OPERATIVE TECHNIQUES IN GYNECOLOGIC SURGERY

Reproductive Endocrinology and Infertility

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Reproductive Endocrinology and Infertility

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Foreword

Operative Techniques in Gynecologic Surgery is presented in four volumes—*Gynecology, Reproductive Endocrinology and Infertility, Urogynecology and Pelvic Reconstructive Surgery*, and *Gynecologic Oncology*. Their purpose is to provide clear and concise illustrations of essential operations representing the fundamental procedures for each of these subspecialties.

This series is distinct from other textbooks in gynecology because of their focus as an illustrated practical guide to the surgical processes using easily accessible photographs and video clips.

In *Gynecology*, the first in the series, we depict the most common operations of our clinical specialty. The second does the same for *Reproductive Endocrinology and Infertility*, the third for *Urogynecology and Pelvic Reconstructive Surgery*, and the fourth for *Gynecologic Oncology*. We assembled a group of outstanding authors and contributors to produce these volumes, under the guidance of highly regarded expert senior book editors.

Gynecology—Tommaso Falcone, MD, is the Head of Gynecology at the Cleveland Clinic and is well known for his expertise in the operative management of benign gynecologic conditions. He and his co-authors, M. Jean Uy-Kroh, MD, and Linda D. Bradley, MD, have carefully assembled a very useful series of photographs and videos that highlight the fundamentals of the surgical operations in our field.

Reproductive Endocrinology and Infertility—Steven Nakajima, MD, is a Clinical Professor of Obstetrics and Gynecology in the Fertility and Reproductive Health group, Stanford University School of Medicine, and his focus is on the procedural and operative aspects of reproductive medicine. Along with the contributions from his colleagues, Travis W. McCoy, MD, and Miriam S. Krause, MD, this book will serve as a clear summary of the necessary procedures in this specialty.

Urogynecology and Reconstructive Pelvic Surgery—Christopher Tarnay, MD, is an Associate Professor at the David Geffen School of Medicine at UCLA, where he is the Chief of Urogynecology and Reconstructive Pelvic Surgery. He and his colleague, Lisa Rugo-Gupta, MD, Clinical Assistant Professor, Stanford University School of Medicine, have contributed substantially to our understanding of the important discipline of Female Pelvic Medicine and Reconstructive Surgery.

Gynecologic Oncology—Kenneth Hatch, MD, is a well-known gynecologic oncologist who is a Professor at the University of Arizona School of Medicine. He is considered one of the primary experts in the surgical management of gynecologic malignancies. Dr. Hatch and his contributors will provide a precise visual explanation of the essential operative treatments in this subspecialty.

We intend this series to enhance the educational activities for our colleagues in the practice of gynecology and dedicate this series to our patients in the hope that it will facilitate optimal care and improved outcomes for our patients.

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Preface

It is our honor to serve as the editors for this book of operative and office procedures currently practiced in reproductive medicine. This summary reflects the changing focus of the subspecialty of reproductive endocrinology and infertility (REI). Many past surgical operations have been replaced by the office procedure of in vitro fertilization (IVF) and embryo transfer (ET). Surgical procedures that used to be routine have been supplanted by minimally invasive approaches, some of which rely on robotic assistance. The changing nature of reproductive medicine and the many new developments in our subspecialty make this book an invaluable resource for REI subspecialists.

Most contributors to this book have a connection with Stanford Medicine or the University of Louisville. Seven of the authors were clinical fellows in REI at the University of Louisville when Steven Nakajima was the Program Director of the REI fellowship (Travis McCoy, Miriam Krause, Maher Abdallah, Mazin Abdullah, John Preston Parry, and Peter Uzelac). Two contributors are current fellows at Stanford (Jonathan Kort in REI and Steven Co in Radiology). Ariel Revel was a Feldman Family Foundation Visiting Professor at Stanford in 2016. Camran Nezhat and Azadeh Nezhat are on the medical staff of Stanford Hospital.

The authors were chosen for their expertise and willingness to share personal surgical knowledge with the medical community. All have distinguished themselves as accomplished surgeons and caring physicians. During the development of this book, our contributors dedicated many hours to complete this project. We extend our appreciation to their family members who granted them the time to contribute.

Steven T. Nakajima, MD
Travis W. McCoy, MD
Miriam S. Krause, MD

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Fertility Operations by Anatomic Location

1

Vagina

Chapter 1.1

Evaluation and Management of the Vaginal Septum

Jonathan D. Kort, Travis W. McCoy, Steven T. Nakajima

GENERAL PRINCIPLES

Definition

- The vaginal septum is at least a partially obstructive lesion along the course of the vagina resulting from failure of vertical fusion of the Müllerian ducts and the invagination of the urogenital sinus, or failure of lateral fusion of the two Müllerian ducts. The transverse septum, which may occur in the upper, middle, or lower vagina, is often obstructive, presenting with primary amenorrhea, muco- or hematocolpos, and cyclical pelvic pain.[1] Longitudinal vertical septae are often associated with concomitant uterine anomalies, and may be only partially obstructive and often present with difficulty placing a tampon, difficulty having intercourse, continued vaginal bleeding despite the use of a tampon or may be an asymptomatic finding during a pelvic exam.[2]
- A functional horizontal vaginal septum may be present from vaginal dilation of the space between a pinpoint or constricted true vaginal opening and the rectum.

Differential Diagnosis

- Transverse vaginal septum:
  - Müllerian agenesis (Mayer–Rokitansky–Kuster–Hauser syndrome)
  - Androgen insensitivity
  - Imperforate hymen
  - Cervical and/or vaginal agenesis
- Longitudinal vaginal septum:
  - Thick, portions of horizontal vaginal septae with fenestrations may occasionally appear similar to a partial longitudinal septum; however, the diagnosis of a complete or partial longitudinal vaginal septum is often straightforward. More attention must be paid to diagnose any associated uterine or renal anomalies.
- Horizontal vaginal septum:
  - Müllerian agenesis (Mayer–Rokitansky–Kuster–Hauser syndrome)
  - Androgen insensitivity
  - Cervical and/or vaginal agenesis

Nonoperative Management

- Transverse vaginal septum: Hormonal suppression of the hypothalamic–pituitary–ovarian axis to prevent cyclic development and shedding of the uterine lining may temporize the dysmenorrhea resulting from hematocolpos, but is only a temporary bridge to surgery.
- Longitudinal vaginal septum: Less than half of longitudinal vaginal septae are symptomatic enough to require surgical management.[2] For patients without dyspareunia or concern for dystocia in labor, expectant management may be the best option.
- Horizontal vaginal septum: Depending on the size of the vaginal opening, small to moderate amounts of retained menstrual blood may be present in the vagina. Hormonal suppression of the hypothalamic–pituitary–ovarian axis may temporize the dysmenorrhea resulting from the hematocolpos, but surgical correction is often necessary.

IMAGING AND OTHER DIAGNOSTICS

- In patients with a suspected imperforate hymen, an ultrasound and pelvic exam are usually sufficient to make the diagnosis. A bulging membrane at the vaginal introitus with bluish discoloration (caused by accumulated menstrual blood) is a characteristic presentation. The hymenal membrane usually distends if the patient is asked to perform a Valsalva maneuver. Patients typically complain of cyclic pain occurring at the time of menses. A uterus is present and can be seen on transabdominal ultrasound. An asymptomatic presentation of an imperforate hymen has been reported, but it is an atypical occurrence (**Figure 1.1.1A–D**).[3]
- For patients with a blind-ending vaginal pouch in which a transverse vaginal septum is suspected, a magnetic resonance imaging (MRI) is useful to confirm the diagnosis as well as identify the location and thickness of the septum.[4]
- For patients with a suspected longitudinal vaginal septum in which a concomitant uterine anomaly is suspected, MRI or ultrasound should be used to evaluate the uterus.
- In patients with a horizontal vaginal septum, a pelvic exam under anesthesia may help to identify the pinpoint or constricted vaginal opening. An ultrasound or MRI are often useful to confirm the presence of a cervix, uterus, and a possible hematocolpos.

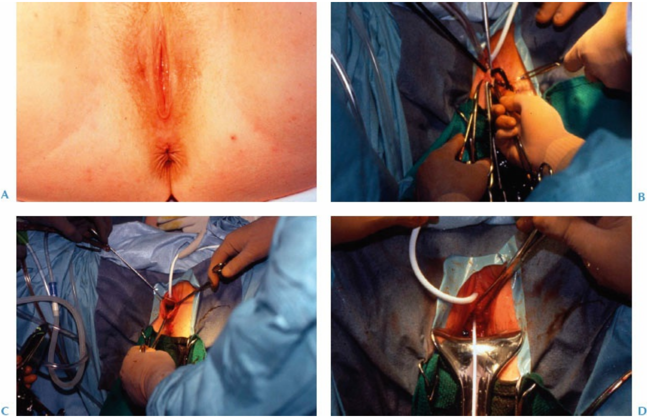


Figure 1.1.1. A: Normal external female genitalia. **B:** After entry through the imperforate hymen, 1,200 mL of retained menstrual blood noted to flow out of a 16 × 12 × 10-cm hematocolpos. **C:** Portions of the imperforate hymen prior to excision. **D:** Pediatric Foley catheter inserted through the cervix into the uterine cavity.

PREOPERATIVE PLANNING

- Prior to surgery, the location and the thickness of the septum should be elucidated by physical exam and imaging. In addition, it is also critical to confirm the presence of the cervix and exclude the diagnosis of cervical agenesis, particularly in cases of a high septum, which would require different surgical management.
- Hormonal suppression of menses prior to surgery may alleviate discomfort while waiting for definitive management.
- Vaginal dilator therapy preoperatively will help thin thick septae and elongate the lower vagina, facilitating surgical correction.[4]

SURGICAL MANAGEMENT

- Patients with a transverse vaginal septum usually suffer from obstructive amenorrhea and cyclical pelvic pain, and definitive surgical management is typically required. Due to the high rates of concurrent endometriosis, they should consider a laparoscopy at the time of resection of the septum.[5]
- It may be helpful for visualization not to drain the hematocolpos prior to surgical management.
- Patients with a longitudinal septum and dyspareunia or anticipating a vaginal delivery should have the septum resected.[6]
- Patients with a horizontal vaginal septum may present with cyclical pelvic pain depending on the size of the vaginal opening. Definitive surgical management is typically required for normal menstrual flow and the ability to conceive with vaginal intercourse.

Positioning

- Transverse vaginal septum: Patients with transverse vaginal septum should be positioned in the dorsal lithotomy position to allow access to the vagina and laparoscopy.
- Longitudinal vaginal septum: Patients with a longitudinal vaginal septum should also be positioned in dorsal lithotomy position, but only access to the vagina is required.
- Horizontal vaginal septum: Patients with horizontal vaginal septum should be positioned in the dorsal lithotomy position to allow access to the vagina and a possible laparoscopy.

Approach

- Resection of all vaginal septae require a vaginal approach, but simultaneous laparoscopy is helpful in cases of transverse vaginal septae due to the high rates of concurrent endometriosis.[5]
- Cases of longitudinal vaginal septae with a concurrent uterine septum may require the ability to correct the uterine septum with a hysteroscopic procedure.

Transverse Vaginal Septum

Visualization

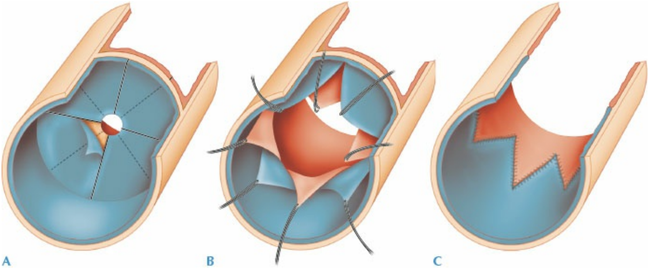
- A Foley catheter should be placed and a diagnostic laparoscopy should be performed to visualize the hematocolpos from above.

Confirmation of diagnosis and localization of vaginal canal

- With the bladder drained, and a rectal exam confirming the path and angle of vaginal canal, a needle should be placed into the hematocolpos to confirm the diagnosis.[6]
- For a high thick septum that is difficult to localize despite laparoscopic visualization and rectal exam, a probe can be placed through the fundus of the uterus, through the cervix, to localize the upper vagina.

Incising the lower aspect of the septum from below

- Two oblique, crossed incisions should be made in the vaginal mucosa and four triangular vaginal flaps are created with sharp and blunt dissection (**Tech Figure 1.1.1A–C**).[7]
- The vaginal flaps are then stabilized with stay sutures.



Tech Figure 1.1.1. A: The mucosa of the vaginal vault (the anterior portion of the septum) is colored blue. It is incised with a crossed incision leaving four flaps. **B:** The mucosa of the upper portion of the vagina (the posterior portion of the septum) is colored light brown. It is incised leaving four flaps at 45 degrees to the anterior portion of the septum. **C:** The upper and lower vaginal flaps are rotated toward each other and sutured with a single layer of interrupted sutures leading to a continuous Z-plasty.

Resection of the areolar septal tissue

- Palpating the Foley catheter anteriorly, and the rectal hand posteriorly in order to avoid the complications of bowel or bladder injury, the areolar tissue exposed from the initial step is resected sharply or with cautery.

Incising the upper aspect of the septum from below

- Two crossed incisions are made in the posterior aspect of the septum, with the crossed incisions from the anterior and posterior aspect of the septum positioned at 45 degrees from one another, creating four more triangular flaps of vaginal mucosa.

Z-plasty: Re-anastomosis of the upper and lower portions of the septum

The upper and lower vaginal flaps are rotated toward each other. If needed, the underlying tissue can be dissected further with careful attention paid to avoid the bowel and bladder, to allow re-anastomosis without tension with a single layer of interrupted, delayed absorbable sutures.[7] This step completes the continuous Z-plasty.

Avoidance of postoperative complications

- Many surgeons will coat the Z-plasty anastomosis with a topical estrogen cream.
- Some will place a rigid vaginal mold in the vagina until discharge, changing it daily. An elastic mold can be used as an outpatient afterward.
- Vaginal intercourse in contraindicated for at least 6 weeks postoperatively.

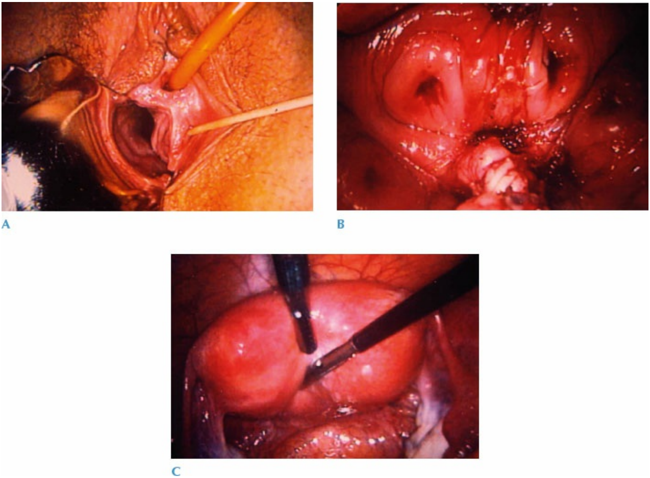
Alternative procedure to avoid disruption of the hymen

For patients who desire to preserve hymenal integrity for cultural reasons, perforating the hymen only enough to allow placement of a Foley catheter through the transverse septum for 2 weeks may also resolve dysmenorrhea and muco- or hematocolpos. To facilitate the placement of the Foley catheter, Gezginç´ and colleagues[8] entered the abdomen via a laparotomy incision and made a vertical incision on the posterior vaginal wall. The Foley catheter was guided through perforation in the transverse vaginal septum located in the upper third of the vagina.

Longitudinal Vertical Vaginal Septum

Resection of the anterior aspect

- This surgery can be performed under general or local anesthesia. A Foley catheter is placed to protect the bladder from the dissection.
- One side of the vagina may be preferentially enlarged due to prior sexual intercourse and the smaller diameter vagina may be difficult to locate or have been missed on prior pelvic exams (**Tech Figure 1.1.2A–C**).
- One Allis clamp is placed at the ventral aspect of the septum, and another at the dorsal aspect of the septum, at the level of separation from the vaginal mucosa. An anterior dissection with an electrocautery needle should then be made from the introitus to the cervix, ending several millimeters from the cervix to avoid any damage to the cervix.[4]



Tech Figure 1.1.2. A: Patient with a longitudinal vertical vaginal septum. Speculum is in the right vaginal canal. Sterile tip applicator is located in the left vaginal canal. Foley catheter placed through the urethra into the bladder. **B:** Vaginal septum excised and two cervical openings noted. **C:** Laparoscopic view of a single fundus containing two separate uterine cavities.

Resection of the posterior aspect

This dissection can then be continued posteriorly, also stopping several millimeters from the cervix, with the electrocautery.

Closure

- The edges of resection should then be sutured with 3–0 or 4–0 delayed absorbable material interrupted sutures.

Alternative technique

- The longitudinal septum could be excised with a tissue-sealing instrument LigaSure Impact™, (Covidien, Minnapolis, MN) and may preclude the need to suture any edges of the resected tissue **(Video 1.1 Vaginal vertical septoplasty)**.

Prevention of adhesions

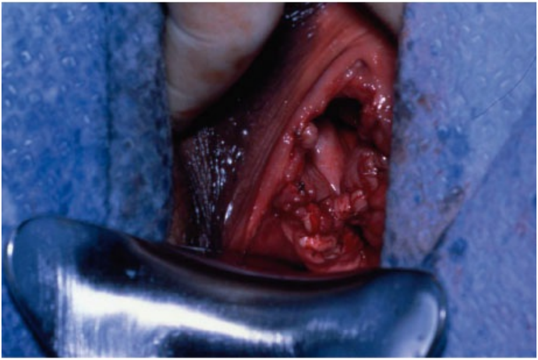
The suture line can then be coated with topical estrogen. If the resection was extensive or the resection lines are close to one another, a vaginal mold can be placed for 1 to 2 weeks postoperatively.

Horizontal Vaginal Septum

Resection of the horizontal septum

- This surgery should be performed under general anesthesia. A Foley catheter is placed to protect the bladder from the dissection (**Tech Figure 1.1.3A–B**).

A



B

Tech Figure 1.1.3. A: Patient with a horizontal vaginal septum. Upper sterile tip applicator is located in the urethra. Lower sterile tip applicator is located through the opening of the vagina. Vaginal opening below the horizontal septum ends in a blind vaginal pouch developed from vaginal intercourse. **B:** Horizontal septum excised and single vaginal cavity exists.

- Identification of the pinpoint or constricted vaginal opening leading into the vagina can be confirmed by visualization of the cervix with the use of small diameter hysteroscope.
- After the vaginal opening is identified, Allis clamps are placed at the lateral aspects of the septum and the septum incised. Depending on diameter and the depth of the falsely dilated posterior vagina ending in a blind pouch (often by prior intercourse), a 1- to 2-cm wide portion of the horizontal vaginal septum may need to be excised rather than just divided. The horizontal septum should be removed from the introitus to the cervix, ending several millimeters from the cervix to avoid any damage to the cervix.

Closure

- The edges of resection should then be sutured with 3–0 or 4–0 delayed absorbable material interrupted sutures.

Prevention of adhesions

- The suture line can then be coated with topical estrogen. If the resection was extensive or the resection lines are close to one another, a vaginal mold can be placed for 1 to 2 weeks postoperatively.

PEARLS AND PITFALLS

Longitudinal septum resection	✖ Avoid dissection too close to the cervix in order to avoid injury to the cervix.
Transverse septum resection	○ Always confirm with palpation of the Foley catheter and a rectal exam to avoid dissecting into the bladder or bowel.
Horizontal septum resection	○ Use of a hysteroscope to visualize the cervix through the constricted vaginal opening can confirm the presence of a horizontal vaginal septum.
Postoperative care	○ Topical estrogen and placement of vaginal molds can avoid stricture formation.

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Chapter 1.2

Creation of a Neovagina

Miriam S. Krause, Steven T. Nakajima

GENERAL PRINCIPLES

Definition

Vaginal agenesis, also known as Mayer–Rokitansky–Kuster–Hauser syndrome (MRKH), is caused by disordered embryologic development of the Mullerian (paramesonephric) ducts. As a consequence, the uterus and upper two-thirds of the vagina do not develop. The lower part of the vagina is present, because this structure develops from the urogenital sinus. Rudimentary small uteri and fallopian tubes may be present. The ovaries are usually normal. This finding occurs in one in 5,000 to one in 10,000 female births.[1] MRKH syndrome is often associated with other genetic, endocrine, and metabolic abnormalities. The most common abnormalities include the urinary tract (30% to 47%)[2] and skeletal (12%)[3] system. The genetic and phenotypic sex of an individual with MRKH syndrome is female (46XX, with external female genitalia, normal breast development, normal female hair growth pattern, and normal female body proportions). MRKH syndrome is usually discovered during the workup for primary amenorrhea. Uterine remnants may contain functional endometrium and cause hematometra and resulting endometriosis. A neovagina can be created to allow for intercourse in individuals with MRKH syndrome. Different options are available and include nonsurgical and surgical treatment. The best procedure for the creation of a neovagina is yet to be determined, because there are only few studies comparing one procedure with another, including only one randomized controlled study.[4] Preference is usually given to the procedure most familiar to the operating surgeon. Some of these procedures may be difficult to replicate because the equipment may not be commercially available, but are included for completeness. Surgical treatment should only be performed in treatment centers specialized in these procedures.[5]

For all of these procedures, though, patient compliance is extremely important for a successful outcome.

Differential Diagnosis

The following conditions present with primary amenorrhea as well and need to be distinguished from vaginal agenesis:

- Imperforate hymen. This finding is characterized by a bulging membrane at the vaginal introitus with bluish discoloration (caused by accumulated old blood). The hymenal membrane usually distends if the patient is asked to perform a Valsalva maneuver. Patients typically complain of cyclic pain occurring at the time of menses. A uterus is present and can be seen on transabdominal ultrasound. Karyotype is 46XX.
- Transverse vaginal septum. The location of the septum within the vagina may be variable, and if patients have been sexually active some vaginal dilation up to the septum may be present. The distinguishing factor compared to an imperforate hymen is a small, blind ending vaginal pouch. A transverse septum does not bulge with Valsalva maneuvers and there may be a segment of varying length missing between the lower and upper vagina. Patients may present with cyclic or constant abdominal pain secondary to accumulation of blood proximal to the septum. A uterus is present and can be visualized on transabdominal or transvaginal ultrasound. Karyotype is 46XX.
- Androgen insensitivity (prior terminology referred to this condition as “testicular feminization”). This disorder is caused by an androgen receptor defect. Individuals have a male karyotype (46XY) but phenotypically appear female with tall stature, relatively large breasts with pale areolae, and absent pubic and axillary hair. Internal genital organs are male with no uterus present. A serum testosterone level will be in the normal male range. The confirmatory test is a male karyotype. Patients with androgen insensitivity may benefit from the creation of a neovagina after removal of testes in the same fashion as patients with MRKH syndrome. A gonadectomy is performed to prevent development of either a gonadoblastoma or dysgerminoma.
- 17-alpha hydroxylase deficiency in a 46XY individual. This disorder is caused by a deficiency in the CYP17A1 gene and leads to hormonal abnormalities mainly of the adrenal steroid pathway (elevated progesterone; low or absent concentration of the following steroids: 17-hydroxyprogesterone, cortisol, dehydroepiandrosterone sulfate (DHEAS), Dehydroepiandrosterone (DHEA), androstenedione, testosterone, and estradiol). Genetically male individuals with this enzyme deficiency are usually raised as female secondary to female external genitalia. They have, however, a blind ending vagina and intra-abdominal testes, and present with primary amenorrhea in puberty. The confirmatory test is a male karyotype. A neovagina can be created using the techniques mentioned below. The gonadectomy is performed to prevent development into either a gonadoblastoma or dysgerminoma.

