x 1.6 = 22.4 times

40. Mastoid tip develops by....
a. 6 years
b. 4 years
c. 2 years
d. None of above

41. Trautmann's triangle is bounded above by....
a. Cavernous sinus
b. Sigmoid sinus
c. Superior petrosal sinus
d. None of above

42. All is true about Citelli's angle except....
a. Also called sinodural angle
b. Lies between sigmoid sinus and middle fossa dura
c. Lies between cavernous sinus and posterior cranial dura
d. It is a useful landmark in mastoid surgery

43. All is true about Donaldson's line except....
a. Passes through HSCC and bisects posterior SCC
b. Passes through posterior SCC and bisects HSCC
c. Landmark for endolymphatic sac
d. Sac lies anterior and inferior to it

44. All is true about Prussak's space except....
a. Lies medial to pars flaccida
b. Lateral to neck of malleus
c. Above lateral process of malleus
d. Through a posterior gap it communicates with mesotympanum

45. Griesinger's sign is a feature of....
a. Cavernous sinus thrombosis
b. Brain abscess
c. Lateral sinus thrombosis
d. None of above

46. All is true about exostosis in EAC except....
a. Multiple
b. Cold water swimming
c. Does not occur at suture lines
d. Seen in cartilaginous meatus only

47. In Fitzgerald-Hallpike caloric test thermal stimulation occurs in the....
a. Posterior SCC
b. Horizontal SCC
c. Superior SCC
d. Cochlea

48. All is true about Gelle's test except....
a. Normally it is positive
b. Compares intensity of sound with change of air pressure
c. Done in otospongiosis
d. Can be done with impedance audiometer

49. Schwartz sign has all these features except....
a. Indicates active focus
b. Pink reflex through intact TM
c. More common in pregnancy
d. A feature of glomus tumor

50. Endolymph is produced by....
a. Endolymphatic sac
b. Organs of Corti
c. Stria vascularis
d. Scala vestibuli

51. Malignant otitis externa—all is true except....
a. Seen in elderly diabetics
b. Infection by pseudomonas
c. Also called necrotizing otitis externa
d. Treated with steroids

52. Most common bacteria in acute otitis media are....
a. *Pseudomonas*
b. *Streptococcus pneumoniae*
c. *Moraxella catarrhalis*
d. Staphylococci

53. Gradenigo's syndrome has all the features except....
a. Retro-orbital pain
b. Otorrhea
c. Diplopia
d. Paralysis of soft palate

54. Hitselberger's sign is a feature seen in....
a. Ménière's disease
b. Glomus tumor
c. Acoustic neuroma
d. Cholesteatoma

55. Recruitment is a typical feature seen in....
a. Acoustic neuroma
b. Ménière's disease

c. Atticoantral disease
d. All of above

56. All is true about tone decay except....
a. A feature of cochlear lesion
b. Also called auditory fatigue
c. Normal person hears a tone continuously for 60 seconds
d. A decay of more than 25 dB is diagnostic

57. Noise trauma shows a dip in air conduction pure tone audiometry....
a. At 2 kHz
b. At 4 kHz
c. At 6 kHz
d. None of above

58. Fluctuating hearing loss is seen in all except....
a. Presbycusis
b. Secretory otitis media
c. Ménière's disease
d. Perilymph fistula

59. All is true for tubotympanic disease except....
a. Discharge limited to mucosa of middle ear
b. Discharge mucopurulent, not foul smelling
c. Perforation central
d. Management conservative
e. Cholesteatoma present

60. All is true for atticoantral disease except....
a. Offensive discharge
b. Perforation marginal or in attic
c. Granulation or cholesteatoma present
d. Simple mastoidectomy

61. All is true for management of tubotympanic disease except....
a. Aural toilet
b. Antibiotics
c. Tympanoplasty
d. Nasal decongestants

62. Macewen's triangle is a surgical landmark for....
a. Prussak's space
b. Sinus tympani
c. Mastoid antrum
d. Facial nerve

63. Absolute bone conduction diminished in patient indicates...
a. Conductive hearing loss
b. Sensorineural hearing loss
c. Mixed hearing loss
d. None of above

64. Otalgia in dental abscess is through
a. V nerve
b. Glossopharyngeal nerve
c. Facial nerve
d. All of above

65. Secretory otitis media is best treated by....
a. Myringoplasty
b. Antibiotics
c. Myringotomy with grommets insertion
d. Mastoidectomy

66. Operation endolymphatic sac decompression is done for....
a. Acute suppurative otitis media
b. Acoustic neuroma
c. Ménière's disease
d. Otospongiosis

67. A patient has conductive hearing loss in left ear and normal hearing right ear, Weber will be lateralized to....
a. No lateralization
b. Right ear
c. Left ear
d. Both ears

68. In a patient with SNHL right ear and normal hearing left ear Weber is lateralized to....
a. Right ear
b. Left ear
c. Both ears
d. No lateralization

69. Reservoir sign is a feature of....
a. Acute SOM
b. Coalescent mastoiditis
c. Otospongiosis
d. Glue ear

70. To visualize mastoid air cell system view taken is....
a. Water's view
b. Caldwell's view
c. Schuller's view
d. Lateral view

71. Siegle's speculum is useful for all except....
a. Provides 2x magnification
b. For mobility testing of TM
c. Gelle's test
d. Browne's sign
e. Acoustic neuroma

72. Extracranial complications of CSOM are....
a. Sigmoid sinus thrombosis
b. Facial nerve palsy
c. Labyrinthitis
d. Subdural abscess

73. Flat type of curve in impedance audiometry is seen in....
a. Chronic suppurative otitis media
b. Serous ototis media
c. Otospongiosis
d. Ossicular chain disruption

74. All is true about Griesinger's sign except....
a. Feature of mastoiditis
b. Thrombosis of mastoid emissary vein
c. Edema over mastoid
d. Mastoid tenderness marked

75. Vestibular function is tested by all except....
a. Caloric test
b. Fistula test

c. Acoustic reflex
d. Cupulometry

76. All is true about otogenic brain abscess....
a. May cause fits, aphasia and hemianopia
b. CSOM with lateral sinus thrombosis can cause it
c. Temporal lobe commonly affected
d. All of above

77. A patient with head injury has a normal temparo-mandible conductive hearing loss. Likely cause could be....
a. Ossicular chain disruption
b. Injury to labyrinth
c. Hemotympanum
d. Otitis media

78. All is true about cholesteatoma except....
a. Also called keratoma
b. Erodes bone
c. Surgery is best treatment
d. Benign tumor

79. Cholesteatoma erodes most commonly....
a. Promontory
b. Lateral SCC
c. Oval window
d. Superior SCC

80. Earliest eye finding in acoustic neuroma is....
a. Ptosis
b. Retinal degeneration
c. Corneal insensitivity
d. All of above

81. SNHL is seen in all except....
a. Michael'aplasia
b. Alport's syndrome
c. Treacher Collins syndrome
d. Pendred syndrome

82. Distance between promontory and tympanic membrane is....
a. 2 mm
b. 3 mm
c. 4 mm
d. 6 mm

83. Tympanic membrane is supplied by all except....
a. Auriculotemporal nerve
b. Alderman's nerve
c. Great auricular nerve
d. Tympanic plexus

84. All are features of retraction of tympanic membrane except....
a. Malleus head is eroded
b. Cone of light is distorted
c. Handle of malleus is foreshortened
d. Malleolar folds become prominent

85. Promontory in middle ear is formed by....
a. Sigmoid sinus
b. Superior SCC
c. Basal turn of cochlea
d. Jugular bulb

86. Cochlear aqueduct functions as....
a. Connects vestibule with cochlea
b. Produces endolymph
c. Connects internal ear with subarachnoid space
d. None of above

87. Narrowest part of middle ear is....
a. Mesotympanum
b. Hypotympanum
c. Epitympanum
d. Peritympanum

88. Cochlear lesion is diagnosed from retrocochlear by....
a. Pure tone audiogram (PTA)
b. Impedance audiometery
c. Brainstem evoked response audiometry (BERA)
d. Cochlear potentials

89. Glue ear is best diagnosed by....
a. Otoscopy
b. X-ray
c. Impedance audiometery
d. Puretone audiometery

90. Inner ear is present in....
a. Petrous bone
b. Mastoid bone
c. Tympanic bone
d. Squamous bone

91. Hyperacusis is....
a. Normal sound become loud and painful
b. Same as paracusis
c. Only loud sounds are heard
d. No hearing at all

92. Best graft in myringoplasty is....
a. Pericardium
b. Dura
c. Mucous membrane
d. Temporal fascia

93. Otitic barotrauma results because of....
a. Cupulometry
b. Descent in air
c. Linear acceleration
d. Ascent in air

94. Cortical mastoidectomy is also called....
a. Bondy's operation
b. Schwartz operation
c. Radical operation
d. Modified radical operation

95. Myxdema has the following features....
a. Irreversible SNHL
b. Reversible SNHL
c. Conductive hearing loss
d. All of above

96. Pseudostratified ciliated cuboidal epithelium in ear is present in....
a. Middle ear
b. Mastoid
c. Eustachian tube
d. Endolymphatic sac

97. Development of eustachian tube is from....
a. 3rd pharyngeal pouch
b. 1st pharyngeal pouch
c. 2nd and 3rd pharyngeal pouch
d. 2nd pharyngeal pouch

98. Schwartz operation is done for....
a. Lateral sinus thrombosis
b. Atticoantral disease
c. Acute coalescent mastoiditis
d. ASOM