Anatomical Considerations

Depending on whether regular sexual activity has occurred in the past, the depth of a vaginal pouch in all of the above conditions can vary significantly.[6]

Nonoperative Management

Nonsurgical creation of a neovagina relies on intermittent pressure on the perineum, thereby stretching the vaginal dimple into a vagina-like space. These options include active and passive dilation and are listed further below.

Imaging and Other Diagnostics

The following can be helpful to make the correct diagnosis:

- History, specifically for cyclic pelvic pain, family history, sexual activity
- Physical exam: Inspection of the introitus during Valsalva maneuver; gentle rectal exam to feel for the presence or absence of a midline uterus (if the uterus is absent, the examiner may feel a smooth band from one side of the pelvis to the other)
- Transabdominal ultrasound (or possibly transvaginal ultrasound, if a vaginal pouch is present; otherwise translabial ultrasound)
- Pelvic magnetic resonance imaging (MRI): This may be especially important for planning of any reconstruction surgery associated with a transverse vaginal septum
- Karyotype: If a Y chromosome (either complete or partial) is present, usually the intra-abdominal gonads have to be removed to prevent malignancy.
- Hormone profiles (e.g., follicle-stimuating hormone [FSH], luteinizing hormone [LH], testosterone)

PREOPERATIVE PLANNING

Besides the standard preoperative planning, several additional factors are important for the creation of a neovagina. These include the timing of the procedure, psychological counseling, a multidisciplinary team approach, and preoperative evaluation.

- Timing of the operation is based on the level of sexual activity, and is usually best performed between the ages of 17 and 20 years when patients are emotionally mature and intellectually reliable to manage a form used to maintain the neovaginal space. Cooperation is very important for the best possible long-term success, and the psychosocial adjustment of the patient to her condition is important for a successful outcome.
- The diagnosis of MRKH syndrome usually comes as a shock to the teenage patient and her parents. Concerns and fears include diminished self-esteem and not feeling "female," as well as concerns for being able to have intercourse and carry children. It is important to discuss all of these concerns, and to stress the fact that different options are available to create a neovagina. A biologic child can be achieved via a gestational carrier. Psychological counseling in a group session with a gynecologist, social worker, and possibly a former patient with MRKH syndrome has been shown to be effective.[7]
- The multidisciplinary team approach includes a gynecologist, psychologist, urologist, and possibly colorectal surgeon, depending on which surgical approach is chosen.
- The preoperative evaluation includes, depending on the presentation, a transabdominal or transvaginal ultrasound, MRI of the pelvis, a chromosome analysis, intravenous pyelogram (for renal and spinal abnormalities), and possibly an exam under anesthesia.

SURGICAL MANAGEMENT

The different surgical procedures rely on three principles for a successful operation: (1) Dissection of an adequate space between the rectum and bladder; (2) creation of an inlay (such as peritoneum, sigmoid, split-thickness skin graft [STSG]); and (3) continuous and prolonged dilation during the contractive phase of healing.

Positioning

The patient is positioned in the dorsal lithotomy position, with the feet in adjustable stirrups. This allows for both a vaginal and laparoscopic approach either at the same time or in sequence. The only exception is the Abbe–Wharton–McIndoe procedure, where the patient is first placed on her abdomen in order to obtain the graft from the patient's buttocks. After that, the patient is placed in the dorsal lithotomy position.

Approach

The surgical techniques can be divided by their anatomic approach: purely vaginal versus the combined vaginal and laparoscopic approach. Surgical preparation should be performed accordingly. They can also be divided depending on what tissue is used to create the neovagina: peritoneum, intestine, split-skin grafts, or vulva.

Different surgical options include:

1. Abbe–Wharton–McIndoe operation
2. Williams vulvoplasty
3. Davydov laparoscopic procedure
4. Laparoscopic sigmoid vaginoplasty (Ruge)
5. Laparoscopic Vecchietti procedure
6. Laparoscopic vaginoplasty using single peritoneal flap (SPF)

Nonsurgical Management

Frank dilation (active dilation)

The patient administers dilators in increasing length and width on a daily basis to the perineal area or vaginal pouch, if one is already present.[8] Stretching should occur first in a posterior direction toward the sacrum, followed by more cranial direction. This change in direction is important to prevent damage to the urethral opening. The dilators should be applied twice daily for 30 minutes for 2 to 4 weeks. Local anesthetic gel can be applied prior to placing the dilator. Regular intercourse in selected patients has had the same results. The Frank procedure, compared to the McIndoe procedure (see below), appears to give more physiologic results with regard to vaginal pH, lubrication, and hormonal cytology throughout the menstrual cycle.[9]

Ingram method (passive dilation)

This technique uses a set of gradually increasing sized vaginal dilators in combination with a racing bicycle seat stool. The patient is instructed on how to place the dilator, which is held in the desired location with supportive underwear and regular clothes worn on top. She then sits on the bicycle stool, leaning slightly forward, with the dilator in place for at least 2 hours daily at 15- to 30-minute intervals. Follow up is monthly, at which point the next larger dilator can be used. Sexual intercourse can be attempted once the largest dilator has been used for 1 to 2 months. Continued dilation should be recommended if intercourse is infrequent. Functional success has been documented in 91.9% of patients using this method.[10] The reported advantages of this treatment compared to Frank dilation are twofold: The patient does not have to press the dilator against the vaginal pouch herself, and the neovaginal space is evenly dilated. Passive dilation has been shown to be successful and can be suggested as an initial therapy, with operative vaginoplasty indicated for failed dilation.

Surgical Management: Abbe–Wharton–McIndoe Operation

This procedure entails a purely vaginal approach and uses an STSG from the buttock area.

Step 1: Taking the graft from the buttock

- The graft is taken from the buttock area that is usually covered when wearing underwear for cosmetic reasons.
- The skin is disinfected with povidone–iodine, which is then removed.
- Mineral oil is placed on the donor site. While assistants stretch the buttock area, a Padgett Electro-Dermatome (Integra, Plainsboro, NJ) is used to obtain the skin graft. The graft should be 0.018-inch thick, 8 to 9 cm wide and 16 to 20 cm long. If the buttock is not large enough to provide the entire graft, half of the length can be taken from each buttock. Pressure should be applied evenly so that the graft is continuous.
- The graft is placed in between moistened gauze.
- The donor sites are dressed using diluted epinephrine (as a hemostatic agent), following a sterile dressing and a pressure dressing. The pressure dressing can be removed after 7 days, and the sterile dressing will eventually separate and fall away.

Step 2: Creation of the neovaginal space

- The apex of the vaginal dimple is incised transversely through the mucosa.
- The space between the bladder and urethra (anteriorly) and rectum (posteriorly) is dissected up to the peritoneum. Placing a catheter in the bladder and a finger in the rectum helps to stay in the desired plane. One channel can be created bluntly on each side of the median raphe, which is then divided.
- The midportion of the medial margin of the puborectalis muscle may be incised bilaterally to prevent vaginal narrowing at the urogenital diaphragm. This is especially important in an android pelvis, such as in the case of androgen insensitivity.
- The dissection should leave some tissue beneath the peritoneum so that the graft is more likely to adhere to the site.
- All blood vessels should be ligated using thin suture in order to prevent separation of the graft and subsequent necrosis.

Step 3: Preparing the vaginal mold

The original McIndoe technique used a rigid balsa wood to shape the skin graft.[11] A newer technique, the Counseller-Flor modification, uses a foam rubber to shape the mold[12]: A 10 × 10 × 20-cm gas sterilized foam rubber mold is cut with scissors into twice the desired size, covered with a condom and placed in the neovagina. After 20 to 30 seconds the foam molds into the neovaginal space. The condom is tied off at the base at this point, using 2–0 silk, and the form is withdrawn. The mold and the condom are both covered by a second condom and tied off.

Step 4: Sewing the graft on the vaginal mold

- The outer condom is then covered with the skin graft. The graft is attached to the form using interrupted vertical mattress sutures with 5–0 nonreactive suture.
- It is important to not leave any gaps, because granulation tissue may develop and this can lead to contraction.
- The graft with the mold is placed in the newly dissected space and the graft edges are attached to the skin edge using 5–0 nonreactive absorbable sutures, leaving room for drainage.
- A Foley catheter is placed in the bladder or a suprapubic catheter can also be used to decompress the bladder.
- The labia are sutured together with nonreactive sutures to keep the mold in place.

POSTOPERATIVE CARE

- The mold is removed for the first time after 7 to 10 days under mild sedation. Using warm sterile saline, the cavity is irrigated and then evaluated. Specific attention is given to make sure the graft has attached well, that there is no granulation tissue, and no necrosis. Too much pressure, specifically superiorly and posteriorly toward the cul de sac, can cause weakening of the tissue and lead to enterocele formation.
- Broad-spectrum antibiotics should be given for the first 7 days.
- The patient is given the following instructions: to remove the mold daily and to irrigate the vagina with saline. The patient should utilize the mold continuously for 6 weeks except for urination and bowel movements. After this time period, the mold should be worn every night for the next 12 months, followed by intermittent wear. If the mold is difficult to insert, continuous application may be necessary.

OUTCOME: RESULTS AND COMPLICATIONS

- The overall satisfaction is reported as 80% to 100%. Hojsgaard and Villadsen[13] report in their series of 26 patients a successful complete attachment of the graft within a week in 33%, and after one revision in an additional 38% of patients. In their study, rectal perforation occurred in 3.8%, bleeding and vaginal stricture in 11.5%, formation of a urethrovaginal fistula in 7.7%, and rectovaginal fistula formation in 3.8%. In a different study, Allessandrescu et al.[14] reported on 201 patients, with the occurrence of rectal perforation in 1%, graft infections in 4%, but overall 86.3% of patients had a good anatomic result.
- Additional complications include formation of a vesicovaginal fistula, intra- and postoperative bleeding, formation of granulation tissue (which can cause coital bleeding and leukorrhea), graft failure as well as a tendency for scarring of the upper portion and subsequent constriction of the neovagina.

Surgical Management: Williams Vulvovaginoplasty

This technique was developed by Williams in 1964[15] and has since then been modified in different ways.[16] It is most successful in women with larger labia. The skin from the labia is used to line the neovagina. It has several advantages: It is technically simple to perform with no need for dilation postoperatively; there are no significant complications reported; and postoperative pain was judged to be minimal. Disadvantages include that the vaginal angle is shallower, and that urine can collect in the newly created pouch. Overall, there are few patients reported in the literature to have undergone this procedure.

Step 1: Vulvar skin incision

An incision is made in the vulva in the form of a horseshoe as close as possible to the hairline, including the medial side of the labia, extending up to the urethral meatus.

Step 2: Reapproximation of inner skin margins

- The inner skin margins are reapproximated with 3–0 polyglycolic acid sutures. The knots are tied on the inside of the newly created vaginal lumen. Originally 0-chromic catgut was used, but this has been since modified.
- Support is given by placing a second layer of stitches involving the perineal muscles and subcutaneous fat.

Step 3: Reapproximation of external skin margins

The outer skin margins of the labia are connected using interrupted sutures. This creates a 3 cm deep pouch.

POSTOPERATIVE CARE

- A Foley catheter is placed and the patient needs to be on bedrest for 7 days to avoid traction on the stitches. Due to inactivity, one may consider the use of anticoagulation.
- The patient then uses dilators for the next 6 weeks.

OUTCOME: RESULTS AND COMPLICATIONS

- There were no significant complications reported, but only small series of patients are available for review. This procedure can be considered after an unsuccessful McIndoe procedure.

Surgical Management: Davydov Procedure

This procedure uses peritoneum for epithelialization of the neovagina. The surgical approach is simultaneously vulvar and abdominal (either open or laparoscopic) in most reports, but can also be performed via perineal approach only.[17–19]

Step 1: Dissection and mobilization of the peritoneum

- Peritoneum from the Douglas pouch is dissected and mobilized via abdominal approach, either via standard laparoscopy or laparotomy.

Step 2: Creation of a vaginal space

A space between the urethra, bladder, and rectum is created via the perineal approach. The mid sagittal plane should be avoided to facilitate dissection. The midline tissue bridge can be removed once the peritoneum is reached.

Step 3: Descent of the peritoneum

- The dissected peritoneum is opened and pulled toward the vulva using four vicryl sutures.
- It is then connected with the vulvar epithelium. Commonly a mold measuring approximately 3.2×11 cm long is used.[19]
- One or two absorbable purse-string sutures are then used via abdominal approach to close the peritoneum over the mold.

Step 4: Securing the mold

- Labial sutures are placed to keep the mold in the desired location for 1 week.
- A Foley catheter is placed to decompress the bladder for the same time period.

POSTOPERATIVE CARE

- The patient is instructed in changing and cleaning the mold: After the first week, the mold is removed only for showering and urination/defecation. After that the utilization (wearing) time of the mold is gradually decreased on an individual basis.
- Intercourse can be undertaken after 5 to 7 weeks postoperatively. Once regular intercourse has been established, the mold can be used less frequently.

OUTCOME: RESULTS AND COMPLICATIONS

- Willemsen and Kluivers[19] evaluated the long-term results using the Frank and Davydov procedure in 160 patients, of which 68 underwent the Davydov procedure. The mean time until complete epithelialization of the neovagina was reached with the Davydov procedure was 11 months with a mean functional vaginal length of 7.8 cm. Complications overall were rare and mainly included the formation of granulation tissue, fistulas, and strictures of the neovagina. However, one patient died in the surgical group. The cause of her death was determined to be hepatotoxicity secondary to anesthetic medications.
- One advantage using peritoneum was that this tissue functions like vaginal epithelium with regard to hormonal changes and lubrication during intercourse.

Surgical Management: Laparoscopic Sigmoid Vaginoplasty (Ruge Procedure)

This procedure uses sigmoid colon for epithelialization of the neovagina. The surgical approach can either be simultaneously vulvar and abdominal (either open or laparoscopic) in most reports, or via abdominal approach only.[20] Originally described as an open abdominal procedure via Pfannenstiel incision, it is now often performed laparoscopically. This technique requires a mechanical intestinal preparation with polyethylene glycol and a rectal enema 36 hours preoperatively.

Step 1: Laparoscopic creation of a vaginal space

- Standard laparoscopic abdominal entry is performed.
- Starting from the pouch of Douglas toward the peritoneum, the space between the bladder and rectum is dissected, using sharp and blunt dissection. It can also be created starting at the perineum working toward the peritoneal cavity.

Step 2: Preparation of the sigmoid graft

- The sigmoid colon is mobilized and a 15- to 20-cm long loop above the rectosigmoid junction is visualized. The goal is to obtain a pedicle on a single artery, usually the third inferior sigmoid artery. Examining the vascular anatomy can be done by transilluminating the mesosigmoid.
- The distal sigmoid border is delineated with a GIA™ 60 mm Stapler (GastroIntestinal Anastomosis Auto Suture, US Surgical Corp, Norwalk, CT).
- The proximal sigmoid border can be attached to a surgical clamp.
- End-to-end anastomosis on the remaining sigmoid is performed via a PCEEA 28 or 31 mm forceps (Premium Plus Circular End to End Anastomosis, Auto Suture, US Surgical Corp, Norwalk, CT).

Step 3: Anastomosing the graft

- The isolated sigmoid segment is pulled toward the perineum through the previously created channel. It is important to avoid any traction on the supporting blood vessels.
- The colovestibular anastomosis is connected using interrupted polyglactin 3–0 sutures.

Step 4: Securing the graft

- Two polyester stitches are used to secure the top portion of the neovagina to the promontory fascia.
- The mesosigmoid and the abdominal cavity are closed in the standard fashion.

POSTOPERATIVE CARE

- A Foley catheter is placed for 3 days postoperatively, and perioperative antibiotics are continued for the same time frame.
- One month postoperatively, an exam under anesthesia is performed, followed by a second exam in the office 1 month later. It is important to check for graft integrity and granulation tissue. If healing has occurred, either intercourse or Hegar dilators (usually once every 2 to 3 days, #26 or #27 size) can be attempted.

OUTCOME: RESULTS AND COMPLICATIONS

- Per Communal,[20] good anatomic results were obtained with this method in 16 patients, with no significant intra- or postoperative complications.
- Functional results were assessed via a patient questionnaire that mentioned 50% dyspareunia during the first year. This number is equivalent to other techniques. Overall, good lubrication of the sigmoid graft has been reported.
- Disadvantages include excessive mucous discharge, introital stenosis, and prolapse of the mucosa. Furthermore, only small patient numbers have been evaluated.

Surgical Management: Vecchietti Procedure

This procedure was first described in 1965[21] with a laparotomy approach and has since then been modified in several ways, the most important modification being the laparoscopic approach[22–24] with similar outcomes.[25] The Vecchietti technique creates a neovagina in as short as 9 days time. Specific equipment including a traction device, acrylic olive, and ligature carrier is required. This equipment can either be purchased (Marina Medical, Sunrise, FL) or be self-prepared.[26],[27] In summary, an olive-shaped dilator is placed on the perineum and pulled toward the peritoneal cavity via traction sutures anchored in the rectus muscles and a traction device on the abdomen.

Step 1: Laparoscopic entry and placement of probes

- Three 5-mm laparoscopic ports are placed: one in the umbilicus and one each in the right and left lower quadrant, about 10 cm below the umbilicus and 10 cm lateral to the midline.
- A Foley catheter is placed in the bladder with a probe to deflect the bladder, as well as a probe in the rectum.

Step 2: Placement of the olive and traction sutures

- The olive-shaped dilator is placed on the perineum with its traction sutures attached.
- Through one of the lower ports, the straight Vecchietti needle is introduced subperitoneally (extraperitoneally) in order to minimize damage to intraperitoneal structures. For this, the port has to be removed and the needle guided subperitoneally and laterally to the rectus muscle until it can be inserted into the rectovaginal space. To minimize rectal or bladder injury, the needle can be guided by a finger in the rectum, and the bladder is deflected anteriorly.
- One of the traction sutures on the olive is hooked on the Vecchietti needle and pulled back through the rectovesical space and subperitoneally exiting outside of the body through the trocar incision.
- The same procedure is repeated with a Vecchietti needle introduced through the other lower port.

Step 3: Closure and tightening of the traction device

- The peritoneum is closed using 2–0 absorbable suture.
- The two sutures are attached to the traction device that is placed on the lower abdominal skin and fixed.
- By tightening the traction device daily (per manufacturer's instructions), constant traction on the olive will create lengthening of the neovagina, at a rate of up to 1.5 cm per day.
- The traction sutures and traction device are removed once the neovagina has a length of 7 to 8 cm.

POSTOPERATIVE CARE

- The Foley catheter needs to stay in place during the traction phase, and the patient is usually hospitalized for 2 to 3 days.
- After removal of the olive, the patient performs continued self-dilation with dilators of increasing size per physician discretion.
- Intercourse can be allowed as early as 20 days after the olive is removed.

OUTCOME: RESULTS AND COMPLICATIONS

- Different studies evaluating the long-term outcome of the laparoscopic Vecchietti procedure overall report good sexual satisfaction rates up to 94%, in 86 patients and low complication rates.[24] The most common complications were bladder or rectal injury.

Surgical Management: Laparoscopic Vaginoplasty Using A Single Peritoneal Flap (SPF), (Video 1.2.1)

This concept is relatively similar to the Davydov procedure, but it uses an SPF only. This peritoneal flap is obtained by mobilization of the supravesical peritoneum to the level of the umbilicus and combined with the use of a glass mold. It was first described by Zhao et al.[28] in 2015 in 83 patients and may be easier to perform compared to the Davydov procedure.

Step 1: Laparoscopic creation of single peritoneal flap

- Entry into the abdomen is performed via standard laparoscopy.
- The space between the bladder and overlying peritoneum is injected with normal saline and dilute adrenaline (1:200,000), which leads to bulging of the supravesical peritoneum. This bulging part is then detached from the bladder with scissors. Landmarks for the incision are the round ligaments, medial umbilical ligaments, and the fibrous strands which would connect any rudimentary horns.
- With the help of this tissue, an SPF is formed measuring about 10 × 10 cm. This SPF is still connected to the peritoneum close to the umbilicus.

Step 2: Creation of a neovaginal space via perineal approach

A neovaginal space is created by injecting the rectovesical space with saline and adrenaline (1:200,000 dilution). For this, a 10-cm long needle is inserted through the rectovesical space starting from the perineum and advanced toward the peritoneal cavity. Next, a transverse incision is made between the labia minora, and using sharp and blunt dissection, a neovaginal space is created up to the separated peritoneum. It is important to secure good hemostasis.

Step 3: Mobilizing the SPF into the neovaginal space

- The peritoneal flap (still attached at the umbilicus) is pulled through the neovaginal space using two Allis clamps with laparoscopic assistance. The peritoneum is placed over a glass mold and sewn in place with 3–0 absorbable suture. The glass mold should measure 9 cm long and 3 cm wide, with a conical shape and an opening on top of the mold to allow drainage of fluid (Beijing Jayyalife Biological Technology Co Ltd, China, MN 99200842). The vaginal mold should be sterilized before use by soaking it in a 0.5% iodophor solution.
- The SPF-covered mold is placed in the neovaginal space and the distal end is sutured to the neovaginal introitus. The glass mold is removed and replaced by a soft paraffin gauze (not commercially available; soft paraffin gauze dressing tampon) wrapped by a condom of 9 cm length and 3 cm width.

Step 4: Creating the top of the neovagina

- Laparoscopically, a purse-string suture is placed on the top part of the mold to close the SPF using 2–0 polysorb. The proximal ends of the cut peritoneum are sutured between the round ligaments in order to prevent prolapse.

POSTOPERATIVE CARE

- The Foley catheter and vaginal paraffin gauze remain in place for 48 hours and are then removed. The gauze is replaced by a glass mold measuring 9 × 3 cm.
- Dilation is performed continuously for 3 months postoperatively and after that only at night. Once the patient is sexually active on a regular basis, the mold can be used less often.
- Conjugated equine estrogen cream (0.625 mg) is applied twice daily to the mold in order to facilitate epithelialization. This local treatment is continued until intercourse occurs.

OUTCOME: RESULTS AND COMPLICATIONS

- Followup in the original study by Zhao et al. occurred for up to 46 months in all 83 patients. No intraoperative complications were reported. Postoperative complications include stenosis of the introitus in 8.4% of patients (resolved with mechanical dilation), formation of granulation tissue at the apex in 17% (resolved after trimming), and excessive mucous production in 13% of patients during the first 3 months after surgery (resolved spontaneously).
- Anatomic success was noted in all patients at 6 months, and functional success as assessed by the Female Sexual Function Index (FSFI) questionnaire was reported in 95.3% of patients.

ABBE–WHARTON–MCINDOE PROCEDURE	
○	To avoid scarring on the buttock area: Use of autologous in vitro–cultured vaginal tissue[29] or oxidized cellulose instead of split-thickness skin graft[30]
○	Replacement for a noncommercial vaginal mold: Use of an obstetrical balloon as sterile premade mold[31]
○	Good functional outcome with adequate vaginal length
✖	Transplanted epithelium can assume oncogenic potential of lower reproductive tract. Patients need long-term followup exams.
✖	The lining of the neovagina will maintain the characteristics of the original tissue, such as hair growth, condylomata[32]
WILLIAMS VULVOVAGINOPLASTY	
○	Relatively easy to perform with no abdominal entry
✖	In patients with enlarged urethral meatus, procedure should not be performed because intercourse can stretch the meatus further
DAVYDOV PROCEDURE	
○	No risk for peritoneal flap necrosis, peritoneum can undergo squamous metaplasia, natural axis of vagina, no donor site scarring
✖	Risk for fistula formation, vaginal dryness, necessity for long-term dilatation, more difficult to perform
✖	Constriction of the neovagina. This can be avoided by placing no more than four sutures for pulling the peritoneum toward the vulva
RUGE PROCEDURE	
○	No need for postop vaginal dilation, adequate vaginal length, natural lubrication, possibility for early intercourse
✖	Excessive mucous discharge, dyspareunia, introital stenosis, prolapse of the mucosa, only small patient numbers evaluated
VECCHIETTI PROCEDURE	
○	Short treatment time until sexual intercourse
✖	Specific equipment necessary
✖	Increased risk for bladder and rectal injury compared to other procedures
SINGLE PERITONEAL FLAP (SPF)	
○	No peritonitis, short operative time, less risk for bladder injury, no rejection of graft tissue, no peritoneal flap necrosis
✖	Postoperative complications include stenosis of the introitus (8.4%), formation of granulation tissue at the apex (17%) and short-term excessive mucous production (13%)[28]

POSTOPERATIVE CARE

Immediate postoperative care specific to each procedure is listed separately above. Long-term postoperative care issues are listed here and apply to all of the different techniques:

- All women who have undergone vaginal reconstruction need to be given the usual precautions with regard to sexual transmitted infection (STI) prevention.
- During their annual exams, a vaginal speculum exam should be performed to evaluate for any malignancies (especially if skin grafts or sigmoid colon were used), colitis, or ulcerations (especially if sigmoid colon was used).
- There is insufficient evidence for HPV vaccination, and routine gynecologic cytology is not recommended.[5]

OUTCOMES

The outcomes differ with each procedure and are listed separately above. Each procedure has advantages and disadvantages. More important than the anatomic outcome is the functional outcome.