99. Sound intensity is measured in....
a. Pounds
b. Diopters
c. Decibels
d. All of above

100. Primary auditory cortex is situated in....
a. Postcentral gyrus
b. Occipital lobe
c. Parietal lobe
d. Temporal lobe

101. True about basilar membrane is....
a. Vibrates due to vibrations of fluid in cochlea
b. Covers oval window
c. Forms roof of scala vestibuli
d. When under tension

102. Acoustic neuroma causes all except....
a. Unilateral deafness
b. Loss of corneal reflex
c. Nystagmus
d. Ptosis

103. Direction of nystagmus is vertical after rotation when....
a. After warm water caloric test
b. After cold caloric test
c. Head is positioned backwards
d. Head tipped sideways

104. A patient presents with a mass in the neck, dull TM, deafness and B type impedance curve most likely diagnosis is....
a. Carcinoma nasopharynx
b. Carcinoma Middle ear
c. Atticoantral disease
d. TB of neck nodes

105. Electrodes of cochlear implant is inserted in....
a. Oval window
b. Round window
c. HSCC
d. Cochlear aqueduct

NOSE

106. True about rhinosporidiosis is....
a. Caused by *Rhinosporidium seeberi*
b. Never cultured
c. Friable, polypoidal mass nose
d. Dapsone and amphotericin B helpful
e. All is true

107. Kartagener's syndrome is characterized by....
a. Absence of cilia
b. Immotile cilia
c. Number of cilia
d. All of above

108. Impulses generated by olfactory receptors are....
a. Relayed to thalamus
b. Pass to olfactory cortex directly from mitral cells
c. Relayed by hypothalamus to olfactory cortex
d. Pass through internal capsule

109. False about through allergic fungal sinusitis is....
a. Type I hypersensitivity
b. Orbital extension
c. CT shows hyperdense sinus infiltration
d. Eosinophil rich mucin

110. True about respiratory epithelium is....
a. Pseudostratified columnar with Bowman's glands
b. Also called Schneiderian membrane
c. Pseudostratified ciliated columnar type with goblet cells
d. Stratified squamous epithelium

111. For DNS surgery is required for....
a. When associated with epistaxis
b. Asymptomatic DNS
c. For functional endoscopic sinus surgery
d. With chronic recurrent sinusitis

112. All is true about CSF rhinorrhea except....
a. Complication of FESS
b. Biochemical examination helpfull
c. Beta-2 transferrin test on electrophoresisis pathognomic
d. Handkerchief gets stiffened with CSF

113. Which anesthetic agents are safe in bronchial asthma....
a. Morphine/thiopentone
b. Chloral hydrate
c. Phenobarbitone
d. Halothane

114. Disease rhinoscleroma is due to....
a. Rhinosporiosis
b. Autoimmune
c. Klebsiella
d. Spirochaetes

115. A 14-year-boy is diagnosed a case of antrochoanal polyp polyp, best treatment is....
a. CWL operation
b. Polypectomy
c. No treatment
d. Antibiotics

116. Best view to see sphenoid sinus is....
a. Town's view
b. Water's view with mouth open
c. Lateral oblique view
d. Schüller's view

117. True about rhinocerebral mucormycosis....
a. Seen in diabetics and immunocompromised persons
b. Amphotericin B useful
c. Septal and palatal perforaions
d. Blackish, serosanguinous discharge
e. All is true

118. Tick the wrong one for septal perforation....
a. May follow septal abscess
b. May be seen in syphilis /tuberculosis
c. Mostly are asymptomatic
d. Bigger perforations easy to close

119. True about cause of nasal obstruction in atrophic rhinitis is....
a. Secretions in the nose
b. Excessive crusting
c. Polyp formation
d. Hypertrophied turbinates

120. Unilateral serous otitis media in 55 year adult is pathognomic of....
a. Antrochoanal polyp
b. Adenoids
c. Nasopharyngeal fibroma
d. Nasopharyngeal carcinoma

121. All is true about Hutchinson's rule except....
a. Retrograde spread via nasociliary nerve
b. Herpes infection of nasal tip
c. Paralysis of orbital muscles
d. Herpes ophthalmicus

122. Charcot leyden crystals are a feature of....
a. Glomus tumor
b. Allergic fungal sinusitis
c. Rhinoscleroma
d. None of above

123. True about rhinophyma is....
a. Acne rosacea
b. Fungal etiology
c. Needs shaving and dermabrasion
d. Premalignant

124. Hyposmia is seen commonly in....
a. Fracture base of skull
b. Polyps nose
c. URC
d. Atrophic rhinitis
e. All of above

125. A 13-year-old boy presents with massive recurrent nose bleed and swelling cheek tick the statement not applicable....
a. Could be acase of nasopharyngeal fibroma
b. Spreads by lymphatics
c. Contrast CT helpfull
d. Arises from fossa of Rossenmüller
e. Surgery is best form of treatment

126. A patient of chronic sinusitis develops chemosis, fever and proptosis, likely diagnosis could be....
a. Frontal lobe abscess
b. Meningitis
c. Cavernous sinus thrombosis
d. Sigmoid sinus infection

127. Which sinusitis is common in children....
a. Maxillary sinusitis
b. Ethmoidal sinusitis
c. Sphenoiditis
d. Frontal sinusitis

128. Mickulicz cells and Russell bodies are a feature of....
a. Rhinophyma
b. Rhinoscleroma
c. Rhinosporidiosis
d. None of above

129. Features of sarcoidosis are....
a. Granulomatous disorder
b. No caseation
c. Kveim test is diagnostic
d. Systemic steroids helpful
e. All of above

130. All is true about Wegener's granuloma except....
a. Systemic condition of nose
b. Lungs and kidneys involvement
c. Steroids and cyclophosphamide very useful
d. Radiotherapy not a treatment of choice

131. All is true about atrophic rhinitis except....
a. Also called ozena
b. Metaplasia to cuboidal or stratified epithelium
c. Merciful anosmia
d. 25 percent glucose in glycerin useful
e. Most prevalent in males of middle age

132. Young's operation is treatment of choice....
a. Rhinoscleroma
b. Angiofibroma
c. Atrophic rhinitis
d. Rhinosporidiosis

133. LeFort's classification of fracture applies to....
a. Fracture of mandible
b. Fracture of maxilla

c. Fracture of maxilla and malar bones
d. All of above

134. Major constituents of nasal septum are all except....
a. Septal cartilage
b. Vomer
c. Ethmoid
d. Palatine bone

135. What all opens in middle meatus except....
a. Posterior ethmoids
b. Nasofrontal duct
c. Maxillary sinus ostia
d. Anterioethmoids
e. Nasolacrimal duct

136. Tick the one which does not apply to ethmoidal polypi....
a. Bilateral
b. Allergic origin
c. Single and trilobed
d. Recurrence is common

137. All is true about nasal valve except....
a. Area of high resistance
b. Bounded by septum and upper lateral nasal cartilage
c. Triangular in shape
d. Is of no clinical importance

138. Sense of olfaction is transmitted to all except....
a. Olfactory receptor cells
b. Olfactory bulb
c. Amygdaloid nucleus and area piriformis
d. Thalamus
e. Temporal cortex

139. All is true about fulminant or invasive fungal sinusitis except....
a. Seen in diabetics and HIV patients
b. Require aggressive surgical debridement
c. Amphotericin–B therapy
d. Fungal balls are present

140. All are risk factors for nose and PNS malignancy except....
a. Wood dust
b. Nickel and chromium
c. Volatile hydrocarbons and smoking
d. *Aggarbati* smoke

141. All is true about inverted papilloma except....
a. Also called Ringertz tumor
b. May be premalignant
c. Transitional epithelium with fibrovascular stroma
d. RT is best form of treatment

142. Kartagener's syndrome consists of all except....
a. Situs inversus
b. Recurrent chronic sinusitis and bronchiectasis
c. Disturbed ciliary motility
d. Absence of dye in side arms on electron microscopy
e. Atrophic rhinitis

143. All is true about carcinoma nasopharynx except....
a. Caused by Epstein—Barr virus
b. Common site of origin—Fossa of Rossenmüller
c. Neck nodes in posterior triangle of neck
d. Surgery treatment of choice

144. All is true about choanal atresia except....
a. Often unilateral
b. Usually seen in females
c. More common on right side
d. Mostly membranous

145. Physaliferous cells (Foamy cell with compressed nuclei) are seen in....
a. Chordoma
b. Terratoma
c. Rhinoscleroma
d. Glomus tumor

146. Trotter's triad or syndrome in NPC includes all except....
a. Conductive hearing loss
b. Ipsilateral immobility of soft palate
c. Neuralgic pains in Vth nerve distribution
d. Recurrent massive nose bleed

147. Egg shall crackling is typically seen in....
a. Compact osteomas
b. Adamantinomas
c. Osteoclastomas
d. All of above

148. Pituitary can be approached through all except....
a. Transseptal
b. Transethmoidal
c. Transantral
d. Sublabial approach
e. All of above

149. All is good for epistaxis except....
a. Trotter's technique
b. Nasal packing
c. Foley's cathetar
d. Antibiotics

150. Rhinolalia aperta is due to all causes except....
a. Cleft palate
b. Palatal perforation
c. UPPP operaion
d. Mass nasopharynx

151. Good for investigation of sleep apnea syndrome are....
a. Flexible fiberoptic endoscopy
b. Nocturnal polysomnography
c. Pulmonary function tests
d. All of above

152. Diagnosis of CSF rhinorrhea is diagnosed by all except....
a. CT scan
b. Fluorescein dye test through lumbar puncture
c. Nasal endoscopy
d. Posterior rhinoscopy

153. All may contribute towards nasal polyp formation except....
a. Infection and allergy
b. Bernoulli's effect
c. Samter's triad
d. Rhinophyma

154. All are features of VMR except....
a. Nasal obstruction and rhinorrhea
b. Vidian neurectomy helpfull
c. Marked eosinophillia
d. Females more affected
e. Conjunctival symptoms present