COMPLICATIONS

Intraoperative complications include bleeding and damage to adjacent structures. Postoperative and long-term complications include fistula formation, strictures, scarring, as well as graft failure. If regular sexual intercourse does not occur, intermittent dilation is important. Details to complications specific for each procedure are listed separately above.

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2

Cervix

Chapter 2.1

Evaluation and Management of Cervical Agenesis

Jonathan D. Kort, Steven J. Co, Steven T. Nakajima

GENERAL PRINCIPLES

Definition

- Cervical agenesis, also known as congenital cervical atresia, is the absence of a cervix in a woman with a functional uterus due to failed development or fusion of the Müllerian ducts. It may be an isolated finding, but is also seen in conjunction with vaginal atresia. It often presents with primary amenorrhea and cyclical or chronic pelvic pain.

Differential Diagnosis

- Müllerian agenesis (Mayer–Rokitansky–Kuster–Hauser syndrome)
- Androgen insensitivity
- Imperforate hymen
- Transverse vaginal septum
- Gonadal dysgenesis and other causes of ovarian insufficiency
- Isolated gonadotropin deficiency

Nonoperative Management

Treatment is geared toward relieving pain, facilitating sexual intercourse for patients diagnosed with concomitant vaginal agenesis, and facilitating fertility when appropriate. Hormonal suppression of the hypothalamic–pituitary–ovarian axis to prevent cyclic development and shedding of the uterine lining will improve pelvic pain secondary to obstructed menstruation before definitive surgical treatment. Norethindrone-based steroids (norethindrone acetate, 5 mg/day tablet) are helpful due to the peripheral conversion to ethinyl estradiol for bone health. For fertility, there are case reports of transmyometrial embryo transfers in conjunction with in vitro fertilization; however, this is experimental and use of a gestational carrier is typically advised.[1] When diagnosed in conjunction with vaginal agenesis, vaginal dilator treatment is appropriate for motivated patients who wish to become sexually active.

IMAGING AND OTHER DIAGNOSTICS

- Magnetic resonance imaging (MRI) of the pelvis will help elucidate if any cervix is present, as well as differentiate the disorder from müllerian agenesis or a transverse vaginal septum (**Figs. 2.1.1** and **2.1.2**).
- A karyotype will help distinguish from androgen insensitivity syndrome.
- An assessment of ovarian reserve (follicle stimulating hormone [FSH], estradiol, anti-müllerian hormone [AMH]) will help differentiate this cause of amenorrhea from primary ovarian insufficiency.
- An abdominal ultrasound will help identify associated renal anomalies if not assessed during the MRI.

PREOPERATIVE PLANNING

- Due to limitations of pelvic imaging, an exam under anesthesia to evaluate vaginal development, in conjunction with evaluation of the pelvis via laparoscopy or exploratory laparotomy may be required to clarify anatomic pelvic structures before determining if hysterectomy or cervicovaginal reconstruction is appropriate.[2] This can be done as a separate procedure or in conjunction with definitive surgery.

SURGICAL MANAGEMENT

The primary goal of surgical management is to alleviate the pain from obstructed menstruation. Patients should be counseled that hysterectomy may be the most appropriate definitive surgical treatment for cervical agenesis and be prepared for that outcome before definitive surgical management is attempted. Reoperation and hysterectomy rates are high among patients who initially attempt cervicovaginal reconstruction.[2,3] In a patient without contraindications, hormonal suppression of endometrial development and vaginal dilator therapy can often palliate pelvic pain and sexual dysfunction until they accept the possibility of hysterectomy.

Positioning

- Patients should be positioned in the dorsal lithotomy position to allow access to evaluate the vagina and abdomen simultaneously. If the vagina is present, placement of a vaginal sizer or sponge-stick will help identify the proximal vagina when assessing the pelvis.

Approach

- With the patient in dorsal lithotomy position, the abdomen is entered. Depending on a surgeons' comfort with minimally invasive surgery, this can be performed with laparoscopy or an exploratory laparotomy.

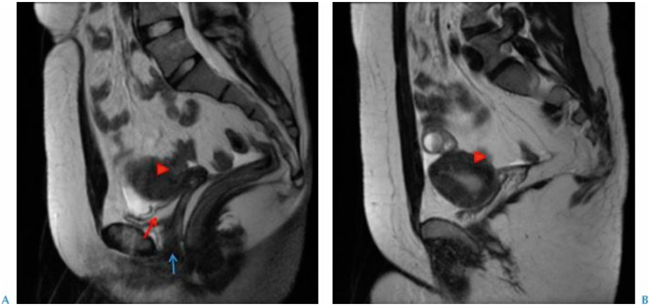

Figure 2.1.1. A,B: T2W sagittal images through the pelvis demonstrate a urethra (*blue arrow*) and bladder (*red arrow*) but no findings of a vagina or cervix is consistent with vaginal and cervical agenesis. There is an isolated or noncommunicating left uterine horn (*red arrowhead*).

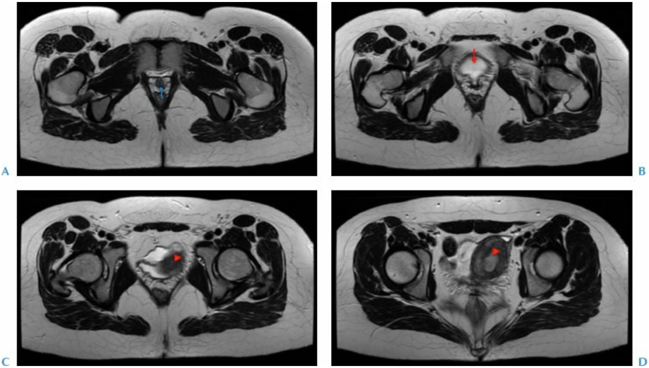

Figure 2.1.2. A–D: T2W axial images through the pelvis demonstrate a urethra (*blue arrow*) and bladder (*red arrow*) but no findings of a vagina or cervix consistent with vaginal and cervical agenesis. There is an isolated or noncommunicating left uterine horn (*red arrowhead*).

Procedures and Techniques

Exploratory laparotomy or diagnostic laparoscopy

- Once general anesthesia is adequate and the patient is draped in the dorsal lithotomy position, the abdomen is entered. The uterus is examined to confirm normal development, ruling out müllerian agenesis, and a bladder flap is developed to allow adequate assessment of the lower uterine and cervical anatomy, distinguishing complete cervical agenesis from cervical dysgenesis and endocervical obstruction. If the cervical stroma is <2 cm in diameter, the surgeons should proceed with hysterectomy; if >2 cm diameter of cervical stroma is present, creation of a neocervical canal may be considered.[2]

Examination of the vagina and perineum

- With the patient in the dorsal lithotomy position under general anesthesia, the vagina should be examined with the guidance of an intraperitoneal probe delineating the anterior (between the bladder and the uterus) and posterior spaces (between the rectum and the uterus) from above. Some surgeons advocate that if vaginal agenesis is encountered, the McIndoe technique may be performed; however, when cervical and vaginal agenesis is diagnosed, vaginal dilator therapy in conjunction with a hysterectomy may achieve a similar outcome with less perioperative morbidity.

Examination of the uterine cavity and cervical–uterine canal

A vertical hysterotomy may be made in the uterine fundus through which a probe can be placed through cervical stroma or an obstructed endocervical canal. If sufficient cervical stroma is identified, the probe can be replaced with a catheter to be left in place for 6 months while the endocervical canal epithelializes. Interrupted sutures to the uterus and vagina should be used to hold the catheter in place. Skin grafts and synthetic grafts have also been used to facilitate recanalization of the endocervical canal.[2–4]

Examination of the abdomen for endometriosis

Due to obstructed anterograde menstruation, many patients will retrograde menstruate into the abdomen via the fallopian tubes that has been linked to endometriosis. While examining the abdomen and pelvis, any endometriosis implants should be excised or vaporized to treat dysmenorrhea.

PEARLS AND PITFALLS

PEARLS	PITFALLS
Due to the lower success rates and higher complication rates among patients opting for cervical vaginal reconstruction in the setting of vaginal atresia, patients with concomitant vaginal atresia should consider hysterectomy.	All patients interested in definitive surgical management should expect the possibility of hysterectomy. Many patients undergoing cervical vaginal reconstruction, even those able to initially menstruate, may require repeat surgeries and definitive hysterectomy.

POSTOPERATIVE CARE

- Due to a relatively high rate of postoperative infectious morbidity, if a catheter is left in place, oral antibiotic prophylaxis is advised. If a uterine–vaginal reanastamosis procedure has been performed, broad spectrum antibiotics are typically given for at least 2 weeks.[2,5]

OUTCOMES

- Measuring success by the ability to obtain cyclic menstruation, in patients not requiring concomitant vaginoplasty, successful outcomes can be reached in 70%; however, for patients with vaginal agenesis, the success rate falls to approximately 40%.[2,3]
- Other case series report 50% to 100% reoperation and hysterectomy rate among patients initially achieving a successful cervicovaginal reconstruction.[2,3]
- Very few case reports of successful pregnancies have been reported following cervicovaginal reconstruction. The number of unsuccessful attempts to achieve a pregnancy is unknown and is likely under reported.

COMPLICATIONS

- Reocclusion and hematometra, reoperation and need for subsequent hysterectomy has often been reported among patients, even those with initially successful cervicovaginal reconstructive surgery.[2]
- Pelvic inflammatory disease, sepsis, and consequent death have been reported in patients, particularly those with congenital cervical and vaginal atresia.[5]

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Chapter 2.2

Laparoscopic Abdominal Cerclage for Cervical Insufficiency

Travis W. McCoy

GENERAL PRINCIPLES

Definition

- Cervical insufficiency is defined as the inability of the cervix to retain a pregnancy in the second trimester.[1] This is due to a presumed weakness of cervical tissue that leads to painless cervical dilation with a resulting delivery of a live fetus (usually previable) in the second trimester.[2] A laparoscopic abdominal cerclage is usually indicated in cases of prior failed vaginal cerclage, or in a patient with cervical anatomic limitations such as prior cervical procedures, injuries, or congenital cervical abnormalities.

Differential Diagnosis

- Preterm labor
- Uterine infection

Nonoperative Management

Nonsurgical treatments such as bed rest, pelvic rest, and modified activity have not been proven effective and their use is discouraged.[1]

IMAGING AND OTHER DIAGNOSTICS

Physical exam of the cervix can identify patients in whom a vaginal cerclage may not be suitable due to prior cervical injury or surgical treatment. Measurement of cervical length by transvaginal ultrasound can be used as part of the decision-making process, though patient history can often provide the most information regarding indications for placement.

PREOPERATIVE PLANNING

Preoperative assessment with a transvaginal ultrasound should be performed to evaluate for the presence of uterine abnormalities that could contribute to preterm labor such as a didelphys, unicornuate, bicornuate, or uterine septum. Preoperative cervical length should also be recorded.

SURGICAL MANAGEMENT

- It is preferable to place a laparoscopic transabdominal cerclage in the nonpregnant state prior to conception. It can be placed in the first trimester, though this can be more difficult due to limitations of uterine manipulation, increased risks if a uterine vascular injury were to occur, and possible risk of fetal exposure to anesthetic agents.
- The cerclage is placed with a Mersilene 5-mm tape 12′′ (Ethicon Inc., Somerville, NJ), double-armed, on a BP-1 needle (blunt point, 65 mm) (Product code RS21). This needle is a ½ circle and prior to use, two heavy needle drivers are used to straighten it. By holding the two needle drivers close to each other on the needle, the curvature is removed one small segment at a time. All but the distal 1 cm is straightened, forming a ski configuration (**Fig. 2.2.1**). The suture is soaked in iodine solution prior to use as a deterrent to bacteria.

Positioning

- The patient is placed in a standard dorsal lithotomy position as for other basic laparoscopy procedures.

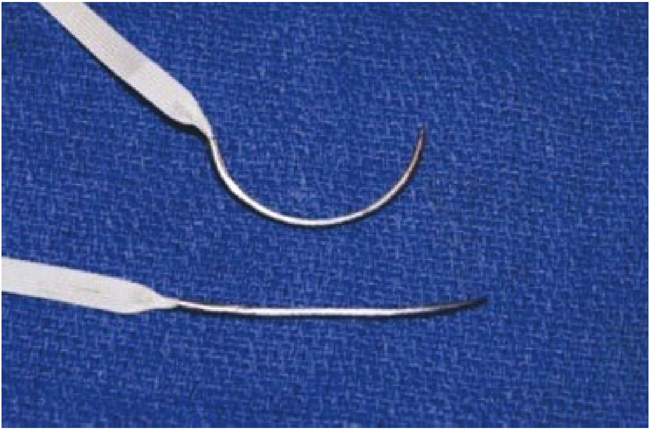


Figure 2.2.1. Suture needle straightened into “ski” configuration.

- If nonpregnant, a uterine manipulator is placed. A manipulator that has the ability to flex the uterus can be beneficial. Appropriate intrauterine manipulators include the ClearView® (Clinical Innovations, Murray, UT), HUMI® (Cooper Surgical, Trumbull, CT), ZUMI™ (Cooper Surgical, Trumbull, CT), or Kronner Manipujector® (Cooper Surgical, Trumbull, CT).

Approach

- An abdominal cerclage can be placed through a laparotomy incision, but laparoscopic placement is equally successful[3,4] and associated with a faster recovery and less patient morbidity.
- For a laparoscopic approach, the procedure can be performed with or without robotic assistance. In most cases, placement of the cerclage requires two 5-mm ports in addition to an umbilical camera port. An additional port may be needed if the uterus is not freely mobile, or if bleeding is encountered.

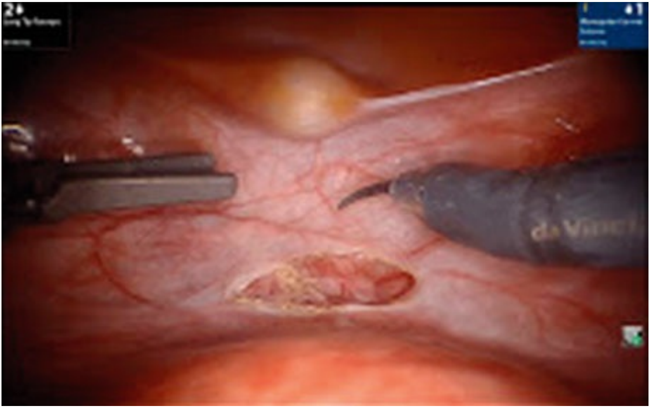
Video of a laparoscopic abdominal cerclage placement

The following steps to perform a laparoscopic abdominal cerclage procedure can be viewed in an unedited video of the procedure (**Video 2.2.1**).

Opening of vesicouterine fold of peritoneum

Open the peritoneum at the vesicouterine fold with monopolar scissors (**Tech Fig. 2.2.1**). Enter the vesicouterine space, dissecting the bladder away from the lower uterine segment enough to allow for visualization of the cervix and localization of the cervix–uterine junction (**Tech Fig. 2.2.2**).

Tech Figure 2.2.1. Opening of vesicouterine fold of peritoneum.



Tech Figure 2.2.2. Exposing the cervix at the level of the internal os.

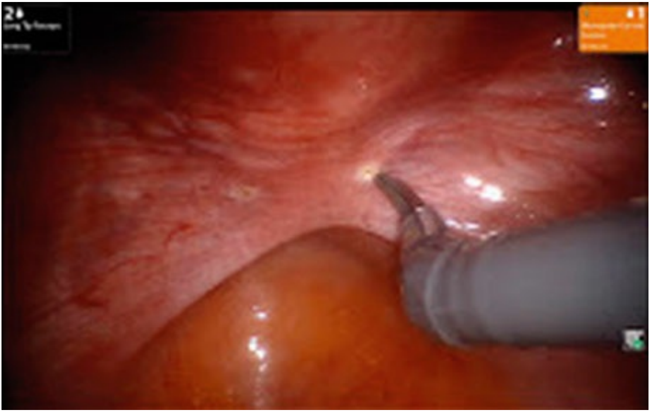
Blunt dissection at location of suture placement

- The location of the internal cervical os is found at the junction of the cervix and uterine body. This junction is usually just caudal to the uterine artery. Blunt dissection is performed on each side perpendicular to and against the cervix. This can be performed with a Maryland grasper or the robotic long tip forceps. This blunt dissection moves vessels aside and opens a pathway for the suture (**Tech Fig. 2.2.3**).
- If placement is attempted during pregnancy, it may be safer to fully complete the dissected tunnel so that the suture may be passed through the tunnel without needle placement.

Tech Figure 2.2.3. Bluntly dissecting against the cervix to create a pathway for suture placement.

Identifying posterior exit locations

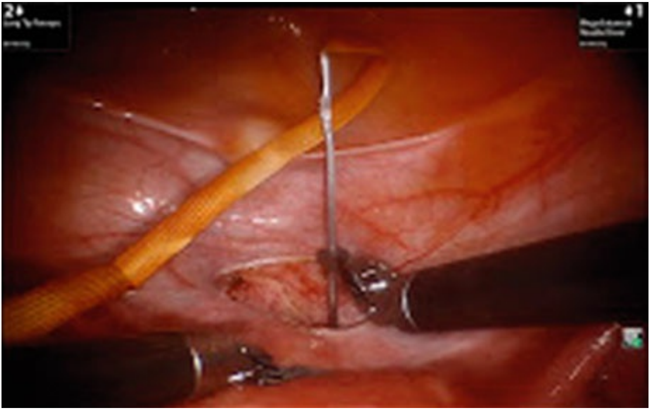
- Elevate the uterus anteriorly and locate the planned exit location for the needle. This reference point can be made by using electrocautery to mark a small point (**Tech Fig. 2.2.4**). This point will generally be approximately 1 cm cranial to the insertion of the uterosacral ligament.



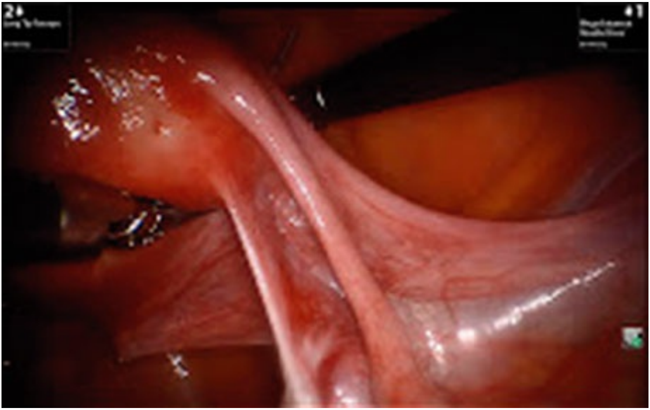
Tech Figure 2.2.4. Marking the anticipated exit point for the needle.

Suture placement

- The suture is ideally passed so that it may be tied anteriorly. This leaves the knot anteriorly rather than posteriorly where it could possibly lead to tubal adhesions. It is generally easier to pass the suture from an anterior to posterior direction, but with the above dissection, it can be placed in either direction.
- Start the first placement in an anterior–posterior direction by placing the needle against the cervix, with the curvature of the needle angled medially (**Tech Fig. 2.2.5**). If the needle is placed through the dense cervical tissue, excessive resistance will be encountered. While holding the needle in place, partially elevate the uterus so that the posterior reference point can be visualized and used as a guide for where to exit with the needle (**Tech Fig. 2.2.6**). If adequate dissection was done earlier, there should be very little tissue to pass the needle through. After pulling the needle through, approximately 4 to 5 in of suture is pulled through the incision.

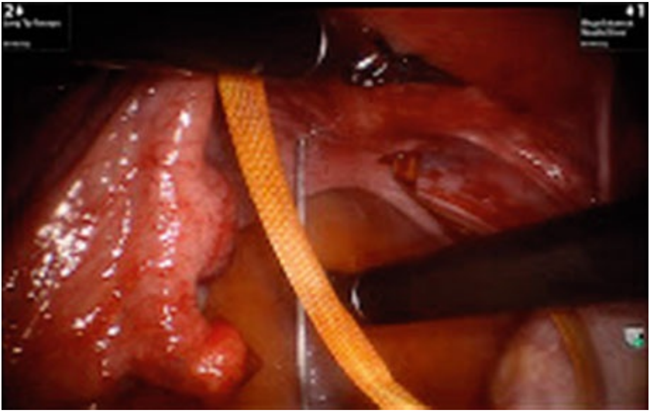


Tech Figure 2.2.5. Placing needle through broad ligament against body of cervix.

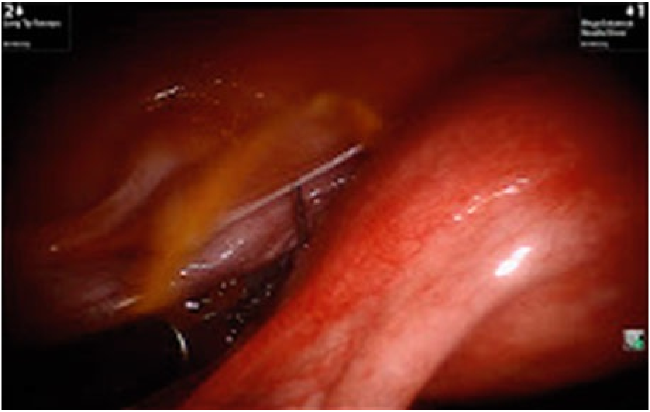


Tech Figure 2.2.6. Needle exiting at intended location.

- The suture is oriented so that it will lie flat against the posterior cervix prior to placement on the opposite side.
- The needle is then passed in a posterior–anterior direction on the opposite side (**Tech Fig. 2.2.7**). The needle is started though the marked location, then the uterus is lowered and the needle is angled so that it exits through the previously dissected tunnel (**Tech Fig. 2.2.8**). The needle should be redirected if it appears to be coursing through heavier tissue.
- If the posterior–anterior needle passage cannot be achieved, options include fully dissecting the tunnel bluntly all the way through the broad ligament or as a last resort, passing the other needle from an anterior–posterior direction and tying the knot posteriorly.



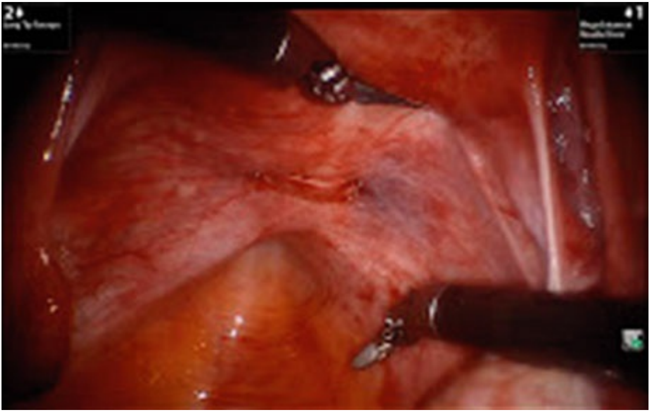
Tech Figure 2.2.7. Passing needle anteriorly.



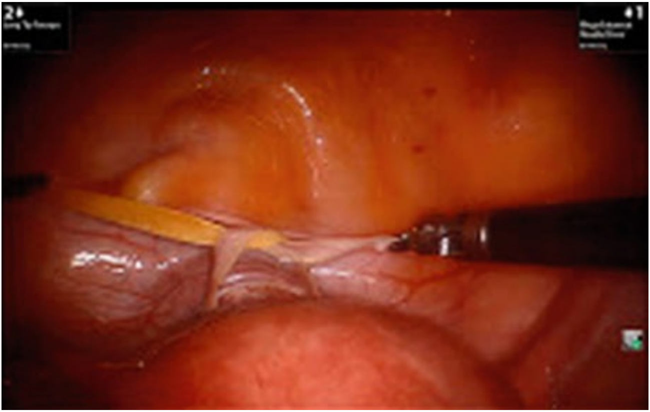
Tech Figure 2.2.8. Needle exiting through previously dissected space.

Suture tying

- The suture should be pulled through so that it lies flat and snug against the posterior portion of the cervix (**Tech Fig. 2.2.9**).
- Care should be taken to tie true square knots which allows the wide tape suture to lie flatly against the cervix (**Tech Fig. 2.2.10**). The suture should be tied only snugly against the cervix. This allows the cervix to be dilated slightly if needed for future hysteroscopy or D&C. Approximately 4 to 5 throws should be placed.



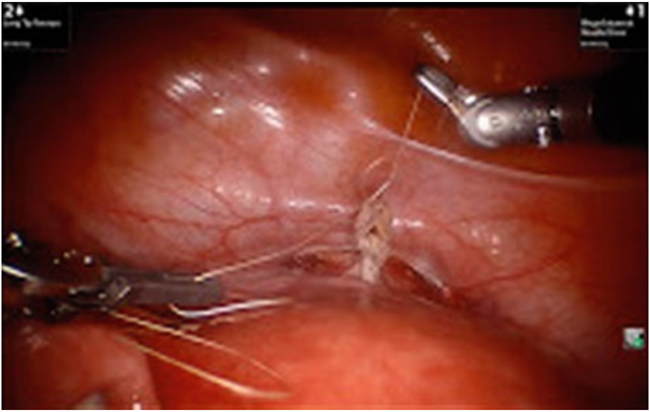
Tech Figure 2.2.9. Suture pulled through until it lies flat against posterior cervix.



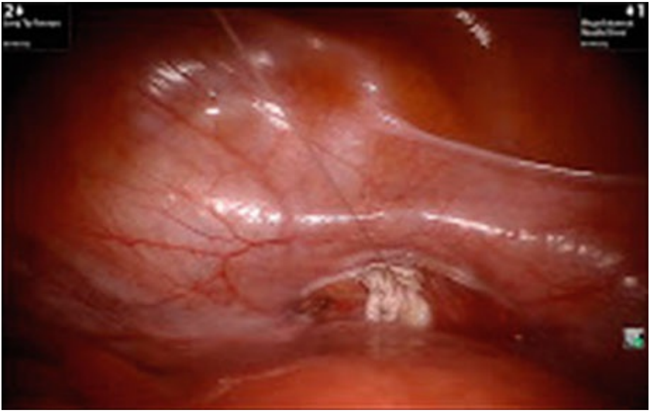
Tech Figure 2.2.10. Tying of square knots in suture.

Securing suture/peritoneum closure

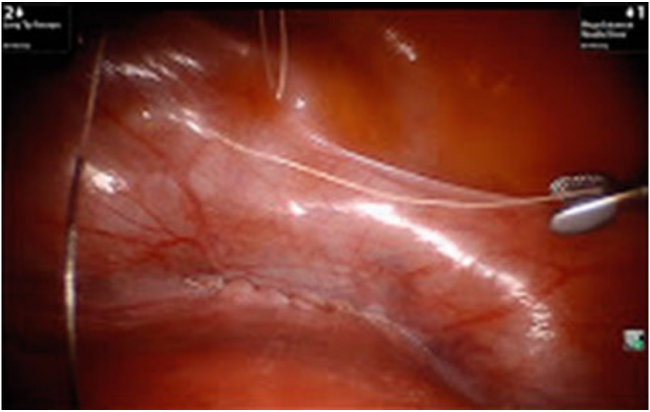
- A separate small suture such as a 4–0 vicryl or silk is used to tie the ends of the tape together to prevent knot loosening (**Tech Fig. 2.2.11**). This same suture is then used to pull the knot down against the cervix (**Tech Fig. 2.2.12**).
- The peritoneal opening is then closed with a small absorbable suture (**Tech Fig. 2.2.13**).



Tech Figure 2.2.11. Suturing the tag ends together.



Tech Figure 2.2.12. Pulling knot down against cervix.



Tech Figure 2.2.13. Closure of peritoneal opening.

PEARLS AND PITFALLS

- Suture that should be used is Mersilene 5mm Tape on BP-1 double-armed needle. This should be straightened out using needle drivers to leave the needle in a ski configuration (**Figure 2.2.1**).
- Blunt dissection should be performed to create a tunnel for suture placement at the level of the internal cervical os. This corresponds to the junction of the cervix and uterine corpus. This dissection should be caudal to the uterine artery, adjacent to the cervical body, and medial to the cervical branches of the uterine artery.
- The needle should be passed perpendicular to the cervix so that the suture lies at the same cervical location both anteriorly and posteriorly.
- Preconceptual placement is preferred rather than placement after pregnancy is achieved.
- The suture should be tied only snugly around the cervix. It is intended to only reinforce the cervix rather than tightly close it off.

POSTOPERATIVE CARE

- Patients may try to conceive immediately after surgery.

OUTCOMES

Fetal survivorship following laparoscopic transabdominal cerclage has been reported between 76% and 100%.[5]

COMPLICATIONS

- Damage to uterine vasculature is a risk of suture placement. Minor bleeding will often stop after tying of the suture. If bleeding persists, the broad ligament must be opened to permit vessel isolation and hemostasis with electrocautery, suture placement, or clip.
- After delivery, the cerclage may be left in place if still intact and in the proper location. It is recommended that after childbearing is complete, the cerclage be removed. Vaginal erosion has been reported as a risk of long-term presence.[6]

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3

Uterine

Chapter 3.1

Correction of Asherman Syndrome

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GENERAL PRINCIPLES

Definition

- Intrauterine synechiae, commonly known as Asherman syndrome, is a condition where the uterine cavity is completely or partially obliterated by adhesions. Though described as early as 1894,[1] it was Joseph Asherman's 1948 paper, "Amenorrhoea traumatica (atretica)"[2] detailing a series of 29 cases that was pivotal for medical awareness about this condition. Though this first paper focused on adhesions involving the cervix and internal os creating hematometra, his subsequent 1950 paper addressed "regional obliteration of the uterine cavity," which is more commonly seen.[3]

Etiology

- Endometrial surgical trauma to the stratum basalis is the primary source of Asherman syndrome. Though endometritis can also contribute, without surgical trauma, infection of the stratum functionale is less likely to extend to the basalis and may be sloughed with menses.
- In societies with limited access to healthcare, nonsurgical infections such as tuberculosis and schistosomiasis can result in intrauterine adhesions. However, in setting with more developed healthcare systems, pregnancy associated curettage is the primary cause and can be associated with upward of 90% of cases.[4]
- The reporting for postsurgical incidence of Asherman syndrome is highly heterogeneous, with one group finding an incidence of 0% with metroplasty[5] where as another can find 37.5%.[6] Since the incidence of Asherman syndrome is practice dependent, it is probably easier to focus on broader principles:
  - The greater the width and depth of endometrial trauma, the more likely intrauterine synechiae will occur.
  - Particularly with hysteroscopic myomectomy, “kissing” fibroids with a submucosal component are more likely to result in adhesions than single fibroids that do not result in concurrent trauma to the opposite endometrial surface.
  - Inflammation at the time of surgery promotes adhesions, such as with curettage for septic abortion.
  - Hindrance of postoperative endometrial proliferation can increase adhesions, as can be found with postpartum lactational amenorrhea.

Symptoms

- Menstrual disturbance is the most common complaint, though the extent of adhesions may not always correlate with symptoms.[7]
- Dysmenorrhea is more likely when hematometra occurs and may occur as cyclical pelvic pain with amenorrhea if outflow is completely obstructed.
- Subfertility and recurrent pregnancy loss can also be sequelae, affecting up to half of women diagnosed with Asherman syndrome, though diagnostic bias may be present.[8,9]

IMAGING AND OTHER DIAGNOSTICS

- Ultrasound imaging can have multiple findings. These can include a thin atrophic endometrium, with hyperechoic adhesive regions. One can also see asymmetry in endometrial thickness, particularly after estrogen therapy, where endometrial stricture occurs at synechiae, but is more robust in other regions. With saline infusion sonography, mechanical disruption with the catheter can be attempted to lyse adhesions.[10] This has been called "PLUG" for pressure lavage under ultrasound guidance.[11] Three-dimensional ultrasound imaging can be preferred to saline infusion sonography, particularly with obliteration of the lower uterine segment where balloon inflation for saline infusion is difficult. Hysteroscopy remains the gold standard for diagnosis, picking up a third more cases relative to even three-dimensional ultrasound.[12] Flexible office hysteroscopy also has meaningful advantages, including closely reflecting intraoperative findings as well as allowing for lysis of more filmy adhesions in advance.
- Numerous classification systems have been proposed, but the one published by March[13] is frequently used owing to its simplicity in designating adhesions as minimal, moderate, or severe. The classification system is as follows: Minimal when <1/4 of the uterine cavity involved with adhesions; moderate when 1/4 to 3/4 of the uterine cavity involved with adhesions and no agglutination of the uterine walls; severe when >3/4 of the uterine cavity involved with presence of agglutination of the uterine walls or thick bands present.
- Heterogeneity in classifying adhesions is one of the reasons comparisons within the literature are so challenging.

PREOPERATIVE PLANNING

- Expectations are one of the most important aspects of preoperative management. Though patients can do well with a single surgery for minimal synechiae, with severe adhesions only half will be resolved with a single surgery and rarely will require as many as four.[14,15] Even then, restoration of the cavity cannot guarantee that the stratum basalis will regrow and for preoperative amenorrheic patients, live birth rates may be only 27%.[14] Similarly, when endometrium is very thin prior to therapy, postoperative outcomes tend to be poor.[16] Imaging and particularly office hysteroscopy are particularly useful for informed consent regarding the extent of disease.
- Preoperative estrogen promotes endometrial proliferation, providing “safe windows” for dissection. Typical protocols involve oral estradiol 4 to 6 mg total daily starting 4 to 8 weeks prior to surgery.
- Of note, when endometritis (including genital tuberculosis) causes intrauterine adhesions, these can extend to the cornual regions, potentially causing greater obliteration, which should shift expectations downward. Postsurgical Asherman syndrome is more likely to be in the midline of the endometrium.

SURGICAL MANAGEMENT

- Adhesiolysis for Asherman syndrome typically occurs in patients who want to preserve fertility. When performing hysteroscopic adhesiolysis for pain associated indications in patients with no future procreative goals (as can happen after endometrial ablation), the balance of risk versus benefit can often lean toward hysterectomy. There are, however, surgeons who possess advanced hysteroscopic skills who can perform a lysis of intrauterine adhesions in an office-based surgery setting. However, sonographic guidance and an operating room setting may be preferable for severe Asherman syndrome owing to the higher risk for uterine perforation.
- Prophylactic antibiotics are not indicated for lysis of intrauterine adhesions according to the American Congress of Obstetricians and Gynecologists (ACOG).[17]

Positioning

- Hysteroscopic adhesiolysis is typically performed with the patient in the dorsal lithotomy position. Whether using hanging or Allen stirrups, consideration should be given to monitor placement, both for the hysteroscope and the ultrasound (if indicated, depending on the extent of surgery). A full bladder not only facilitates transabdominal sonographic visualization, but also makes the uterus more axial, decreasing the likelihood of trauma to the posterior wall of the uterus where it is naturally more anteflexed.

Cervical Dilation

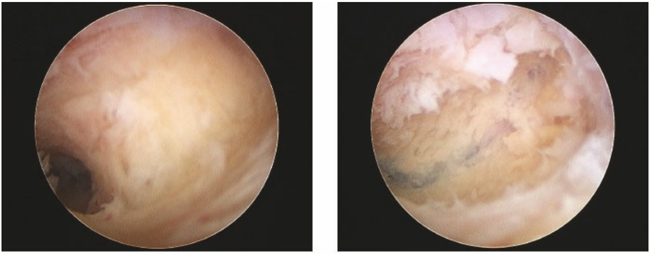
- Preoperative laminaria are reasonable if a larger caliber hysteroscope is intended for use.
- Numerous protocols for misoprostol have been proposed with doses ranging from 200 to 800 μg both orally and vaginally.[18]
- Intracervical vasopressin has also been shown to reduce the force required for dilation and lowers blood loss.[18]

Intraoperative imaging

Though minimal intrauterine midline synechiae can often be managed without an ultrasound as intracavitary boundaries are clear, sonography becomes more important with complete obliteration of the uterine cavity. Transabdominal imaging has been classically used, but transrectal sonography, particularly in morbidly obese patients, may be preferred. Intracorporeal ultrasound and fluoroscopy have also been used, but these are frequently less available.

Adhesiolysis

- The choice of scissors relative to energy-based approaches remains debated among capable gynecologists (**Tech Fig. 3.1.1A-B**, **Video 3.1.1**). The use of energy has potential disadvantages including risk for perforation and a negative effect on endometrial regrowth. Though more studies need to be done, it appears that energy sources for endometrial ablation may be suboptimal for surgery where endometrial regrowth is the goal.[19]
- In spite of theoretical advantages of the use of scissors, proponents for using energy-based dissection note that the literature does not demonstrate a clear advantage for any approach. In that context, using energy for dissection avoids the problem of dull scissors, which can occur in many operative settings. In addition, energy has been used successfully in several cases with complete intracavitary obliteration, where the endometrial cavity has been expanded through fundal to isthmic myometrial scoring with a knife electrode.[15,20] Hysteroscopic morcellation of adhesions is increasingly performed and may particularly have a role for thick synechiae, where resection may be preferred to transection.
- Joseph Asherman initially described management of intrauterine adhesions with hysterotomy and using his finger to sweep away adhesions.[3] Today, intraoperative circumstances may rarely warrant hysterotomy, but in general this should not be deliberately planned preoperatively and arguably should be explored only after three to four hysteroscopic attempts.[21] Should the adhesions be so extensive that the primary surgeon does not feel comfortable performing the surgery without hysterotomy, referral to a specialist with advanced hysteroscopy skills may be a better approach.
- For severe adhesions, Pratt dilators have been advanced toward each cornua under ultrasound or laparoscopic guidance, effectively leaving a residual septum-like remnant that can then be transected. We personally prefer to avoid this approach owing to an increased risk for false passages and perforation. An alternative that may pose less risk in some circumstances is to use an ultrasound-guided 2.5-mm flexible hysteroscope preoperatively in the office, followed by estrogen therapy.



A B

Tech Figure 3.1.1. A: Hysteroscopic view of severe Asherman syndrome after an uterine curettage for a retained placenta. **B:** Hysteroscopic view of uterine cavity after lysis of intrauterine adhesions.

POSTOPERATIVE TREATMENT

Preventing recurrent adhesions

- The more extensive the intrauterine adhesions, the greater the likelihood of postoperative recurrence. One study showed no reformation with mild adhesions, 16.7% with moderate, and 41.9% with severe adhesions.[22]
- Multiple approaches have been proposed, including postoperative estrogen, physical barriers such as balloons and intrauterine contraceptive devices (IUDs), hysteroscopic second look with sweeping of filmy adhesions, and intrauterine infusions of polyethylene oxide-sodium carboxymethyl cellulose gel, hyaluronic acid, and even human amnion. When looking at randomized controlled trials for these interventions, few have been performed, and apart from one program with atypically high rates of postoperative adhesions (calling in to question external validity), most are underpowered to show a difference. As we await better data that accounts for the heterogeneity of patients and practices, biologically plausible approaches in the setting of low cost and minimal risk are listed below:
  - Estrogen therapy may promote endometrial proliferation, although it may be difficult to grow over scarred and devascularized tissue.
  - An intrauterine balloon placed immediately after hysteroscopy may keep opposing uterine walls from annealing, but it should not be overinflated or kept in more than 3 days so as to avoid pressure necrosis to endometrium. Though triangular balloons can provide better separation for cornual regions, adhesions are less frequently in the cornua, and for many the triangular balloons are more difficult to place and remove. Doxycycline 100 mg twice daily for the duration of balloon placement is commonly practiced.
  - Second-look flexible office hysteroscopy with sweeping of adhesions can prevent their persistence.[23]
  - Though IUDs have been used, in one randomized controlled trial copper IUDs resulted in higher rates of adhesions than using no therapy at all, consistent with copper's inflammatory qualities.[6] The use of a Lippes loop has also been used in the past. ACOG does not recommend use of antibiotics for IUD placement.

PEARLS AND PITFALLS

Preoperative planning	○ Flexible office hysteroscopy combined with ultrasound can enhance the informed consent process and set realistic expectations ○ Preoperative estrogen therapy should be considered, especially for severe disease
Surgical technique	○ Concurrent ultrasound use will reduce the risk of uterine perforation with severe disease ○ Consider transrectal ultrasound over transabdominal for morbidly obese patients
Preventing recurrence	○ Low-cost, low-risk approaches such as immediate postoperative balloon use, estrogen, and second-look office hysteroscopy with sweeping of adhesions may be reasonable approaches until better evidence becomes available. ✖ The current literature is too heterogeneous to be confident with evidence-based recommendations.

OUTCOMES

- Though surgical technique matters, outcomes as previously noted depend heavily on the extent of disease. It is common for severe adhesions to require multiple surgeries. A “good outcome” also depends on how it is defined in the literature, where adequate intrauterine capacity with endometrial regrowth may still not allow for or sustain a pregnancy.
- A thin preoperative endometrium may have difficulty regenerating after prior injury to the stratum basalis. In one series looking at severe disease, a third of patients had live births, but notably 22% of these live births were associated with placenta accreta.[15]

COMPLICATIONS

- Intraoperative complications frequently relate to uterine perforation. Though in many settings the need for repeat surgery could be considered a complication, with severe intrauterine adhesions repeat surgery should be thought of as inherent to balancing safety and success.
- Postoperative complications relating to pregnancy relate to risk for uterine dehiscence (with operative perforation or deliberate myometrial thinning), mid-trimester loss, and abnormal placentation (leading to hemorrhage). For women with procreative goals, preoperative counseling ideally should address the likelihood of subsequent pregnancy as well as potential adverse obstetrical outcomes.

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Chapter 3.2

Repair of Cesarean Section Scar

Peter S. Uzelac, Steven T. Nakajima

GENERAL PRINCIPLES

Definition

- A cesarean section scar defect is characterized by incomplete healing of the anterior uterine wall at the site of a previous cesarean section incision. The classic imaging appearance is that of a thin residual myometrium and a tent-like indentation of the lower uterine segment which peaks toward the serosal border. An array of nomenclature to describe the defect appears in the literature and includes uterine scar isthmocele, niche, diverticula, and postcesarean scar defect (PCSD) (**Fig. 3.2.1A**).
- Symptoms associated with a previous cesarean section scar defect include abnormal uterine bleeding, pelvic pain, and a reduction in fertility potential (attributed to persistent fluid or blood collection at the site of the defect which can impact the cavity in a similar fashion as the presence of a hydrosalpinx).[1]
- A thin anterior uterine wall also increases the risk for obstetrical complications in subsequent pregnancies including scar dehiscence, placenta accreta, and a cesarean section scar ectopic pregnancy.[2]
- Although there is no established criteria for the diagnosis, some authors have suggested that repair is indicated if the residual myometrial thickness is <3.5 mm or there is a defect present that accounts for >50% of the thickness of wall.[3]

Risk Factors

Several modifiable and nonmodifiable risk factors for the development of cesarean section scar defect have been proposed.[4] Modifiable techniques during the cesarean section procedure include the location of incision, closure technique (single versus double layer, locked versus unlocked, suture material), and factors involved with adhesion formation (nonclosure of peritoneum, inadequate hemostasis, tissue manipulation). Nonmodifiable risk factors include poor inherent tissue healing and an increasing number of prior cesarean sections.[5] An association with retroflexion of the uterus has also been observed.

Differential Diagnosis

- A cesarean section scar defect is often symptomatic and can present with abnormal uterine bleeding (postmenstrual spotting or blood-tainted discharge), dysmenorrhea, dyspareunia, or abdominal pain.
- The suspected defect should not be confused with a nabothian cyst (circular anechoic area(s) in cervix) and can easily be differentiated from a vascular malformation with the use of color flow Doppler (**Fig. 3.2.2A,B**).

IMAGING AND OTHER DIAGNOSTICS

- A cesarean section scar defect can be detected as an incidental or diagnostic finding on B-mode ultrasound or after the instillation of saline contrast during hysterosonography. A high index of suspicion is sometimes necessary in the latter as air bubbles can enter the scar pouch during saline infusion, generating ultrasound echoes and masking the defect (**Figs. 3.2.3A,B**).
- The defect can also be observed at the time of hysteroscopy and is characterized by an indentation in the anterior uterine wall cephalad to the internal cervical os.

PREOPERATIVE PLANNING

- Preparation for the repair of a previous cesarean section scar defect should take into account the patient's future reproductive goals. Successful amelioration of irregular bleeding symptoms have been reported with the use of electrical energy (resection and/or roller ball).[6] However, many practitioners employ a technique that reinforces and thickens the anterior wall in the event of a future pregnancy. Although long-term and randomized data is lacking, it is generally accepted that the thicker the residual anterior uterine wall, the less likely a subsequent adverse obstetrical event. Preoperative quantification of the thickness of the anterior wall at the sight of the defect (in millimeters) can help as a comparison to postoperative assessment.

Figure 3.2.1. A: Postcesarean scar defect (PCSD) prior to repair. The scar was 1.5 to 2.5 mm in thickness. **B:** After the repair, the PCSD was 5.5 mm in the thinnest section.

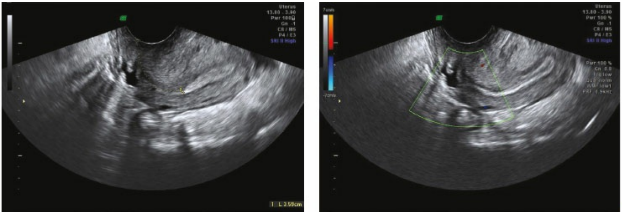


Figure 3.2.2. A: Retroflexed uterus with scar defect anteriorly. The cervical canal is delineated with *yellow dashed line*. **B:** Same defect with color flow confirming the anechoic area is not vascular in origin.

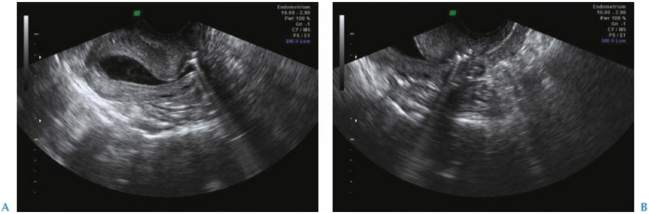


Figure 3.2.3. A: Scar defect during hysterosonography. **B:** Air bubbles obscuring same defect as in Figure 3.2.3A.

SURGICAL MANAGEMENT

- Surgical reconstruction of a cesarean section scar defect has been described by both vaginal and abdominal (laparoscopic, robotic, open) techniques. One advantage of an open mini-laparotomy approach (through the site of the previous Pfannenstiel incision) may be the ease in identification of the extent of defect and evaluating the completeness of the repair. The advantage of a laparoscopic (with or without robotic assistance) or hysteroscopic approach would be a shorter recovery time from these minimally invasive approaches.
- Indication for surgical repair of a cesarean section scar defect is for cessation of abnormal uterine bleeding, amelioration of pelvic pain, promotion of fertility, and decreasing obstetrical risks in subsequent pregnancies. The procedure involves identification of the scar defect, characterizing the extent of the defect, separation, and reapproximation of the superior and inferior edges. After repair, the defect can be tested for completeness.