155. Saddle nose is seen in all except....
a. Septal abscess
b. Atrophic rhinitis
c. Post SMR
d. Nasal polyp

156. Septal perforation is feature of all except....
a. Septal abscess
b. Iatrogenic/Postseptal surgery
c. Syphilis
d. Tuberculosis
e. Vasomotor rhinitis

157. Unilateral nasal discharge in a child is pathognomic of....
a. Chromic rhinitis
b. Foreign body nose
c. Fungal sinusitis
d. All of above

158. Cottle's test is done to test....
a. Nasal patency
b. Nasal valve
c. Dangerous area of nose
d. All of above

159. Dangerous area of face is....
a. Little's area
b. Olfactory area
c. Lower part of external nose and upper lip
d. All of above

160. Contents of pterygopalatine fossa are all except....
a. Maxillary artery
b. Maxillary nerve
c. Sphenopalatine ganglion
d. Ophthalmic artery

161. Mass in the hypopharynx produces a characteristic voice called....
a. Hotpotato voice
b. Rhinolalaia
c. Stuttering
d. None of above

162. LASER stands for....
a. Limited amplification with stimulationof emitted radiation
b. Light amplification by stimulated emission of radiation
c. Low application of smooth evaluation of radiation
d. All of above

163. Mechanism of Glegg's nasal snare in polypectomy....
a. Cutting only
b. Crushing and cutting
c. Avulsion
d. All of above

164. Intranasal antrostomy is done in....
a. Superior meatus
b. Middle meatus
c. Inferior meatus
d. All of above

165. All blood vessels take part in Kiesselbach's plexus except....
a. Anteroethmoidal
b. Sphenopalatine
c. Facial
d. Posterior ethmoidal

166. Osteomeatal complex in middle meatus includes all except....
a. Uncinate process
b. Bulla ethmoids
c. Hiatus semilunaris
d. Aggar nasi

167. Maggots or mysiasis of nose is due to....
a. Fungus
b. Bacteria
c. Larvae of flies
d. None of above

168. Paranasal sinus absent at birth is....
a. Maxillary sinus
b. Frontal sinus
c. Ethmoidal sinuses
d. Sphenoidal sinus

169. Oroantral fistula is not seen in....
a. FESS
b. Trauma
c. Tooth extraction
d. Carcinoma maxilla

170. Rhinosporidiosis is best treated by....
a. Systemic antifungals
b. Topical antifungals
c. Excision and cautery of base
d. Simple polypectomy

171. Vaccum headache is a feature of....
a. Frontal sinusitis
b. Meningitis
c. Cavernous sinus thrombosi
d. Head injury

172. A young male boy presents with massive recurrent nosebleed with a mass nasopharynx, likely diagnosis is....
a. Nasopharyngeal carcinoma
b. Nasopharyngeal fibroma
c. Carcinoma nose
d. Fungal sinusitis

173. In 25 percent glucose in glycerine nasal drops used to treat atrophic rhinitis, glucose acts by....
a. Hygroscopic action
b. Ciliary regeneration
c. Inhibiting the growth of proteolytic organisms
d. Placebo

174. Ozena is another name for....
a. Allergic rhinitis
b. Atrophic rhinitis
c. Rhinitis medicamentosa
d. Rhinitis sicca

175. Cholesteatoma of the nose denotes....
a. Rhinitis caseosa
b. Rhinitis sicca
c. Rhinitis medicamentosa
d. Rhinitis granulosa

176. Frisch bacillus causes....
a. Rhinoscleoma
b. Rhinosporidiosis
c. Atrophic rhinitis
d. Tertiary syphilis

177. Syphilis of the nose causes septal perforation in the....
a. Cartilaginous septum
b. Bony Septum
c. Membranous Septum
d. Nasal bones

178. Leprosy or tuberculosis of the nose causes septal perforation in the....
a. Cartilaginous septum
b. Bony septum
c. Membranous Septum
d. Nasal Bones

179. Most common site for CSF rhinorrhea is....
a. Frontal sinus
b. Sphenoidal sinus
c. Anterior ethmoids
d. Posterior ethmoids

180. The capacity of Higginson's syringe is....
a. 5 oz
b. 3 oz
c. 2 oz
d. 4 oz

181. A 55 year diabetic male presents with a mass in the nose and blackish discharge from nose, it could be....
a. Histoplasmosis
b. Blastomycosis
c. Actinomycosis
d. Mucormycosis

182. Synechia formation after septal surgery is prevented by applying....
a. Nasal gauge dressing
b. Ribbon gauge with steroids
c. Mitomycin application
d. None of above

183. Sluder's neuralgia is due to....
a. Inferior turbinate pressing the septum
b. Middle turbinate pressing septum
c. Superior turbinate pressing septum
d. All of above