Positioning

- The patient should be placed in the normal standard dorsal lithotomy position as for other laparoscopic gynecologic procedures. The partial introduction of an intrauterine system to the level of the lower uterine segment for the installation of dye (Kronner Manipujector® [Cooper Surgical, Trumbull, CT]) can be helpful in identification of the defect as it is approached abdominally and as a test of water-tightness after the repair.

Laparotomy

Abdominal incision

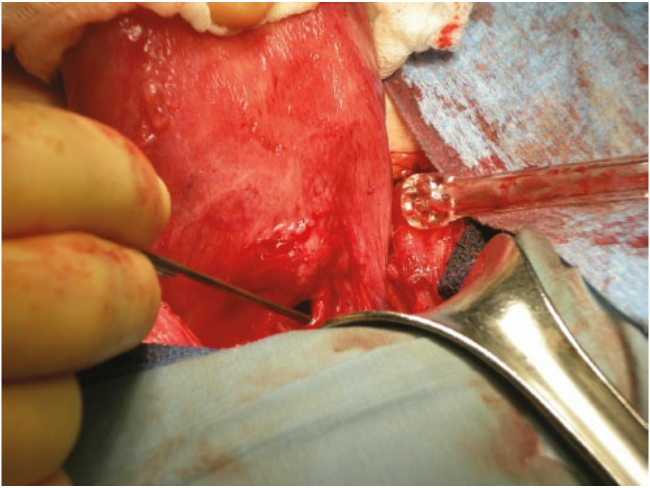
- The first step is re-entry of the abdomen at the site of the previous Pfannenstiel incision. Taking into account patient habitus and extent of the uterine defect it may be possible to begin with a mini-laparotomy. A preoperative diagnosis of a retroverted uterus should be appreciated. Special attention should be made to minimizing tissue trauma with gentle manipulation. Blunt dissection should be avoided. This area can be vascular and timely hemostasis without the excessive use of electrocautery should be the goal. Lysis of any adhesions should be performed. Anatomy can be distorted especially with multiple prior cesarean sections. It is important to verify that you are in the correct plane of the defect to ensure equal cut edges.

Creation of the bladder flap

We recommend the creation of a bladder flap to avoid entry into the bladder.

Determine location of defect

- From the abdominal approach, the exact location of the scar defect may not be readily apparent. Instillation of uterine dye may provide localization. We have also employed a blunt tip probe for localization of the scar defect (**Tech Fig. 3.2.1**).



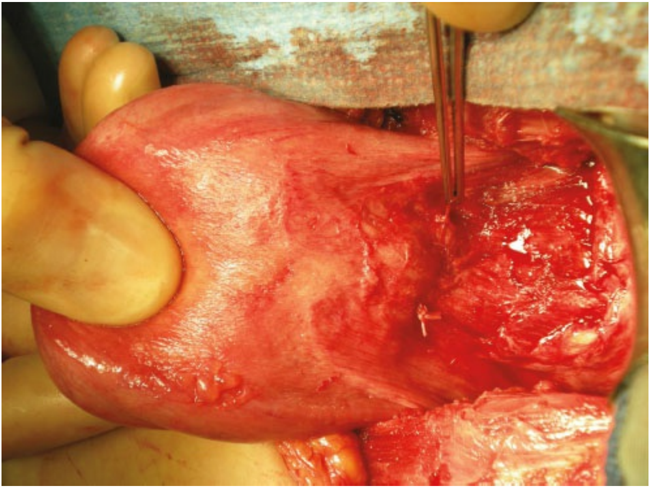
Tech Figure 3.2.1. A blunt tip probe is used to aid in localization of scar dehiscence.

Incise and open defect

Once the area of the defect is identified, we prefer a sharp incision to open. This provides the cleanest edges for reapproximation.

Reclosure of scar

- A two-layered, running, nonlocking suture is performed with 2–0 and 3–0 Vicryl® suture (Ethicon, Inc., Somerville, NJ) (**Tech Fig. 3.2.2**). Careful attention should be made to reapproximate the endometrial edges.



Tech Figure 3.2.2. Suture material in place after reclosure of cesarean section scar.

Reapproximation of bladder flap

- The bladder flap should be reapproximated, but not advanced upward onto the lower uterine segment of the uterus.

Laparoscopy and/or Hysteroscopy

Initial choice of either procedure

- The use of either a laparoscopic versus a hysteroscopic approach is primarily influenced by the patient's desire for future fertility. If symptoms of pelvic pain or dysmenorrhea are attributed to residual menstrual blood sequestered behind a fibrous band of adhesions in the niche, then resection of fibrous tissue with the hysteroscope may be the only treatment required to resolve these symptoms. If the patient is interested in future fertility, a laparoscopy to incise the defect and reapproximate the cut edges is the treatment of choice. Hysteroscopy may also be utilized during the laparoscopy to identify the extent of the niche defect.
- The initial description of the laparoscopic repair of an uteroperitoneal fistula was described by Nezhat and colleagues in 2003.[7] A recent review of this topic by the same group highlighted the increased incidence of this defect due to the rise in cesarean delivery.[8]

Creation of the bladder flap

- A bladder flap is created to move the bladder off the lower uterine segment and avoid entry into the bladder.

Determine location of defect

- The light from a hysteroscope can illuminate the niche defect. The brightness of the hysteroscopic light source can be seen through the thinned myometrium. The extent of the defect can also be identified with the use of cervical dilator.

Incise and open defect

Once the area of the defect is identified, a sharp incision through and around the defect is made. This provides the cleanest edges for reapproximation.

Reclosure of scar

A two-layered, running, nonlocking suture is performed with 2–0 and 3–0 Vicryl® suture (Ethicon, Inc., Somerville, NJ). Careful attention should be made to reapproximate the endometrial edges.

Reapproximation of bladder flap

- The bladder flap should be reapproximated, but not advanced upward onto the lower uterine segment of the uterus.

Hysteroscopic visualization of repaired defect

- If a hysteroscope was used to identify the defect, visualization of the repaired defect can be performed. Absence of fluid leaking through the repair assures adequate approximation of the hysterotomy incision.

PEARLS AND PITFALLS

INTRAOPERATIVE DECISION-MAKING
✖ Identification of defect may be difficult.
SURGICAL TECHNIQUE
○ Avoid blunt dissection and limit use of electrocautery to avoid postoperative adhesion formation. ○ Close defect with two layers of a nonlocking running delayed absorbable suture.
POSTOPERATIVE MANAGEMENT PRIOR TO CONCEPTION
○ Consider postoperative saline infusion hysterosonography to confirm successful repair.
IMMEDIATELY AFTER CONCEPTION CONFIRMED
✖ High index of suspicion for abnormal implantation or placentation once pregnancy is achieved.

POSTOPERATIVE CARE

- We advise the patient to delay conception for 3 months following the repair. A postoperative saline infusion hysterosonography can be performed to ensure the completeness of the repair.
- When future pregnancy is achieved, we recommend liberal use of ultrasound to rule out an ectopic gestation at the site of the repair and/or abnormal placentation.

OUTCOMES

- Repair of the scar defect can ameliorate pain and bleeding symptoms and restore fertility.
- Paucity of data.
- Small cohort studies reported.[9]

COMPLICATIONS

- Residual defect
- Intrauterine scarring
- Perform saline infusion sonography after repair of a PCSD to assess both any residual defect and/or intrauterine scarring.

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Chapter 3.3

Excision of Uterine Septum

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GENERAL PRINCIPLES

Definition

Uterine anomalies occur in up to 5% of women, with approximately one-third of these being septated uteri.[1,2] A septate uterus is typically defined as having a fundal indentation of the uterine cavity >1.5 cm. Uterine septa are associated with miscarriage and preterm birth, with insufficient data linking to infertility. Even small septa of between 1 and 1.5 cm are associated with a significant increase in preterm birth.[3] While randomized controlled trials are lacking, there is evidence that suggests that treatment of a septum improves live birth rates, lowers miscarriage rates and preterm birth rates in women with infertility, and prior miscarriage.[3,4]

Differential Diagnosis

- Arcuate/subseptate uterus: Defined as having a fundal indentation of <1 cm.
- Bicornuate uterus: Distinguished from a septate uterus by indentation of the outer fundus >1 cm. Can commonly have a coexisting septate component.

IMAGING AND OTHER DIAGNOSTICS

Three-dimensional ultrasound with or without saline infusion show equivalent diagnostic accuracy and lower cost compared to MRI or laparoscopy/hysteroscopy. Three-dimensional ultrasound imaging should be considered first-line in the evaluation of a uterine septum. Hysteroscopy alone or a hysterosalpingogram (HSG) are inadequate due to the lack of external uterine contour evaluation.[4]

PREOPERATIVE PLANNING

- Imaging should be used to attempt to determine the extent of the uterine septum and to define the outer contour of the uterus.
- Intraoperative abdominal ultrasound scanning through a full bladder can be helpful in guiding the extent of the septum resection and may reduce the incidence of a residual septum.[5]
- Surgery should be planned in the early proliferative phase or after endometrial preparation. Endometrial preparation can improve visualization during the procedure. This can be accomplished with the use of combined oral contraceptive pills or a progestin (norethindrone acetate 2.5 to 5 mg daily) taken for 14 to 21 days prior to the procedure.

SURGICAL MANAGEMENT

- If preoperative diagnostic procedures are unclear in determining the external uterine contour, a diagnostic laparoscopy can be considered at the same time as the hysteroscopy to verify outer uterine contour. Laparoscopy can also allow for the diagnosis and treatment of coexistent endometriosis that is found with a higher incidence in women with a septate uterus.[6]
- Resection of the septum can be achieved with the hysteroscopic scissors, a monopolar resectoscope loop, or bipolar electrocautery such as the Gynecare Versapoint™ (Ethicon, Somerville, NJ).
- With all methods, the septum generally only needs to be incised to allow retraction into the anterior and posterior uterine walls. In cases with a thicker septum, excision may be necessary.

Positioning

- The patient is placed in the standard dorsal lithotomy position.

Distention Media

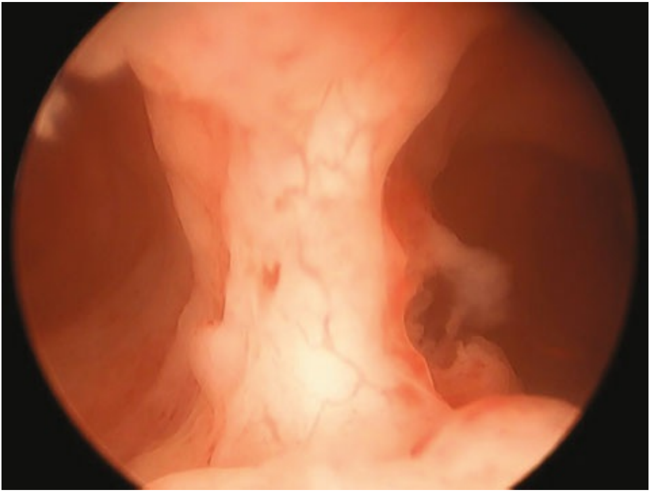
- Normal saline is used for procedures using nonelectrical instruments or with bipolar instruments. Monopolar instruments require hypotonic solutions such as 3% sorbitol, 5% mannitol, or 1.5% glycine. Fluid deficits should be limited to 2,500 mL of normal saline or 1,000 mL of hypotonic solutions due to concerns of hyponatremia with hypotonic solutions. Hypertonic solutions such as 32% Dextran-70 in 10% glucose (Hyskon®, CooperSurgical Inc., Trumbull, CT) should be avoided due to side effects of pulmonary edema and anaphylaxis.[7]
- Keeping intrauterine pressure below the patient's mean arterial pressure can decrease distention fluid absorption. Intracervical injection of a very dilute vasopressin solution (8 mL of 0.05 U/mL vasopressin) can also decrease absorption.[7] Concentrations of vasopressin should not exceed 0.4 U/mL.[7]

Performance of diagnostic laparoscopy

- If preoperative diagnostic procedures are unclear in determining the external uterine contour, a diagnostic laparoscopy can be considered prior to the hysteroscopy to verify outer uterine contour. In cases with an indented outer fundus, the septum resection may not achieve a fully normal triangular cavity due to a partial bicornuate configuration.

Initial hysteroscopy and planning

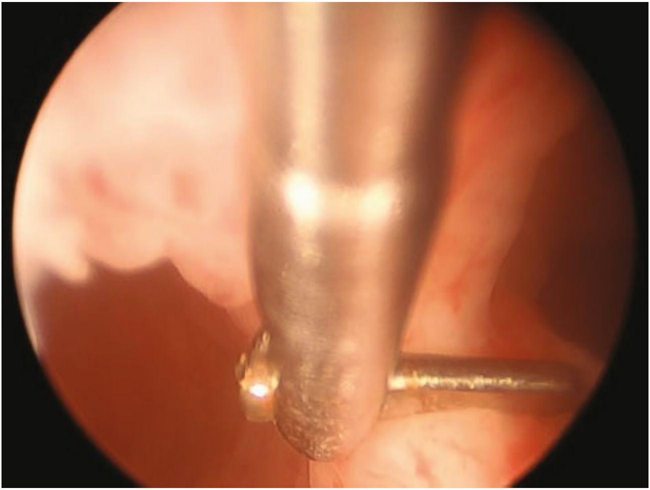
- In cases of an incomplete septum, the hysteroscopy should be performed utilizing the least amount of cervical dilation necessary to allow passage of the operative hysteroscope. Excessive dilation will lead to leakage of the distention fluid. If distention fluid leakage occurs, placement of an additional single tooth tenaculum on the cervix near external cervical os can create a tight seal against the hysteroscope sheath.
- Inspect the septum and plan the septal incision in the midportion of the septum, taking care to prevent dissection into the anterior or posterior walls of the uterus (**Tech Fig. 3.3.1**).
- A 12-degree scope is ideal for instrument usage. A 0-degree scope view will be limited by blockage from the instruments. With a 30-degree scope, the instrument may be out of the visual field due to the orientation of the instrument and the lens of the hysteroscope.
- See details below for steps regarding a complete uterine septum.



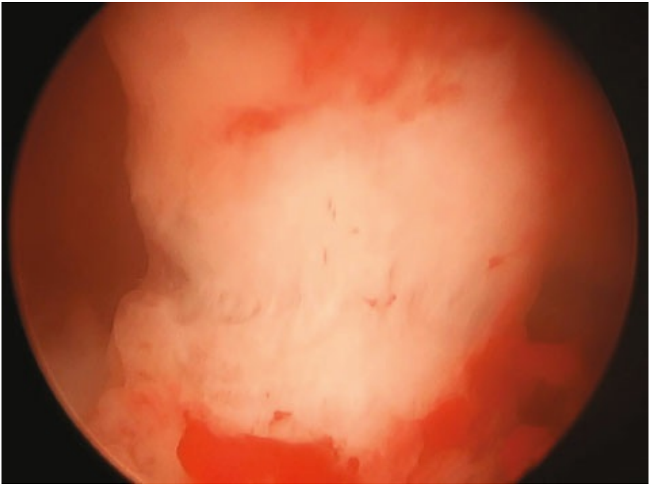
Tech Figure 3.3.1. Initial view of an incomplete uterine septum.

Septum incision with scissors

- Incise the septum horizontally, staying in the middle of the septum vertically (**Tech Fig. 3.3.2**). Maintain proper orientation by keeping the fallopian tube ostia visualized. The incision should be in a plane that would connect the two ostia. As the septum is incised, the septum will usually retract into the anterior and posterior uterine walls (**Tech Fig. 3.3.3**).

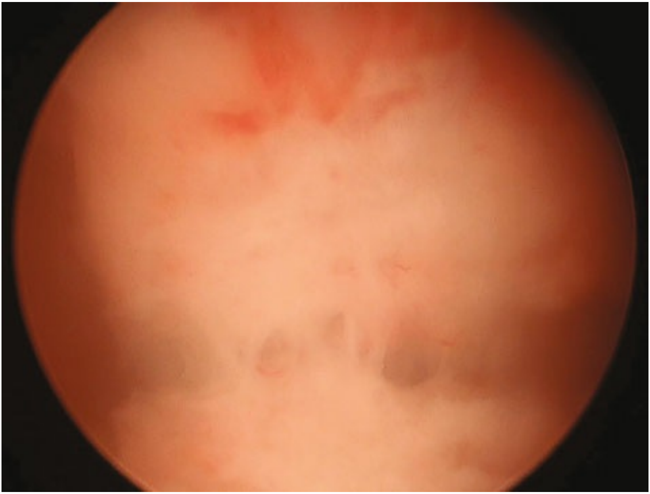


Tech Figure 3.3.2. Start of incision in midportion of septum.

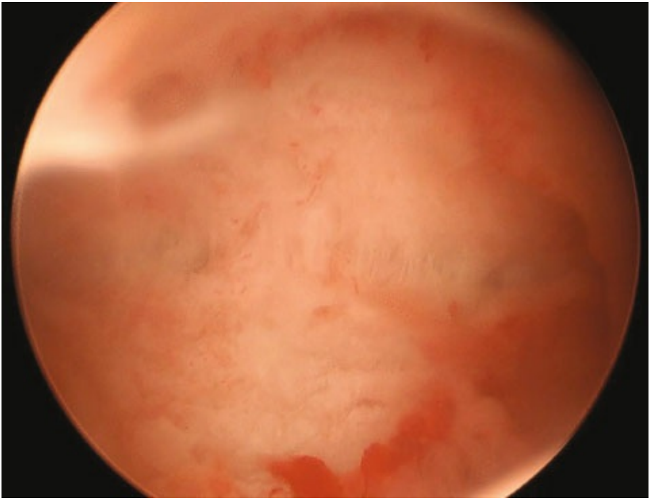


Tech Figure 3.3.3. Retraction of septum anteriorly and posteriorly.

- The incision continues, keeping in the transverse plane that would connect the fallopian tube ostia (**Tech Fig. 3.3.4**).
- As the fundus is approached and the septum thickens, an incision slightly anterior and posterior to the midplane may be necessary to fully remove the septum.
- The procedure is completed when a normal triangular cavity is recreated, or when myometrial tissue is reached in the midline. The myometrial tissue appears more red and vascular compared to the typical white appearance of the septum. The presence of bleeding usually indicates having reached the myometrium (**Tech Fig. 3.3.5**).



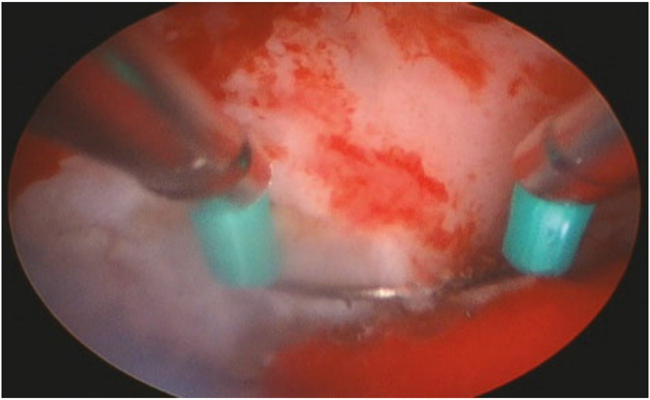
Tech Figure 3.3.4. Upper thicker septum seen.



Tech Figure 3.3.5. Unified uterine cavity.

Use of bipolar or monopolar instruments

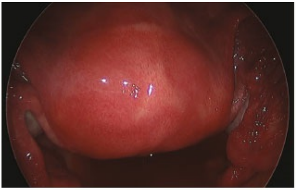
- Septum resection can be similarly performed using a monopolar loop electrode through a resectoscope or with a bipolar instrument such as the Gynecare Versapoint™ (Ethicon, Somerville, NJ).
- A resectoscope can be used with a monopolar loop that is straightened so that it extends directly forward, rather than angled down for resection. Pure cutting current is used with a current of 90 W. Isolated bleeding can be coagulated with limited coagulation of 30 W (**Tech Fig. 3.3.6**).
- The bipolar Versapoint™ instrument vaporizes tissue and can be used with normal saline fluid distention (**Tech Fig. 3.3.7**).
- The principles of septum incision with electrical instrument is similar as with the scissors.



Tech Figure 3.3.6. Resectoscope monopolar loop used to incise uterine septum.

Tech Figure 3.3.7. Versapoint™ bipolar instrument being used to resect uterine septum.

- In cases where a laparoscope was inserted to verify the outer uterine contour, the illumination of the uterine cavity from the hysteroscopic light source can be utilized to indicate when the uterine septum has been adequately excised. To visualize the illumination of the uterus, the light source to the laparoscope should be turned down or disconnected and held with minimum contact to the laparoscope. With a darkened view of the pelvic structures, this allows visualization of the hysteroscopic light source within the uterus (**Tech Fig. 3.3.8A–E**).



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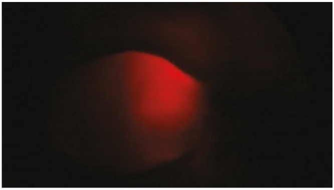

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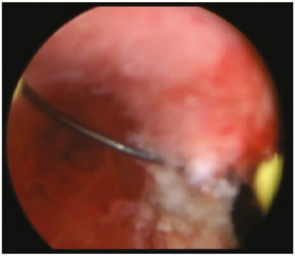

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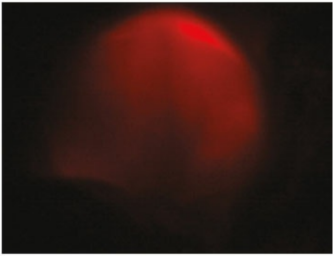
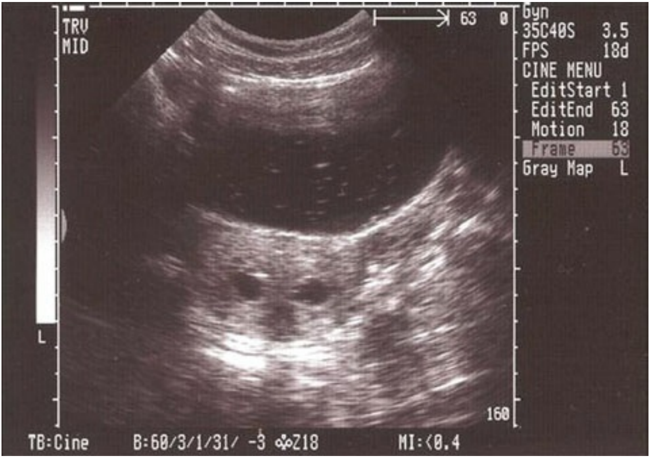


D

E

Tech Figure 3.3.8. Laparoscopy assisted resection of uterine septum. **A:** Laparoscopic view of external uterine contour. **B:** Hysteroscopic light illuminating the right uterine horn of uterus prior to excision of the uterine septum. **C:** Incision of uterine septum with resectoscope monopolar loop. **D:** Hysteroscopic light illuminating the entire fundus of the uterus after uterine septum excised. **E:** Hysteroscopic view of unified uterine cavity.



Tech Figure 3.3.9. Transabdominal ultrasound of an incomplete uterine septum demonstrating two uterine cavities, transverse view.

- In cases where transabdominal ultrasound scanning is used to identify the location and extent of the uterine septum, transverse scanning can identify the two uterine cavities (**Tech Fig. 3.3.9**) and sagittal scanning can be used to judge the distance to the outer uterine serosa.

Complete uterine septum

- If a complete septum is present with two cervical openings, inspect each hemicavity first. If the septum at the cervical os is very thin, it may be incised initially with Metzenbaum scissors just enough to allow passage of the hysteroscope into the now unified external cervical os. In most cases, the cervical portion of the septum should be left in place and the cavities unified at the level of the internal cervical os.
- Insert an 8-F pediatric Foley catheter into one hemicavity. This is only partially inflated with approximately 1 mL of fluid. The hysteroscope is inserted into the other cavity and the point of the internal cervical os is estimated. By slightly inflating/deflating the pediatric Foley while visualizing the other cavity, the septum should be seen to bulge. It is at this point that the septum should be cut across against the Foley balloon. Once the septum has been crossed, connecting the two cavities, the resection can proceed as previously discussed.
- Any portion of the septum in the uterine cavity should be excised, while leaving the septum through the cervix.

PEARLS AND PITFALLS

- ○ Patients should be pretreated with 2 to 3 weeks of progestin therapy prior to surgery.
- ○ Perform a laparoscopy prior to hysteroscopy if preoperative imaging of the outer uterine configuration is unclear and assess for any co-existent endometriosis.
- ○ Intracervical/intrauterine injection of dilute vasopressin can reduce fluid absorption.
- ○ Use of scissors or bipolar instruments allow the use of normal saline for uterine distention.
- ○ Hypotonic agents such as 5% mannitol or 3% sorbitol is used when utilizing monopolar current.
- ✖ Avoid the use of hypertonic solutions such as 32% Dextran-70 in 10% glucose.
- ○ For a complete uterine septum, leave the cervical portion of the septum intact.

POSTOPERATIVE CARE

- After completion of the septum resection, a 10-F Foley catheter is placed through the cervix into the uterine cavity. This balloon is inflated with 3 mL of water. The balloon is filled just enough to keep it in place postoperatively. Overdistention of the balloon catheter often leads to more painful cramping for the patient. To prevent graduate spontaneous deflation of the balloon catheter over the next 3 to 4 days, the catheter is further occluded by a free tie of 0-Silk suture tied in two to three areas of the catheter. A catheter plug can also be placed in the end to prevent drainage of residual blood in the proximal portion of the catheter. The entire catheter/plug can be inserted into the vagina for patient convenience. Occasionally the patient's vagina may be irritated by the catheter and it can be left to exit the vagina and held in place against the perineum by the patient's underwear garment.
- The Foley catheter is left in place for 3 to 4 days postoperatively. During this time the patient is kept on prophylactic antibiotics (doxycycline 100 mg orally twice daily).
- Ovulatory patients can be allowed to cycle naturally after surgery. In anovulatory patients, proliferation of the endometrium with oral estradiol 2 mg orally twice daily for 4 weeks, overlapping with medroxyprogesterone acetate 10 mg orally per day during the last week of estrogen therapy.
- A saline infusion sonogram is performed after the first cycle to evaluate for intrauterine adhesions and extent of any residual septum.
- Patients are generally counseled that they can try to conceive following the second menses after surgery. A study of patients conceiving after in vitro fertilization found similar success in patients who underwent embryo transfer within the first 2 months after surgery or waited >10 wks.[8]

OUTCOMES

- The spontaneous miscarriage rate decreased from 63.6% to 12.5% postoperatively in women with a septum and history of miscarriages.[9]
- The presence of a residual uterine septum of <1 cm as shown by ultrasonography does not appear to decrease reproductive outcomes compared to women in whom the septum was completely resected.[10]

COMPLICATIONS

- Uterine bleeding, which is decreased by the placement of an intrauterine balloon catheter which serves to tamponade bleeding postoperatively.
- Intrauterine adhesion formation has been reported to occur in 5% to 24% of women after septum resection.[11,12]

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Chapter 3.4

Uterine Polypectomy

Travis W. McCoy

GENERAL PRINCIPLES

Definition

- Uterine polyps are localized overgrowths of endometrium. They are common, with a prevalence range from 8% to 35%. Abnormal uterine bleeding is the most common presentation, occurring in 68% of cases. Spontaneous regression can occur in 27% of patients after 1 year and is more likely to occur with smaller polyps <1 cm.[1] The majority of polyps are benign, but premalignancy or malignancy occurs in 5.4% of those in postmenopausal women compared with 1.7% in premenopausal women.[2]
- Endometrial polyps are commonly found in infertile women. Overall evidence supports that they have a detrimental effect on fertility, with improvements seen after surgical removal.[3]

Differential Diagnosis

Submucous myomas, retained placental tissue, intrauterine adhesions

Nonoperative Management

- Observation: Polyps are thought to regress spontaneously in 27% of cases.[1]
- Medical management: There is no evidence to support medical therapy to treat polyps, though levonorgestrel-IUDs and oral contraceptive pills can reduce the incidence of polyp formation.[3]

IMAGING AND OTHER DIAGNOSTICS

Polyps can be visualized by several means, including standard 2D transvaginal sonography, 3D sonography, saline infusion sonography (SIS) (by both 2D and 3D ultrasound), hysterosalpingography (HSG), or hysteroscopy. The use of SIS has increased diagnostic accuracy over noncontrasted 2D and 3D ultrasound. For SIS studies, the use of 3D imaging may also provide additional diagnostic accuracy improvements and is comparable to hysteroscopy in diagnosing intrauterine lesions.[3] Polyps can also be diagnosed by HSG, but with a low specificity.

PREOPERATIVE PLANNING

- Preoperative imaging should be used to distinguish polyps from other pathology such as myomas.
- Adequate surgical visualization can be achieved by performing the hysteroscopy during the early follicular phase of the menstrual cycle or by suppressing endometrial growth using hormonal therapy. Suitable hormonal preparation includes oral contraceptive pills or norethindrone acetate 2.5 to 5 mg daily for 7 to 21 days preprocedure.

SURGICAL MANAGEMENT

- Polypectomy may be performed though several hysteroscopic techniques. Methods of removal include direct removal using hysteroscopic grasping forceps, resectoscopy, electric power morcellators (MyoSure® [Hologic Inc., Marlborough, MA], Truclear® [Smith & Nephew, Andover, MA]), blind polyp forceps, or uterine curettage. Each method has advantages and disadvantages, and surgeons often need flexibility in using different techniques to properly complete the procedure.

Positioning

- The patient is placed in standard dorsal lithotomy position.

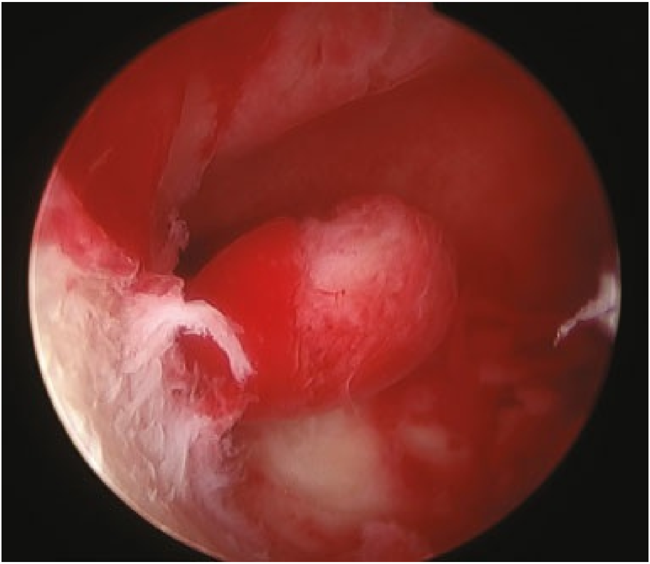
Approach

- Standard hysteroscopic approach is utilized. Procedures can be performed under general anesthesia, moderate sedation, or under local paracervical block.

Procedures and Techniques

Performance of diagnostic hysteroscopy

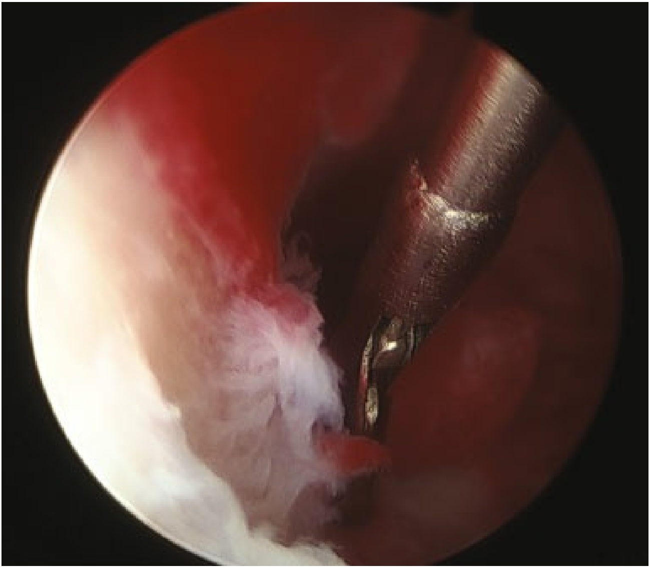
- Diagnostic hysteroscopy is performed in the standard fashion to delineate the size and location of cavity lesions (**Tech Fig. 3.4.1**). Care should be taken to not dilate the cervix any more than is necessary to allow passage of the scope, to limit fluid leakage around the scope.
- Using a camera with a 12-degree viewing angle allows the best visualization while using rigid grasping forceps or scissors.



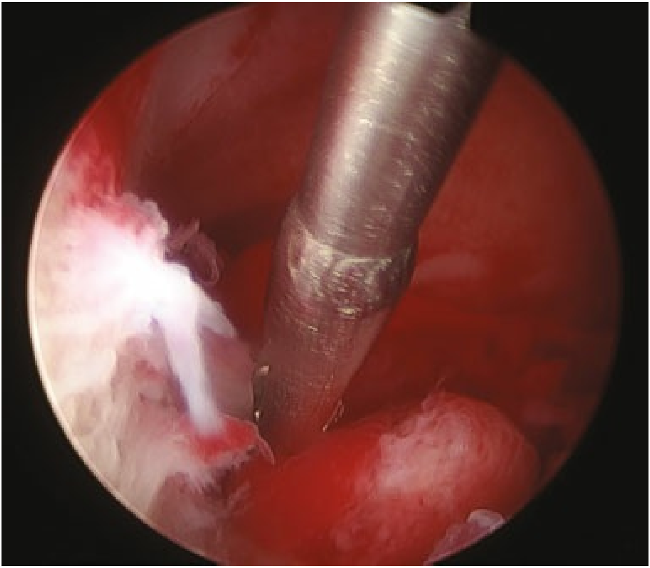
Tech Figure 3.4.1. Initial hysteroscopic view of polyp.

Use of hysteroscopic grasping forceps

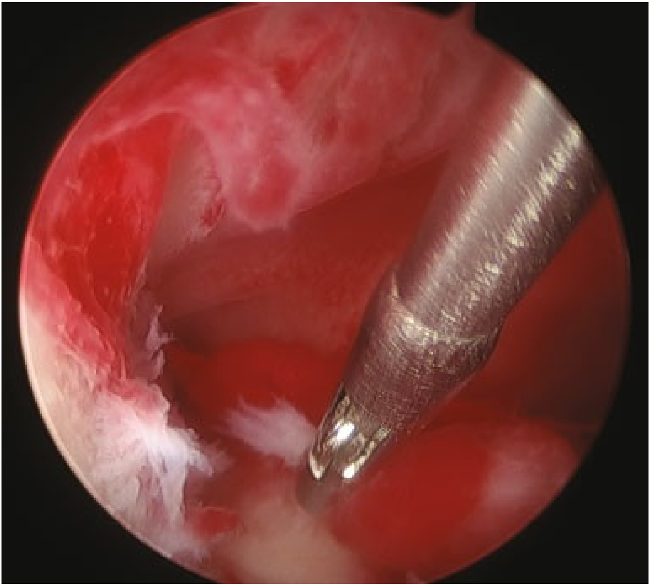
- A grasping forceps is used to grasp the base of the polyp at the uterine wall attachment. The forceps is moved away from the polyp base by moving the camera/grasper unit together resulting in tearing the polyp from its attachment (**Video 3.4.1**).
- Rotating the forceps by ½ turn or more can also be used to tear the polyp from its connection (**Tech Figs. 3.4.2**, **3.4.3** and **3.4.4**).
- If the polyp is unable to be torn from its base, a hysteroscopic scissors can be used to cut the polyp from the uterine attachment.



Tech Figure 3.4.2. Grasping base of polyp.



Tech Figure 3.4.3. Twisting the base of the polyp to shear away from uterine wall.



Tech Figure 3.4.4. Separated polyp from the uterine wall.

Sharp curettage

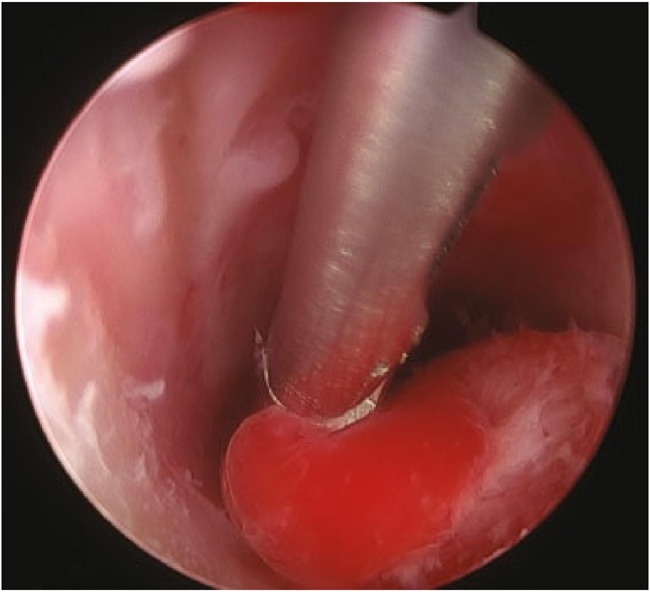
A sharp uterine curette can also be used to remove the polyp by way of a standard dilation and curettage (D&C). The polyp should be visualized initially with the hysteroscope, and after curettage the cavity should be reinspected to insure that the polyp was removed in its entirety.

Electric powered morcellation

Polyps can be removed using hysteroscopic morcellation devices such as the MyoSure® (Hologic Inc., Marlborough, MA) and Truclear® (Smith & Nephew, Andover, MA). Both of these devices work in a similar fashion to cut the polyp while simultaneously suctioning the fragments out of the uterus. These devices can aid in the removal of larger polyps, but can add a significant cost to the procedure.

Polyp removal from the uterine cavity

- Small polyps can be grasped with a hysteroscopic forceps and directly removed by pulling the polyp close to the end of the scope, then withdrawing the scope unit out of the uterus, pulling the polyp with it (**Tech Fig. 3.4.5**).
- Larger polyps may be removed by grasping them blindly with polyp forceps. Caution should be exercised with any blind procedure. The polyp forceps can grab and tear myometrium or lead to uterine perforation.
- If the removal cannot be completed with the above steps, the cervix can be dilated up enough to allow use of a power morcellation device, resectoscope, or passage of a larger instrument such as a sponge forceps.
- After removal, repeat visualization of the cavity should be performed to ensure that the entire specimen was removed.



Tech Figure 3.4.5. Polyp grasped with forceps while withdrawing hysteroscope out of the uterus.

PEARLS AND PITFALLS

○	Use a 12-degree hysteroscope for the best combination of viewing and working angle.
○	Use hysteroscopic graspers at the base of the polyp to shear away from the uterine wall.
✖	Electric hysteroscopic morcellators can speed the process, but are usually not needed and can add extra expense.

POSTOPERATIVE CARE

- Some self-limiting bleeding is to be expected following the procedure.

OUTCOMES

- Studies have not adequately evaluated the improvement in fertility after removal of polyps. Recurrence of polyps has been reported to occur in 13% to 43% of patients, with a higher risk of recurrence with larger numbers of polyps present, hyperplastic polyps without atypia, and increased time to follow up.[4,5]

COMPLICATIONS

- Incomplete removal
- Uterine perforation

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Chapter 3.5

Uterine Myomectomy

Travis W. McCoy, Steven T. Nakajima

GENERAL PRINCIPLES

Definition

- A myomectomy is a surgical removal of uterine fibroids. This may be performed through an open laparotomy incision, using only the hysteroscope for a fibroid with a submucous component, or exclusively with the laparoscope. A myomectomy is the procedure of choice in patients wishing to retain the option of future conception. Other interventional therapies such as uterine artery embolization, magnetic resonance–guided focused ultrasound (MRgFUS) or high-intensity focused ultrasound (HIFU), and laparoscopic myolysis are associated with higher risks of pregnancy complications or have little data in support of pregnancy posttreatment.[1]
- A laparoscopic approach, most commonly with robotic assistance, allows improved patient recovery with less morbidity, outpatient treatment, equivalent results, decreased blood loss, and less pelvic adhesive disease as compared to conventional open myomectomy.[2,3] In experienced hands, a robotic laparoscopic approach can successfully be used to treat fibroids numbering up to twenty and very large uterine size (>20 weeks gestational age), limited by the ability to place intra-abdominal trocars.

Differential Diagnosis

- Myomas are by far the most common uterine masses encountered in women of child-bearing age, but other masses such as adenomyosis and leiomyosarcoma must be considered in the differential diagnosis.

Nonoperative Management

- Medical treatment with gonadotropin releasing hormone (GnRH)-agonists can lead to an approximate 30% reduction in volume, but the effects are limited to the duration of use. Ulipristal acetate and mifepristone have also been used for the treatment of fibroids. Studies on the long-term effectiveness of these medications is limited.[4]

IMAGING AND OTHER DIAGNOSTICS

- Patients should initially be assessed with a pelvic ultrasound. If all fibroids can be clearly visualized and localized in relation to the uterine cavity, this alone may suffice for surgical planning. In all other cases, a pelvic magnetic resonance imaging (MRI) study should be performed and referred to intraoperatively to locate all fibroids. The goal of surgery should be to remove as many fibroids as can be located. In complex cases with multiple fibroids, use of ultrasound or intraoperative findings alone is inadequate and can lead to missing clinically significant fibroids.

PREOPERATIVE PLANNING

Laparoscopic Approach

- The first objective is to determine if a patient is a suitable candidate for a laparoscopic approach. This decision may be surgeon dependent, but the primary limitation is a high order number of fibroids present (>10–20). In most cases, even very large fibroids can be managed successfully with a laparoscopic approach. The limiting factor may be the amount of room available for trocar and instrument placement within the patient's abdomen.
- If all fibroids cannot be clearly visualized and localized with a pelvic ultrasound, then an MRI should be performed. It is important for the surgeon to become familiar with reviewing and reading the MRI in axial, sagittal, and coronal views to determine feasibility of the laparoscopic approach and to use this intraoperatively to assist in locating and excising all fibroids.
- Preoperative screening for anemia should be performed. Ideally hemoglobin levels should be above 10 g/dL prior to surgery. If below this, consideration should be given to medical management to improve levels, such as use of oral contraceptive pills, iron supplementation, GnRH-agonist therapy, and/or tranexamic acid to limit menstrual blood loss.
- Patients should be engaged in the discussion as to risks involved with the morcellation of fibroids. Inadvertent morcellation of a leiomyosarcoma, though rarely encountered, could lead to a change in stage and possibly treatment outcomes. This small risk must be weighed against the increased risk of patient morbidity, lengthened recovery, and adhesion formation due to an open incision to remove the fibroids.

Abdominal Myomectomy Technique

- Preoperative ultrasound is usually sufficient in establishing an estimate of the overall uterine size and the size and number of fibroids. At the time of surgery, most fibroids should be palpable, guiding excision.
- Anticipation of blood loss should be discussed with the patient, including the possibility of requiring a blood transfusion.

SURGICAL MANAGEMENT

- Treatment should be aimed at removing all clinically significant fibroids and as many as feasible in order to lengthen the amount of time before smaller fibroids become symptomatic in the future (**Video 3.5.1**).
- Intraoperative blood loss can be lessened by the injection of a dilute vasopressin solution. A typical solution is made by diluting 20 units of vasopressin in 80 to 100 mL of saline. This can be injected into the myometrium either by using a laparoscopic cyst aspiration needle through a trocar, or by inserting a long spinal needle transabdominally into the uterus. The total dose of vasopressin should be limited to 5 units (approximately 20 to 25 mL of above solution). Complications of vasopressin use include bradycardia, hypertension, and cardiac ischemia and arrest.[5]
- Uterine incisions should be planned so as to allow removal of multiple fibroids if possible, thus limiting the number of incisions that will decrease the overall total surgical time.
- Uterine incisions should be closed in multiple layers with absorbable suture. Preferred suture is an absorbable barbed suture (2–0 V-Loc™ 90 [Covidien, Medtronic Minimally Invasive Therapies, Minneapolis, MN]). Care should be taken to approximate the cut tissues carefully, eliminate dead space, and obtain full hemostasis.
- Care should be taken to keep a tally of the number of fibroids removed and to ensure that all are completely removed from the abdomen at the end of the case. Retention of even small fibroids/fragments have been associated with parasitic growth, adhesions, and even bowel obstruction.[6]

Positioning

- The patient is placed in the standard dorsal lithotomy position. An intrauterine manipulator is used to allow for chromotubation with indigo carmine or methylene blue. This will also stain the endometrial cavity, allowing better visualization of the cavity when addressing submucosal fibroids or entry into the uterine cavity when resecting an intramural leiomyoma.
- Discuss with anesthesiology providers the anticipation of having the patient in Trendelenburg position for an extended period of time. Often the maximum Trendelenburg position is required, but if possible the least angle of Trendelenburg positioning needed to maintain the intestines out of the pelvis should be used.

Approach

- Laparoscopic trocars must be placed high in the abdomen in order to allow room to work, taking into account that often the uterus/fibroids will be retracted in a cranial direction closer to the camera/ports.
- For procedures using robotic assistance, the use of three arms in addition to the camera port allows for better uterine manipulation. With the da Vinci Si® robot (**Fig. 3.5.1A**), Arm 1 is placed on the patient's right, while Arms 2 and 3 are placed on the patient's left, for a right-handed surgeon. An assistant port is placed midway between the camera and Arm 1. With the da Vinci Xi® robot (**Fig. 3.5.1B**), the camera and three accessory ports are placed in the upper abdomen in a straight line since the camera can be placed in any of the ports. The assistant port is place in right lower quadrant. With both systems, the camera port can be placed intraumbilical for uteri of 16 weeks gestational size or smaller, or moved to a supraumbilical location for larger uteri.
- Fundal fibroids should be approached first, followed by anterior, and lastly posterior fibroids. This provides the most mobility to the uterus that will aid in anteflexion to reach posterior fibroids.

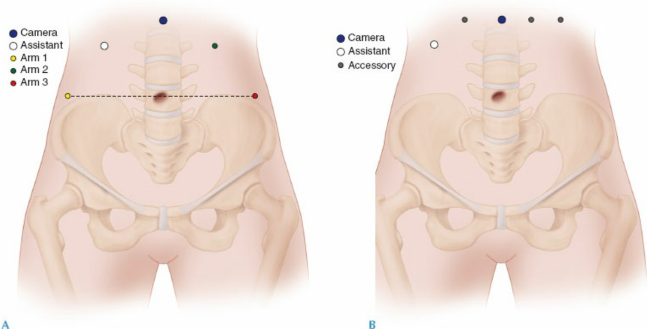
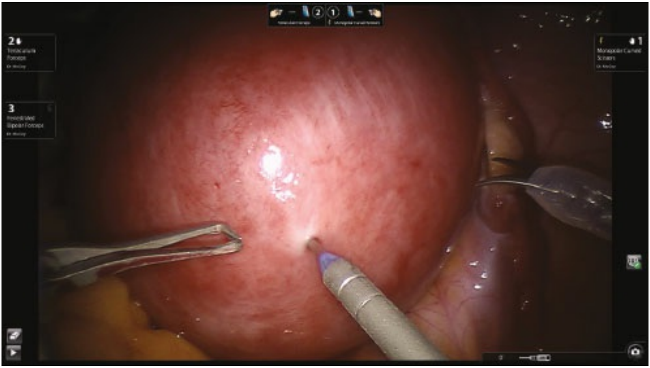


Figure 3.5.1. A: Typical laparoscopic port placement using the da Vinci Si® robot. Arm 1 is placed on the patient's right (*yellow dot*), while Arms 2 (*green dot*) and 3 (*red dot*) are placed on the patient's left, for a right-handed surgeon. An assistant port (*white dot*) is placed midway between the camera (*blue dot*) and Arm 1. **B:** Typical laparoscopic port placement using the da Vinci Xi® robot. The camera (*blue dot*) and three accessory ports (*gray dots*) are placed in the upper abdomen in a straight line since the camera can be placed in any of the four ports. The assistant port (*white dot*) is place in right lower quadrant.