184. Cavernous sinus infection is indicated by all except....
a. Ptosis
b. Ophthalmoplegia
c. Constricted pupil
d. Engorgement of retinal veins

185. A 35 year female presents with history of fever, facial pain and thick nasal discharge, fever and pain subsides with antibiotics and other supportive treatment. After 4 weeks she has again mucopurulent nasal discharge and mucosa of lateral wall of nose is swoolen and congested, next line of management should be....
a. MRI
b. CT PNS
c. Plain X-ray
d. Inferior meatus antrostomy

186. Nasal polyp that is trifoliate in appearance is....
a. Nasal glioma
b. Antrochoanal polyp
c. Ethmoidal polyp
d. Encephalocele

187. Most common cause of epistaxis in children is....
a. Nose picking
b. Nose piercing
c. Malignancy
d. Idiopathic

188. Impacted nasal septum implies....
a. Deviated nasal septum with spur
b. Mild DNS
c. Septal thickness
d. DNS touching the lateral nasal wall

189. Inferior turbinate hypertrophy on the opposite side secondary DNS is known as....
a. Compensatory hypertrophy
b. Relative hypertrophy
c. Metastatic hypertrophy
d. Dystrophic hypertrophy

190. Etiology of antrochoanal polyp is believed to be....
a. Infective
b. Allergic
c. Viral
d. Fungal

191. Etiology of ethmoidal polyposis is believed to be....
a. Infective
b. Allergic
c. Viral
d. Fungal

THROAT

192. True about Venturi jet ventilation is....
a. Good for pediatric endoscopy
b. For endolaryngeal LASER
c. Should be periodically terminated
d. All is true

193. Complications of Venturi jet ventilation are....
a. Pneumothorax
b. Hypoventilation
c. Surgical emphysema
d. Abdominal distension
e. All of above

194. Cri du chat syndrome has all features except....
a. Deletion of short arm of chromosome 5
b. Narrow and diamond-shaped endolarynx
c. Recurrent nerve palsy
d. Interarytenoid cleft

195. True about Down's syndrome is....
a. Abnormal shape of nasopharynx
b. Poor tone of tensor palati
c. Eustachian tube dysfunction
d. All of above

196. True about histiocytosis is....
a. Granulomatous disorder
b. Osteolytic frontal bone lesions
c. Hepatosplenomegaly
d. Steroids useful

197. True about cystic hygroma is except....
a. Called lymphangiomatous ectasia
b. Airway/feeding problem
c. Spontaneous remission common
d. Early surgical intervention needed

198. All is true about lymphoma except....
a. Most common pediatric malignancy
b. Fine needle aspiration biopsy good help
c. Surgery is the management
d. Bone marrow aspiration good

199. CPAP in SAS means....
a. Chronic pulmonary airway pressure
b. Continuous positive airway pressure
c. Continuous pulmonary airway pressure
d. All of above

200. All is true about true vocal cords except....
a. Thickness is 1.7 mm
b. Lymphatics very poor
c. Posterior cricoarytenoid is adductor
d. Carcinoma VC bad prognosis

201. All is true about vocal cord medialization except....
a. Steroids very useful
b. Teflon paste injection helpful
c. Thyroplasty type II may be done
d. Autologus collagen is another help

202. All is true about paraganglioma except....
a. Called chemodectomas or glomus
b. Urinary VMA measurement helpful
c. Formula of 10 percent applicable
d. Serum catecholamines level decreases

203. All is true about carcinoma glottis *in situ* except....
a. Serial microlaryngoscopy and stripping is good
b. Radiotherapy is equally good
c. LASER another method of treatment
d. Biopsy for records and documentation

204. True about TM Joint syndrome is....
a. Trauma mandible may be a factor
b. Associated with bruxism
c. NSAIDs may be helpful
d. All is true

205. True about Gutzman's sign is....
a. Anterior thyroid cartilage pressure decreases voice pitch
b. Useful sign for SLN paralysis
c. Lateral thyroid cartilage pressure increases voice pitch
d. Reverse true in SLN palsy
e. All is true

206. All is true about apoptosis except....
a. Tumor necrosis factor is the cause
b. A programed cell death
c. Changes occur at nuclear level
d. All is true

207. True about Marjolin's ulcer is....
a. It is a skin ulceration
b. Occurs at the site of old scar following burns
c. Malignant degeneration may occur
d. All is true

208. All is true about verrucous carcinoma except....
a. A variant of squamous cell carcinoma
b. Most common site buccal mucosa
c. RT is very helpful
d. Surgery not good

209. True about Passavant's ridge is except....
a. Closes nasopharynx from oropharynx
b. Formed by superior margin of superior constrictor
c. Present on posterior wall of pharynx
d. Deficiency causes rhinolalia clausa