Laparoscopic Approach

Injection of vasopressin

- Insert the injection needle into the myometrium and into the body of the fibroid. Slowly withdraw the needle while attempting to inject the solution. Generally this will allow the vasopressin to infiltrate around the fibroid as the needle is slowly withdrawn (**Tech Fig. 3.5.1**). For subserosal/pedunculated fibroids, injection should be on the lower aspect of the fibroid and not into the uterus itself.



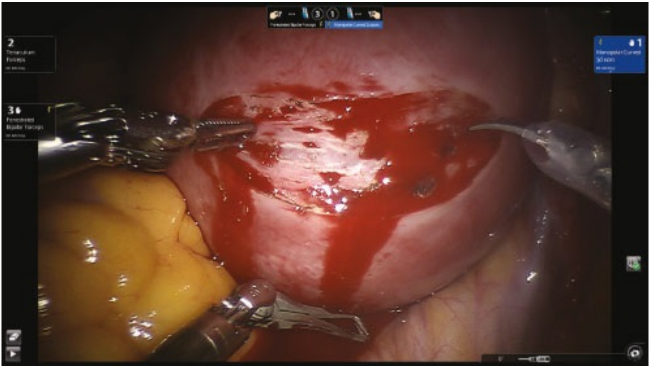
Tech Figure 3.5.1. Injection of dilute vasopressin solution into myometrium overlying the fibroid.

Incision planning

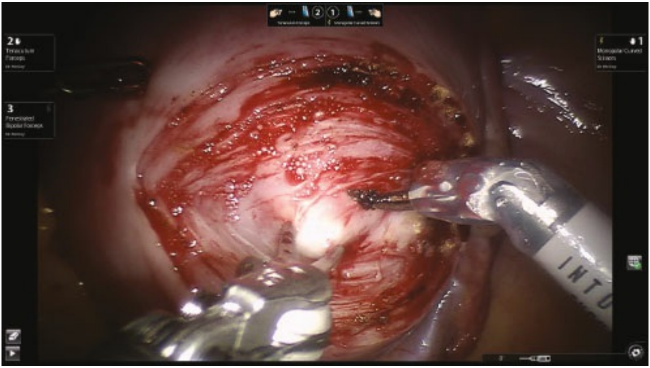
The incision should be planned to achieve removal of one or more fibroids if possible. The orientation of the incision should be placed to facilitate closure of the incision. Incisions that are directly horizontal or vertical are more difficult to close due to required needle and instrument positioning. Even a slight oblique offset can ease the closure.

Uterine incision

- The uterine incision is typically made with a monopolar scissor, while holding the blades open, using only the tip of one blade. The serosa and majority of the myometrium is opened using a cutting current on a setting of 40 to 50 W. Using a cutting current and a quick movement of the instrument allows minimal thermal damage to tissue (**Tech Fig. 3.5.2**). The myometrium should be opened for a length approximately two-thirds the width of the targeted fibroid. Extending the incision too wide is usually unnecessary for fibroid removal and often leads to additional bleeding and operating time.
- Extend the incision all the way through the myometrium until it is clear that the monopolar scissor tip is cutting into the fibroid. This helps to ensure that the proper dissection plane outside the fibroid is reached.
- A tenaculum is used to grasp the fibroid and elevate it away from the body of the uterus. The tenaculum can be a robotic instrument or a laparoscopic instrument inserted through the assistant port. Small areas of bleeding do not need to be cauterized, as the traction on the fibroid both helps to assist in the enucleation and serves to compress the blood vessels to limit blood loss (**Tech Fig. 3.5.3**).



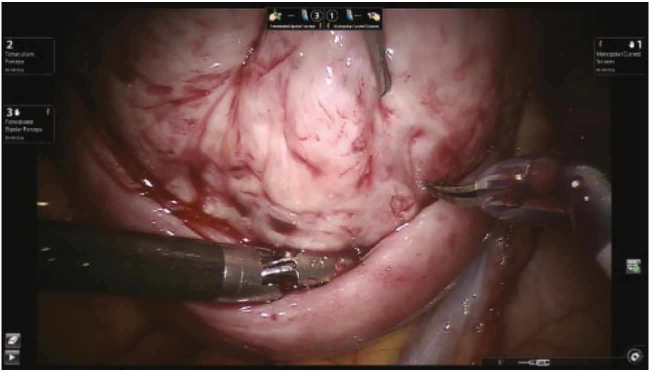
Tech Figure 3.5.2. Initial incision through the serosa.



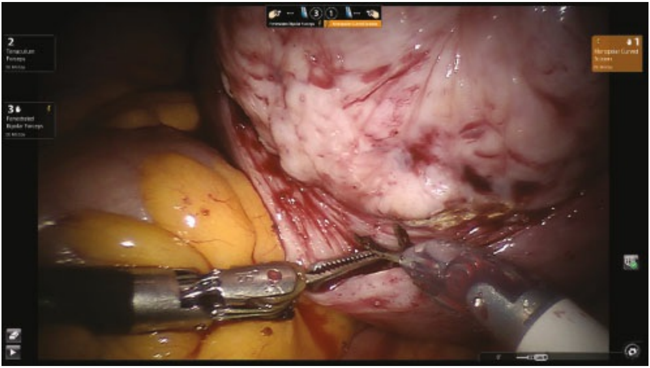
Tech Figure 3.5.3. Incision extended to the fibroid, which is then grasped and elevated with a tenaculum.

Beginning enucleation

- During the enucleation process, it is of utmost importance to keep the dissection plane as close as possible to the fibroid. The fibroid does not have a capsule, but is surrounded by a network of vessels. By staying internal to these vessels, bleeding can be kept at a minimum (**Tech Fig. 3.5.4**).
- The majority of the dissection is performed using a single blade of the scissors with cutting current. Obvious small vessels can be coagulated if needed. The majority of hemostasis will be obtained during the closure of the hysterotomy.
- If the dissection plane is unclear, cutting back into the fibroid will necessarily cross into the proper plane (**Tech Fig. 3.5.5**).



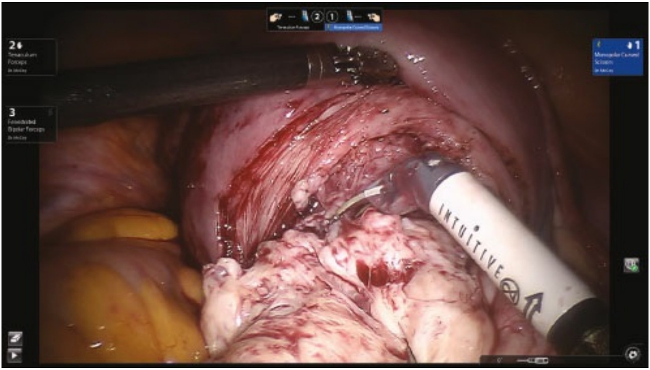
Tech Figure 3.5.4. Proper dissection plane between fibroid and overlying vessels.



Tech Figure 3.5.5. Cutting back into fibroid to re-establish proper dissection plane.

Completing fibroid enucleation

- As dissection proceeds around the fibroid, the natural tendency will be to drift away from the posterior aspect of the fibroid, which leads to the bleeding that is often encountered. In this stage of the dissection, repeated cuts should be made back into the fibroid to ensure that the proper plane is being maintained (**Tech Fig. 3.5.6**).
- If the fibroid is submucosal in nature, care should be taken to dissect the endometrium away from the fibroid. In cases where the fibroid extends into the cavity, the endometrial layer may need to be opened and will be closed separately prior to closure of the myometrium.
- As the fibroid nears extraction, traction should be lessened so as to avoid tearing the remaining tissue and vessels.



Tech Figure 3.5.6. Dissection stays against the posterior side of fibroid.

Place fibroid aside

- Fibroids should be placed aside for locating later. Small fibroids can be kept in the posterior cul-de-sac, but others can be kept in the right paracolic gutter. Avoid placing them in the mid-upper abdomen, as they can often slide under loops of small bowel and be difficult to locate later.
- If multiple fibroids are being removed, keep a tally of the number remaining inside of the abdomen.
- Another option is to place a separate suture inside the abdomen and string all of the removed fibroids together. The suture can be kept long and a portion of the suture between the fibroid(s) and the needle along with the distal end can be drawn up through the abdominal wall fixing the fibroid(s) in a stationary position. Even when there are only two or three fibroids, this maneuver helps to save time searching for a missing fibroid (**Tech Fig. 3.5.7**).

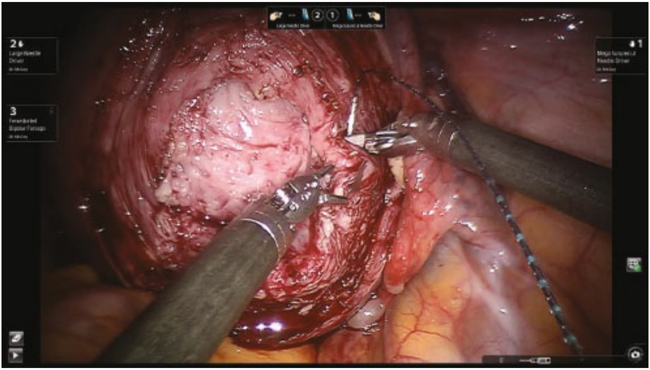
Tech Figure 3.5.7. Fibroid fixed to anterior abdominal wall by a suture prior to morcellation.

Obtaining hemostasis

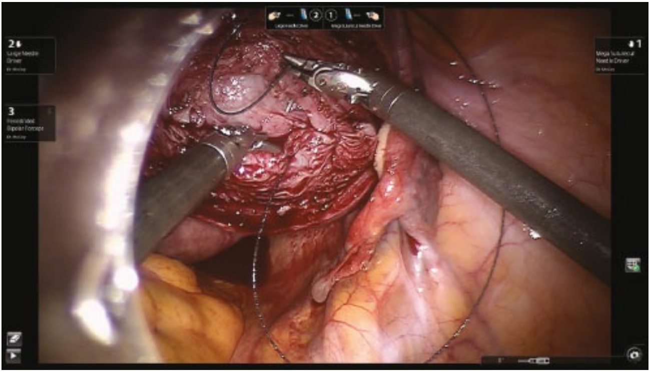
- Bleeding from individual vessels can be cauterized using bipolar cautery. The majority of bleeding will be of venous origin and most hemostasis will be obtained through suturing.

Closure of the defect

- If there is minimal active bleeding, delaying the closure by a few minutes will allow the uterine musculature to contract down leaving a smaller defect that will speed closure. If there is no active bleeding, removing multiple fibroids before closure of the incisions can shorten operating time and limit delays from instrument changes.
- If the endometrial cavity was opened, this should be closed in a running fashion with a small absorbable suture (4–0 Vicryl®).
- The preferred suture for uterine closure is an absorbable barbed suture (2–0 V-Loc™ 90 [Covidien, Medtronic Minimally Invasive Therapies, Minneapolis, MN]). A 12-in suture length allows multiple layers to be closed with a single suture. A GS-22 needle (1/2 circle, 27 mm) is used for smaller defects and can be passed through an 8-mm laparoscopic trocar. A GS-21 needle (1/2 circle, 37 mm) is used in larger defects and can speed closure, but requires a 10-mm trocar for passage into the abdomen.
- The barbed suture is anchored in the base of the opening (**Tech Fig. 3.5.8**). Multiple layers in a running fashion should be used, utilizing as many layers as needed to achieve hemostasis, cut tissue approximation, and elimination of dead space. Smaller incisions may be closed in two layers, where large defects may take four or more layers.
- If the endometrium was dissected away from the fibroid, the sub-endometrial tissue should be incorporated into the first myometrial layer so as to eliminate the formation of dead-space between the cavity and myometrium (**Tech Fig. 3.5.9**).

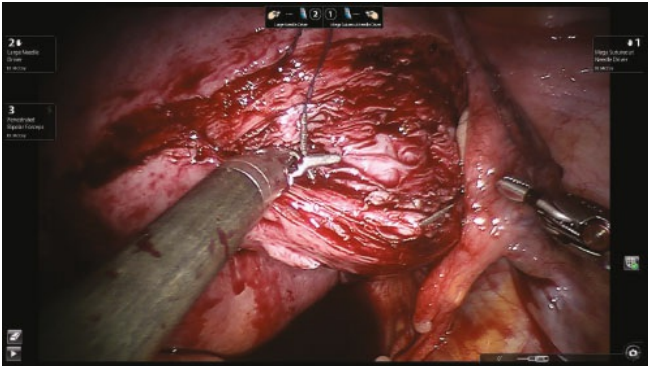


Tech Figure 3.5.8. Starting initial closure of myometrium.



Tech Figure 3.5.9. Suturing subendometrial tissue to myometrium to close potential dead space.

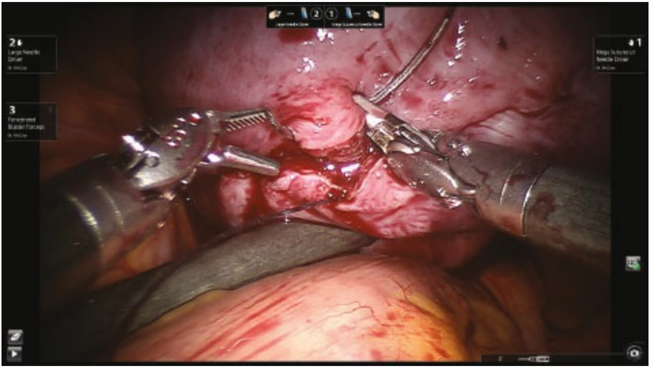
- After closing the first layer of the myometrium, care should be taken to invert the edges so that the cut surfaces are approximated. This can be done by using a forceps to "tuck" the previous layer down under the next suture layer. This can also be facilitated by using a horizontal mattress type suture technique on subsequent layers, which promotes the layer inversion (**Tech Fig. 3.5.10**).



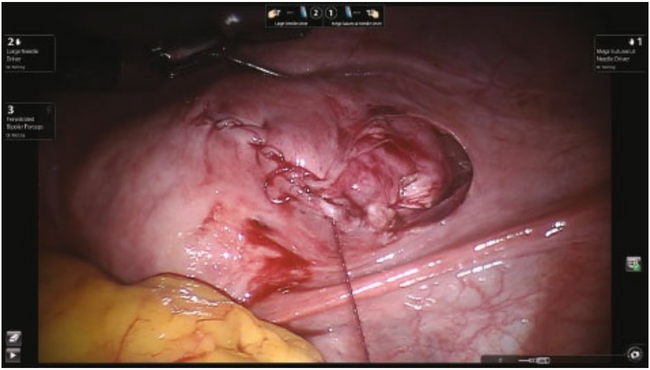
Tech Figure 3.5.10. Using horizontal mattress suture to reapproximate second myometrial layer.

Finishing the closure

- The outer layers of myometrium and serosa can be brought together in several ways. In most cases this layer is already fully hemostatic and the final closure only serves to reapproximate the edges. Using a subserosal horizontal mattress suture, as is used in a skin closure, can provide very good final closure appearance without leaving exposed suture that could promote adhesion formation (**Tech Fig. 3.5.11**). A simple running method can also be used, and taking very small bites of only a few millimeters can promote serosal approximation while avoiding excessive suture exposure and causing further bleeding from the needle puncture sites (**Tech Fig. 3.5.12**).



Tech Figure 3.5.11. Closing serosal layer using a running subserosal suture.



Tech Figure 3.5.12. Alternative method of serosal closure using small bites of running suture.

- Continued bleeding from the incision is usually due to inadequate hemostasis at a deeper level. Use of cautery on the incision edge creates further tissue damage and usually does not help in slowing bleeding. Placing additional deep sutures through the serosa and across the incision can sometimes aid in hemostasis. This can also be managed through observation and will often stop as the uterus continues to contract.

Adhesion prevention

- Adhesion prevention is best achieved by limiting surface serosal damage, limiting the number of incisions, minimizing the use of clamps on the uterine serosal edge, preventing everted wound edges, and by placement of incisions in a fundal or anterior location.[7]
- Absorbable barriers such as Seprafilm® (Sanofi Biosurgery, Bridgewater, NJ) or Interceed® (Ethicon Inc., Somerville, NJ) should be placed over all incisions at the completion of the case. Interceed® can actually induce fibrosis in the presence of blood, so this should be placed at the end of the case after fibroid removal, when bleeding is less likely to be present.

Fibroid removal

- Fibroids can be removed from the abdomen by several methods. Small fibroids may be removed directly through laparoscopic trocars. Larger fibroids can be morcellated using a power morcellator intra-abdominally, within a contained enclosure,[8] or manually through an extended incision (**Video 3.5.2**). They can also be removed through a posterior colpotomy incision.
- When removing fibroids, smaller ones should be removed first so as to lessen the likelihood of losing track of them around the bowel. A tally should be kept of the number inside and the number removed to ensure that all fibroids are accounted for.
- Care should be taken to ensure that all pieces of myoma are fully removed. It is wise to ensure that all pieces of each fibroid are removed prior to moving on to the next fibroid.

Abdominal Myomectomy Technique

Intraoperative technique

- A Pfannenstiel incision can often be utilized for uteri of <20 weeks gestational size. The patient should be examined under anesthesia to determine the mobility of the uterus. A vertical midline incision should be used if the uterus is immobile or doubt exists as to whether it can be exteriorized through a Pfannenstiel incision.
- In most cases, an abdominal retractor is not needed, as the uterus can be exteriorized and allow adequate access to all fibroids.
- Use of a tourniquet around the uterus in addition to vasopressin injections can reduce intraoperative blood loss. A 1-in Penrose drain is wrapped around the posterior aspect of the uterus. The drain is then tied anteriorly around the lower uterine segment with a single overhand knot and clamped with a hemostat to keep it from coming loose. Care should be taken to ensure that the tourniquet is not directly compressing the fallopian tubes. The drain knot should also not be compressing the bladder.
- The techniques for removal of fibroids during an abdominal myomectomy are similar to those described for a laparoscopic approach. Unidirectional barbed suture can be used, or an absorbable 2–0 or 0 Vicryl® (Ethicon, Cincinnati, OH) can also be used.

PEARLS AND PITFALLS

- Preoperative planning with careful ultrasound or MRI is essential to locating and removing all fibroids.
- Uterine incisions should be placed to allow removal of the maximum number of fibroids while minimizing the number of incisions.
- Dissection should stay as close as possible to the fibroid to limit damage to surrounding vessels.
- Uterine closure should focus on the reapproximating the natural location of the myometrium, achieving hemostasis, and eliminating dead space.
- For laparoscopic cases, removed fibroids should be tracked carefully to ensure that all are removed from the abdomen. In cases of morcellation, close attention should be given to completely removing all small pieces.

POSTOPERATIVE CARE

- Laparoscopic patients can often be discharged shortly after an observation period in the recovery room and further managed on an outpatient basis. Those with an abdominal myomectomy can usually be discharged in 1 to 3 days.
- Patients may try to conceive 3 months postoperatively.

OUTCOMES

- Compared to abdominal myomectomy, both laparoscopic myomectomy and robotic-assisted laparoscopic myomectomy are associated with decreased blood loss, shorter length of hospital stay,[9] and lower incidence of adhesions at second look laparoscopy.[10]
- Studies of reproductive outcomes directly comparing abdominal and laparoscopic myomectomy are lacking. A prospective study of women undergoing laparoscopic myomectomy found that 70% who desired to conceive were successful.[11] Other pregnancy outcomes and complications do not seem to differ in regards to route of myomectomy.

COMPLICATIONS

- Adhesion formation can occur, but a laparoscopic approach causes fewer and less severe adhesions as compared to an open myomectomy.
- Amount of blood loss is dependent on the size and number of incisions, but is significantly less than what is encountered in an open myomectomy.
- Retained fibroid fragments can lead to adhesion formation or parasitic myoma growth.

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4

Tubal

Chapter 4.1

Tubal: Lysis of Adhesions

Travis W. McCoy

GENERAL PRINCIPLES

Definition

Tubal and/or ovarian adhesions can decrease fertility by limiting the interaction of the fallopian tube with the ovary, hindering the ability of the tube to capture an egg (oocyte).

Differential Diagnosis

- Postinfective adhesions
- Postoperative adhesions
- Adhesions due to endometriosis or other pelvic inflammatory processes

IMAGING AND OTHER DIAGNOSTICS

- A hysterosalpingogram (HSG) easily demonstrates distal tubal occlusion, and at times can provide the suggestion of peritubal or ovarian pelvic adhesions. However, the sensitivity of an HSG to detect more subtle adhesions is low.[1]
- Standard transvaginal ultrasonography can sometimes detect the presence of adhesions on the basis of limited mobility of the ovary. Sometimes the presence of normal or pathologic amounts of pelvic fluid can delineate or suggest the presence of filmy adhesions.
- All imaging modalities have limited sensitivity and specificity in the diagnosis of pelvic adhesions without tubal closure or the presence of a hydrosalpinx.

PREOPERATIVE PLANNING

- Extent of abnormality seen by HSG or ultrasound can help to anticipate surgical findings. More severe findings raise the odds of requiring more extensive surgical dissection, and therefore could relate to ultimately decreased odds of fertility. The presence of distal tubal closure necessitates the discussion of performance of a neosalpingostomy, or possible salpingectomy if the tubes are damaged beyond repair.
- Patients should be counseled that even with the most careful techniques of adhesiolysis and adhesion prevention measures, new adhesions could form postoperatively.

SURGICAL MANAGEMENT

- The treatment of tubal adhesions is primarily performed in an effort to improve fertility. Only rarely may pelvic adhesions cause pain, most commonly when they involve the patient's intestines. Treatment of adhesions is often necessary during the treatment of endometriosis.

Positioning

The patient should be placed in the normal standard dorsal lithotomy position as for other laparoscopic gynecologic procedures. An intrauterine manipulator capable of allowing chromotubation is helpful. Devices such as the ClearView® (Clinical Innovations, Murray, UT), HUMI® (Cooper Surgical, Trumbull, CT), ZUMI™ (Cooper Surgical, Trumbull, CT), or Kronner Manipujector® (Cooper Surgical, Trumbull, CT) allow both manipulation as well as chromotubation. We prefer to use a very dark chromotubation solution consisting of 10 mL of indigo carmine 0.8% solution (two ampules) mixed in 100 mL of saline.

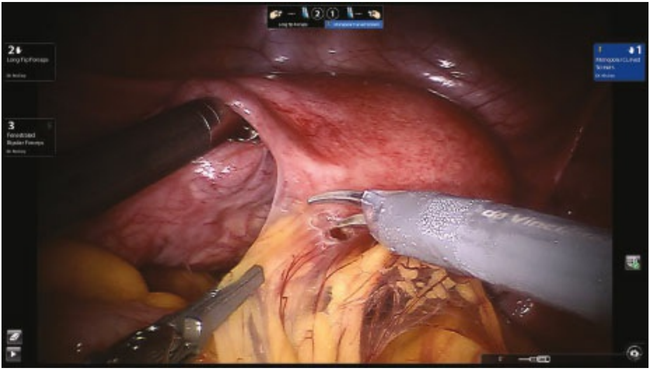
Approach

- The preferred method of adhesiolysis is by a laparoscopic approach. It is the treatment of choice due the increase in postoperative adhesions as well as patient morbidity following laparotomy.
- The procedure can almost always be approached through the use of 5-mm laparoscopic ports. The number of ports needed will be proportional to the severity of the disease. It is recommended to start with a lateral lower quadrant and suprapubic port in addition to an umbilical camera port. An additional contralateral lower quadrant port can be added for additional assistance.
- Instruments for the lysis of adhesions can include monopolar scissors or harmonic scalpel. Monopolar scissors are preferred as they can be used without cautery for filmy adhesions, or use low power (15 to 20 W) pinpoint cautery for adhesions with vascularity.