210. Reed Sternberg cells are typical of....
a. Rhinoscleroma
b. Hodgkin's disease
c. Acoustic neuroma
d. Glomus tumor

211. True about cherubism is....
a. Painless enlargement of mandible
b. Autosomal dominant

c. Multiloculated lucencies
d. Self-limiting disease
e. All is true

212. True about Eagle's syndrome is....
a. Associated with elongated styloid process
b. Dysphagia is present
c. Referred pain around ear
d. Calcified stylohyoid ligament
e. All is true

213. Lymphatic metastasis is more common in....
a. Carcinoma glottis
b. Carcinoma supraglottis
c. Carcinoma subglottis
d. All is true

214. True about rhabdomyosarcoma is....
a. Orbit neck and face common sites
b. Seen before 10 years of age
c. Most common soft tissue malignancy
d. Chemoradio is effective
e. All is true

215. Lymphatic metastasis is less common in....
a. Carcinoma lip
b. Floor of mouth
c. Carcinoma tongue
d. Subglottis

216. All is true about primary occult tumor....
a. Usually squamous cell carcinoma
b. Repeated examination and biopsies helpful
c. Base of tongue and nasopharynxcommon sites
d. All is true

217. Lymphatic metastasis is more common in....
a. Transglottic tumors
b. Pyriform sinus
c. Postcricoid carcinoma
d. Retromolar trigone

218. Differential diagnosis of a midline single mass can be all except....
a. Thyroglossal cyst
b. Delphian node
c. Aberrant thyroid
d. Cystic hygroma

219. True about paraganglioma is....
a. CT and MRI helpful
b. Occurs from carotid body, jugulotympanic areas
c. 10 percent multicentric
d. Surgical excision required
e. All is true

220. True about melanoma is....
a. Head and neck areas 20 percent
b. Variegated color
c. Prognosis good when ulcerative
d. Irregular border and surface

221. True about craniopharyngioma is....
a. Visual loss present
b. Arises from squamous cell nest of Rathke's pouch
c. Hypopituatrism
d. All is true

222. True about Wegener's granuloma is....
a. Steroids and methotrexate helpful
b. Autoimmune disorder
c. Pulmonary and renal involvement present
d. Upper and lower granulomatous disease
e. All is true

223. Sjögren's syndrome includes all except....
a. Xerostomia
b. Female male ratio is 9:1
c. Positive antinuclear antibodies
d. May be associated with rheumatoid arthritis
e. All is true

224. True about teratoma is....
a. Tumor of pluripotent embryonal cells
b. Majority seen by 1 year of age
c. 10 percent occur in head and neck
d. Composed of all 3 germinal layers
e. All is true

225. Hemoptysis is seen in all....
a. Carcinoma bronchus
b. Pulmonary infarction
c. Cystic fibrosis
d. AV fistula
e. All of above

226. True about nocardiosis is....
a. A type of actinomycosis
b. Associated with diabetes and immunosupression
c. Cuture on Sabauraud's agar media
d. Treatment is Incision and drainage and sulphonamides
e. All is true

227. All is true about parotid duct except....
a. Also called Stensen's duct
b. Lies along a line joining tragus and middle of upper lip
c. Stone formation is rare
d. Opens against crown of 1st molar

228. Unilateral proptosis is due to....
a. Graves disease
b. Tumors of PNS
c. Infections
d. Leukemias
e. All of above

229. All are premalignant conditions except....
a. Papillomas of oral cavity
b. Multiple papillomas of larynx
c. Plummer Vinson syndrome
d. Inverted papillomas of nasal cavity

230. True about recurrent papillomas larynx is all except....
a. Tracheostomy is avoided
b. Associated with HPV 6 and 11
c. Alpha interferon and CO_2 LASER good
d. Jet ventilation useful

231. True about Hurthle cell tumor is....
a. More at 45 to 50 years females
b. May be benign or malignant
c. Cell show granular cytoplasm with mitochondria
d. Usually negative with technetium-99 scan
e. All is true

232. All is true of foreign body aerodigestive tract except....
a. Usually children
b. Stridor and wheezing
c. Over inflation due to air trapping on X-ray
d. Wait and watch for spontaneous expulsion

233. True about ingestion of disc battery is....
a. More damaging due to lithium, Na and KOH and Hg
b. Repeat X-ray helpful
c. Endoscopic removal done
d. All is true

234. Exophthalmos in thyroid diseases improves with....
a. Giving of T4
b. Hypophysectomy
c. Thyroidectomy
d. Drugs's which inhibit T lymphocytes production

235. True about fibrous dysplasia is....
a. Developmental lesion seen at younger age group
b. Diffuse painless bony swelling seen
c. May be monostoticor polystotic
d. Irregular, mottled opaque appearance on X-ray
e. All is true

236. All can be CP angle tumors except....
a. Acoustic neuroma
b. Meningioma
c. Neurofibroma
d. Aneurysm

237. True about carcinoma esophagus is....
a. May follow cardiac achlasia
b. Associated with Plummer Vinson syndrome
c. Surgical treatment of choice for carcinoma lower third esophagus
d. Oculopharyngeal syndrome
e. All is true

238. Normal resting pressure in lower esophagus is....
a. 40 to 60 mm of Hg
b. 5 to 10 mm of Hg
c. 15 to 30 mm of Hg
d. None of above

239. Pseudostratified nonkeratinizing epithelium in larynx lines all except....
a. Vocalcords, falsecords
b. Aryepiglottic folds
c. Ventricles/saccule
d. Laryngeal surface of epiglottis

240. Lamier-Hackman's dehiscence lies between....
a. Cricopharyngeus and superior constrictor
b. Cricopharngeus and inferior constrictor
c. Circular and longitudinal fibers of esophagus
d. None of above

241. All form boundaries of parapharyngeal space except....
a. Base of skull
b. Ramus of mandible
c. Inferior constrictor medially
d. Carotid sheath and vertebral fascia

242. Cavernous sinus is related to all except....
a. Internal carotid artery
b. IIIrd, IVth, VIth nerve
c. Optic nerve
d. CN-V1 and V2

243. Blood supply to the tonsil is by all except....
a. Facial artery
b. Lingual artery
c. Internal maxillary artery
d. Ascending pharyngeal artery

244. Adenoids is supplied by all except....
a. Ascending palatine artery
b. Ascending pharyngeal artery
c. Greater palatine artery
d. Asceding branch of thyrocervical trunk

245. A female has Singers node with reflux, best treatment is....
a. Voice therapy with proton pump inhibitor
b. Microlaryngoscopic excision
c. LASER
d. Vocal cord stripping

246. Psammoma bodies are a feature of....
a. Glomus tumor
b. Adenocystic carcinoma Parathyroid
c. Papillary carcinoma of thyroid
d. None of above

247. Abbe-Estlander flap is used for reconstruction of....
a. Tongue
b. Lip
c. Cheek
d. Nose

248. Trotter's triad consists of all except....
a. Involve sinus of morgagni and mandibular nerves
b. Involves eustachian tube
c. Immobility of soft palate
d. Neuralgic pain in Vth nerve distribution
e. All is true

249. Mouse nibbled appearance of vocal cord is seen in....
a. Syphilis
b. Tuberculosis
c. AIDS
d. Carcinoma

250. Preoperative biopsy is contraindicated in all except....
a. Nasoph, carcinoma
b. Glomus tumor
c. Nasoph, fibroma
d. Parapharyngeal tumor

ANSWERS

Ear

1. c	2. d	3. c	4. a	5. b	6. c	7. b
8. c	9. c	10. b	11. d	12. b	13. c	14. b
15. d	16. b	17. a	18. c	19. b	20. b	21. c
22. d	23. e	24. c	25. c	26. c	27. c	28. a
29. b	30. e	31. a	32. b	33. b	34. b	35. b
36. b	37. b	38. d	39. a	40. c	41. c	42. c
43. b	44. d	45. c	46. d	47. b	48. d	49. d
50. c	51. d	52. b	53. d	54. c	55. b	56. a
57. b	58. a	59. e	60. d	61. d	62. c	63. b
64. a	65. c	66. c	67. c	68. b	69. b	70. d
71. e	72. bc	73. b	74. a	75. C	76. d	77. a
78. d	79. b	80. c	81. c	82. a	83. bc	84. a
85. c	86. c	87. a	88. c	89. c	90. a	91. a
92. d	93. b	94. b	95. b	96. c	97. b	98. c
99. c	100. d	101. d	102. d	103. d	104. a	105. b

Nose

106. e	107. b	108. b	109. a	110. bc	111. acd	112. d
113. bd	114. c	115. b	116. b	117. e	118. d	119. b
120. d	121. c	122. b	123. ac	124. e	125. bd	126. c
127. b	128. b	129. e	130. d	131. e	132. c	133. c
134. d	135. e	136. c	137. d	138. e	139. d	140. d
141. d	142. e	143. d	144. d	145. a	146. d	147. bc
148. e	149. d	150. d	151. d	152. d	153. d	154. c
155. d	156. e	157. b	158. b	159. c	160. d	161. a
162. b	163. c	164. c	165. d	166. d	167. c	168. b
169. a	170. c	171. a	172. b	173. c	174. b	175. a
176. a	177. b	178. a	179. a	180. b	181. d	182. c
183. b	184. c	185. b	186. b	187. a	188. d	189. a
190. a	191. b					

Throat

192. d	193. e	194. c	195. d	196. d	197. c	198. c
199. b	200. cd	201. ac	202. d	203. b	204. d	205. e
206. d	207. d	208. cd	209. d	210. b	211. e	212. e
213. b	214. e	215. d	216. d	217. b	218. d	219. e
220. c	221. d	222. e	223. e	224. e	225. e	226. e
227. d	228. e	229. b	230. d	231. e	232. d	233. d
234. c	235. e	236. d	237. e	238. b	239. cd	240. c
241. c	242. c	243. d	244. c	245. a	246. c	247. bc
248. e	249. b	250. a				

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