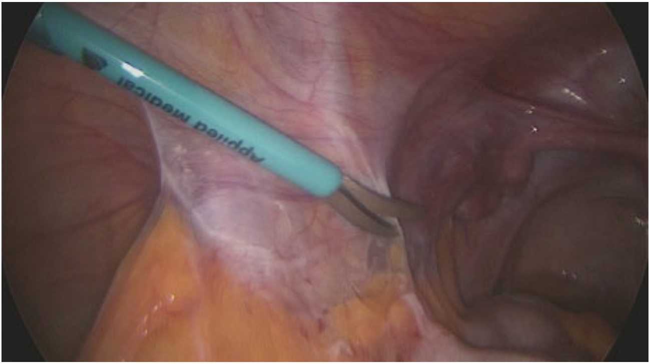
Procedures and Techniques

Intestinal adhesiolysis

- Any adhesion involving the sigmoid, rectum, small bowel, or omentum within the pelvis should be lysed to allow retraction of the intestines out of the pelvis for optimal visualization (**Tech Fig. 4.1.1**).
- Physiologic adhesions between the descending colon/sigmoid and the left abdominal/pelvic sidewall may be lysed to gain better access to the left adnexa (**Tech Fig. 4.1.2**).



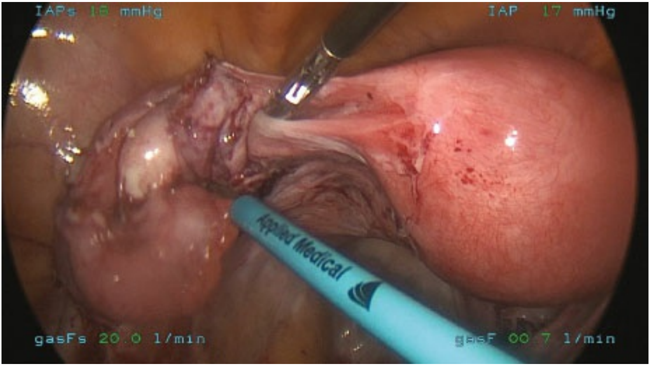
Tech Figure 4.1.1. Lysing any intestinal or omental adhesions.



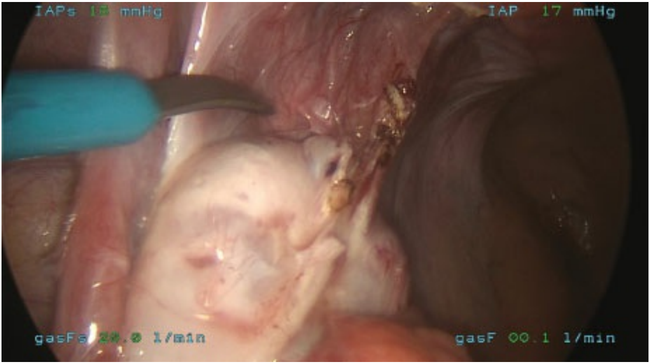
Tech Figure 4.1.2. Relaxing physiologic connections of sigmoid to left pelvic sidewall for better adnexal exposure.

Ovarian adhesiolysis

- Before addressing the tubes, adhesions around the ovary should be lysed. Grasping the utero-ovarian ligament with an atraumatic grasper and rotating it medially attempts to lift the ovary out of the pelvis, placing posterior adhesions on traction for more clear delineation (**Tech Fig. 4.1.3**).
- Dense adhesions may attach the ovary to the peritoneum overlying the ureter. In these cases retroperitoneal exploration may be necessary to delineate the ureter location prior to separating the ovary from the sidewall (**Tech Fig. 4.1.4**).

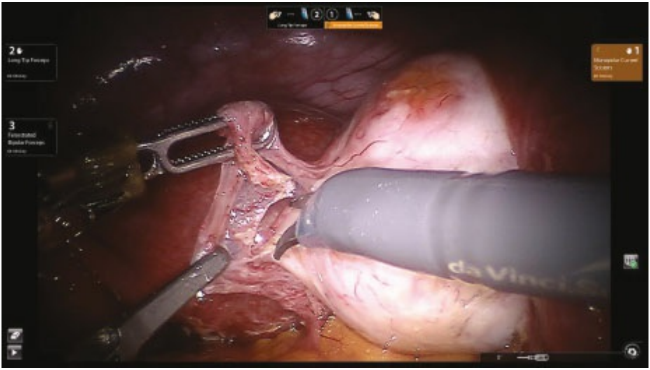


Tech Figure 4.1.3. Grasping utero-ovarian ligament and rotating medially to place ovary on traction out of pelvis.



Tech Figure 4.1.4. Dense adhesions under ovary may need retroperitoneal exploration to safeguard ureter.

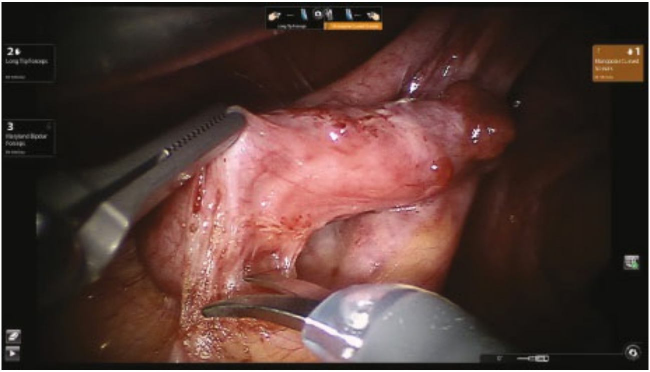
- Adhesions may often form a filmy layer on the surface of the ovary. These adhesions should be removed, as they could act as a barrier preventing an oocyte from reaching the tube (**Tech Fig. 4.1.5**).



Tech Figure 4.1.5. Any filmy adhesions should be fully removed from the ovarian surface.

Normalize mobility of the body of the fallopian tube

- Any adhesions that restrict the movement of the body (isthmic and ampullary portions) of the tube should be relieved. This could involve adhesions from the tube to the round ligament, lateral sidewall, uterus, or ovary. In some cases these may be easily resolved, but dense adhesions may not provide a clear plane for separation without significantly affecting the mesosalpinx. In these cases, normal tubal interaction with the ovary may not be fully achieved (**Tech Fig. 4.1.6**).



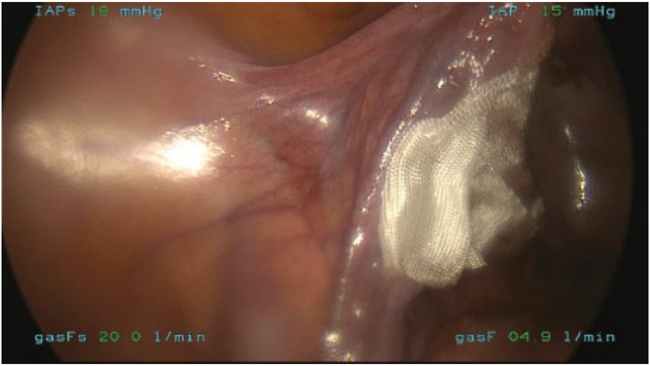
Tech Figure 4.1.6. Mobilizing the body of the tube to allow maximum extent of movement.

Treatment of distal fimbriated end

- The fimbriated end should be freed up as much as possible to allow it to drape over the ovary to receive an oocyte.
- Care should be taken when lysing fimbrial adhesions as the vascularity in this region can lead to significant bleeding. Encountered bleeding should be addressed with a bipolar cautery instrument such as a Maryland bipolar or microbipolar. If unavailable, a monopolar fine-tipped grasper can be used to directly grasp the origin of the bleeding and minimal use of electrocautery applied to obtain hemostasis.
- The fimbrial opening can be identified by chromotubation, and the opening should be gently probed with a Maryland forceps, as adhesions can also be found within the ampulla and should be lysed.

Adhesion prevention

- Careful dissection with limited trauma and judicious use of electrocautery are key in the prevention of future adhesion formation. All adhesion barriers have limitations as to their effectiveness, though for this procedure, we prefer to use Interceed® (Ethicon Inc., Somerville, NJ). Use ½ of a standard 3 × 4-in sheet to wrap around the distal portion of the tube to form a tubal "sock" The remaining ½ sheet is then used to wrap under the ovary, making an effort to separate the tube from both the ovary and pelvic sidewalls during the healing process (**Tech Fig. 4.1.7**).
- The patient can attempt to conceive immediately following surgery. However, if Interceed® is placed, this can be expected to persist for 1 month after surgery (per manufacturer's insert).
- If unable to conceive after 6 to 12 months of appropriate timed intercourse, the patient should consider in vitro fertilization (IVF). Repeat surgical management is unlikely to give added benefit.



Tech Figure 4.1.7. Covering tube and ovary with antiadhesion barrier at end of procedure.

PEARLS AND PITFALLS

INTRAOPERATIVE DECISION-MAKING

- ✖ Repeated attempts at tubal lysis of adhesions are unlikely to significantly improve function and should not be performed.
- ○ In cases of irreparable or nonviable tubes, a salpingectomy should be performed.

SURGICAL TECHNIQUE

- ○ Limit use of electrocautery to avoid vascular damage and postoperative adhesion formation.

POSTOPERATIVE CONCEPTION

- ○ If unable to conceive in 6 to 12 months of appropriate timed attempts, consideration should be given to progression to IVF.

OUTCOMES

- Chance of conceiving postoperatively is related to the severity of tubal damage.

COMPLICATIONS

- Reformation of adhesions, limiting tubo-ovarian interaction and function.

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Chapter 4.2

Tuboplasty/Neosalpingostomy

Travis W. McCoy, Steven T. Nakajima

GENERAL PRINCIPLES

Definition

A damaged fallopian tube in which the fimbriated end of the tube has become occluded due to adhesive disease can result in a hydrosalpinx. Besides rendering the tube nonfunctional, the presence of a hydrosalpinx reduces pregnancy rates in patients undergoing in vitro fertilization (IVF).[1] A tuboplasty is a surgical procedure that involves lysing fimbrial adhesions to open a partially occluded distal end. A tubal neosalpingostomy is a procedure in which a fallopian tube can be reopened as a method of restoring fertility or less commonly as treatment for pelvic pain occurring due to the presence of the hydrosalpinx.

Differential Diagnosis

Distal tubal damage in the form of partial or complete fimbrial closure is most commonly due to postinfective adhesions, but can also result from postoperative adhesions or scarring due to endometriosis. Pelvic adhesive disease can also cause functional restrictions, limiting the interactions of the tube and ovary without affecting the fimbria.

IMAGING AND OTHER DIAGNOSTICS

Distal tubal obstruction is most easily demonstrated by hysterosalpingogram (HSG), though this test can have both false positive and negative results with findings suggestive of a blockage in the setting of a normal tube, or vice-versa. A moderate to severe hydrosalpinx may also be visualized through standard transvaginal ultrasound, hysterosalpingo-contrast sonography (HyCoSy),[2] MRI, or pelvic CT, though the latter two are much less sensitive for tubal damage.

PREOPERATIVE PLANNING

Establishment of the severity of tubal damage by HSG or ultrasound can help in counseling patients. The success of a surgical repair of hydrosalpinges, relating to the chance of subsequent pregnancy as well as the odds of reclosure, is directly related to the severity of the hydrosalpinx.[3] Coexisting significant endometriosis may further lower chances of success. The patient should be counseled that there could be a spectrum of findings and necessary treatments at the time of surgery. These could range from mildly damaged tubes leading to the successful repair of the affected tube(s) to the more severe finding of badly damaged tubes with a nonviable tubal mucosa necessitating a salpingectomy. In cases of such severe damage, likelihood of pregnancy following repair attempts is very low, and subsequent reclosure could lead to the formation of a recurrent hydrosalpinx which can lead to diminished success through IVF and/or pelvic pain. In this situation, the patient will benefit from a definitive salpingectomy.

SURGICAL MANAGEMENT

- The primary indication for surgical repair of hydrosalpinges is for the preservation of fertility. The preferable approach to the procedure would be through a laparoscopic approach. The same steps could be utilized for the repair through an open laparotomy approach, but a laparoscopic approach is recommended due to a lower risk of subsequent pelvic adhesions. Due to the delicate nature of the repair required, often a significantly better repair can be accomplished with the use of a robotic-assisted laparoscopic approach. The procedure involves lysis of adhesions to restore a normal ovarian/tubal relationship, then locating and opening the fimbriated end of the tube. The edges of the new opening are then sutured to the outer tubal serosa, as if opening and everting the petals of a flower.
- Different techniques have been described to perform a neosalpingostomy; however, the highest success rates and patency rates have been seen with suturing open the tubes as described here.[3]

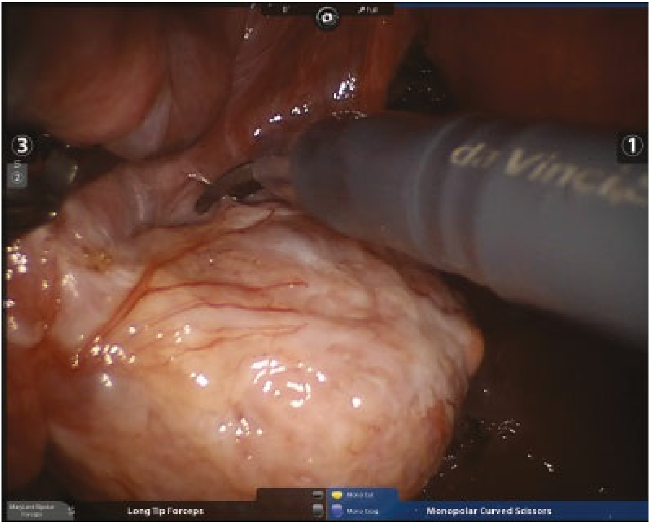
Positioning

The patient should be placed in the normal standard dorsal lithotomy position as for other laparoscopic gynecologic procedures. An intrauterine manipulator capable of allowing chromotubation is helpful. Devices such as the ClearView® (Clinical Innovations, Murray, UT), HUMI® (Cooper Surgical, Trumbull, CT), ZUMI™ (Cooper Surgical, Trumbull, CT), or Kronner Manipujector® (Cooper Surgical, Trumbull, CT) allow both manipulation as well as chromotubation. We prefer to use a very dark chromotubation solution consisting of 10 mL of indigo carmine 0.8% solution (two ampules) mixed in 100 mL of saline.

Procedures and Techniques

Lysis of peritubal/periovarian adhesions

- The first step is restoring the normal anatomic relationships between the fallopian tube and the ovary. This includes lysing any ovarian adhesions between the ovary and the uterus or pelvic sidewall. The ampullary end is often adhered to the ovary and care must be taken in this area to free up the end of the tube without cutting into the edge of the mesosalpinx, which can lead to significant bleeding that may require cautery to obtain hemostasis. Excessive cautery should be avoided to decrease chances of vascular damage and recurrent adhesion formation (**Tech Fig. 4.2.1**).



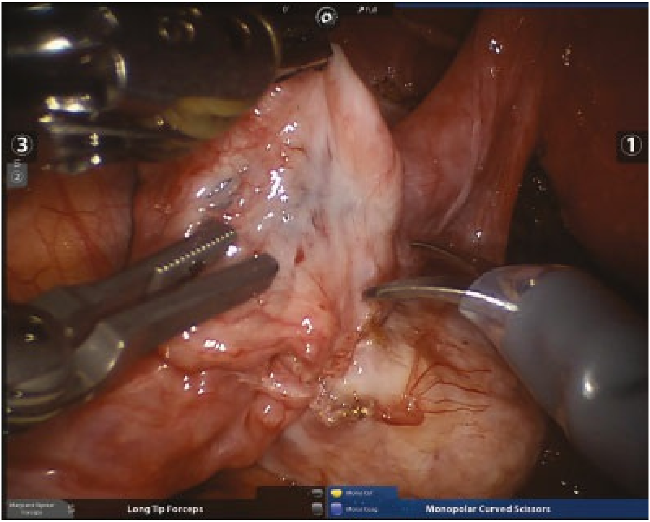
Tech Figure 4.2.1. Lysis of tubo-ovarian adhesions.

Locating fimbrial end

Performing chromotubation with steady pressure at this point can help to fill the fallopian tube and delineate the distal end. In cases of partial closure there may be some exposed fimbria present. It is possible that the tubes may not fill due to a false cornual blockage induced by uterine manipulation. Due to the significant chance of finding a false blockage, in this situation we would recommend proceeding with the surgical correction. Confirmation can later be determined with a follow-up HSG.

Determine location and direction of incisions

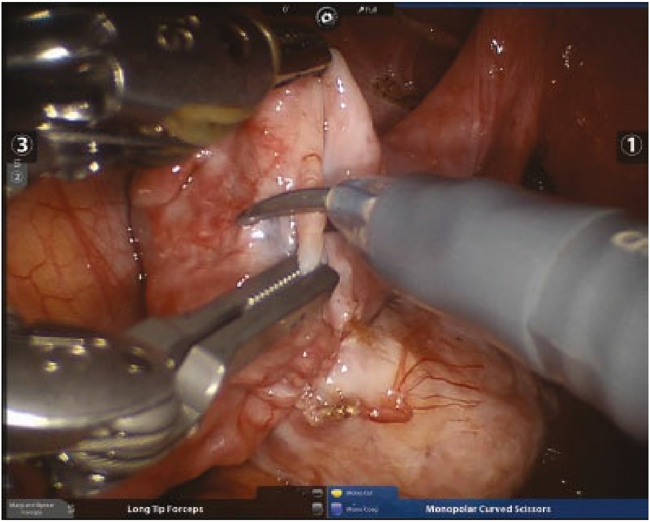
Tubes are most easily opened by making either three or four radial cuts at the distal tubal end point. In near-normal size tubes without significant wall thickening, three radial cuts are often the easiest and give good results. Thicker-walled tubes are generally easier to repair using a cruciate four-incision cut. Attempts should be made to place incisions in less vascular areas if possible (**Tech Fig. 4.2.2**).



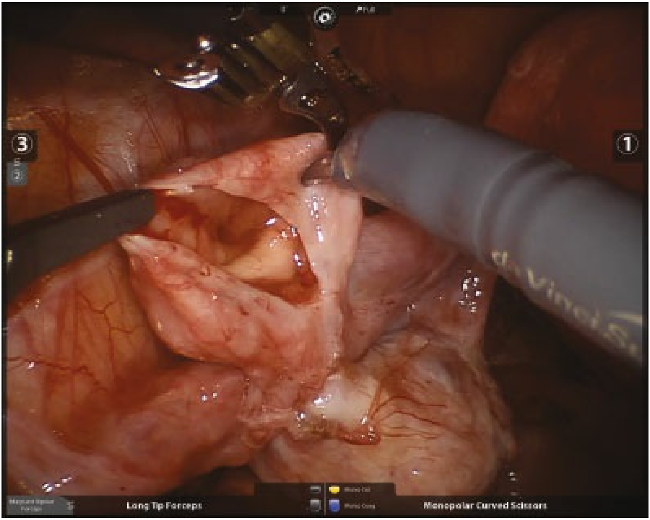
Tech Figure 4.2.2. Selecting the distal location for tubal opening.

Incise and open the tubal end

A goal of the procedure is to open and maintain patency; thus efforts should be made to limit electrocautery use if at all possible. Initial incisions should be made with scissors without the use of electrocautery. The first attempt to cut the tube often opens only the serosa and a subsequent cut must be made to enter the thicker muscular and mucosal layers. After the initial opening is made, plan the other radial incisions by determining how the final "leaves" will fold outward (**Tech Figs. 4.2.3** and **4.2.4**).

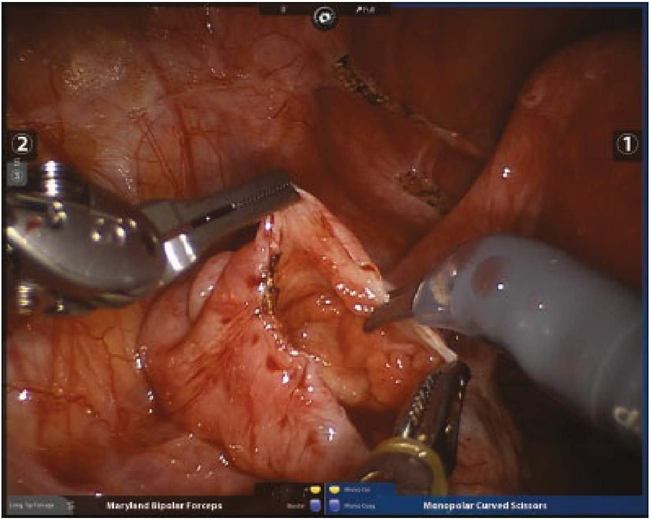


Tech Figure 4.2.3. Incising the distal tube.



Tech Figure 4.2.4. Initial opening of tube.

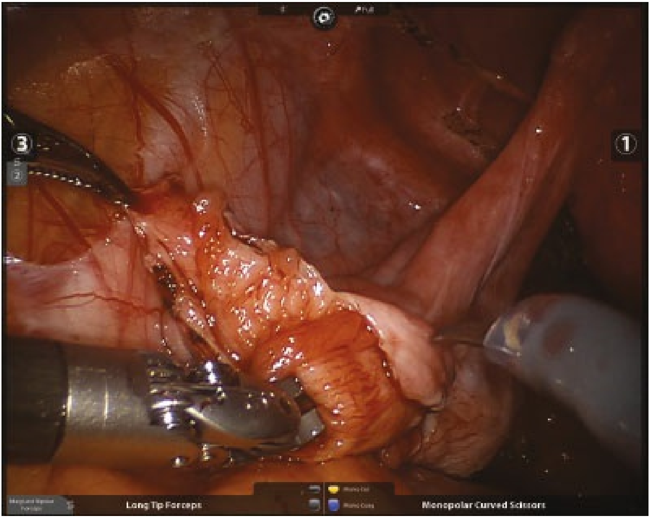
- Use pinpoint electrocautery to achieve hemostasis along the incisions. Use a low wattage bipolar or monopolar energy source. Use of fine tipped instruments such as a micro-bipolar or Maryland bipolar instrument allows targeting of active bleeding while minimizing excess tissue damage. A monopolar scissor may also be used by opening the scissor and using only the tip to cauterize bleeding. Use low wattage settings of 15 to 20 W to minimize thermal damage. Small amounts of pinpoint bleeding can be observed so that energy use may be limited (**Tech Fig. 4.2.5**).



Tech Figure 4.2.5. Making second radial cut perpendicular to initial opening.

Determine the viability of the tubal mucosa

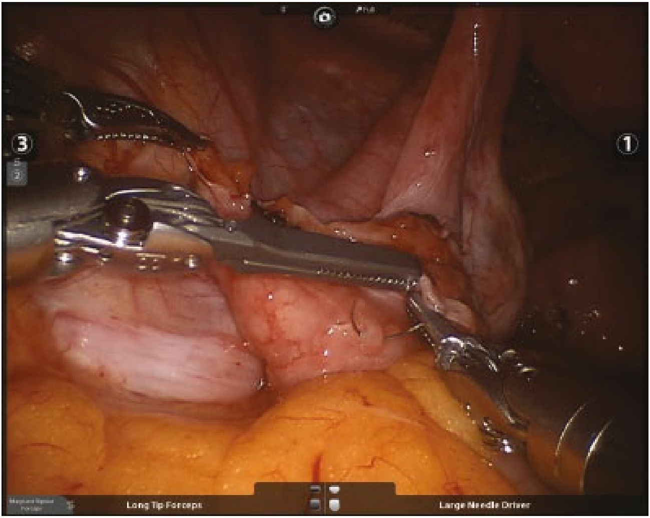
- Irrigate the inside of the tube to inspect the tubal mucosa. The amount of healthy tubal mucosa available within the lumen is directly related to the functional ability of that tube. A normal tube will have a thick red lumen with multiple linear folds covering all portions of the tube. In contrast, a smooth whitish-pink lumen indicates an absence of normal mucosa and a nonfunctioning tube.
- Tubes with even limited amounts of pink/red mucosa can still be functional and can be left in place and repaired. If there is a complete absence of functional mucosa, a repair of that tube should not be undertaken and the entire tube should be removed (**Tech Fig. 4.2.6**).



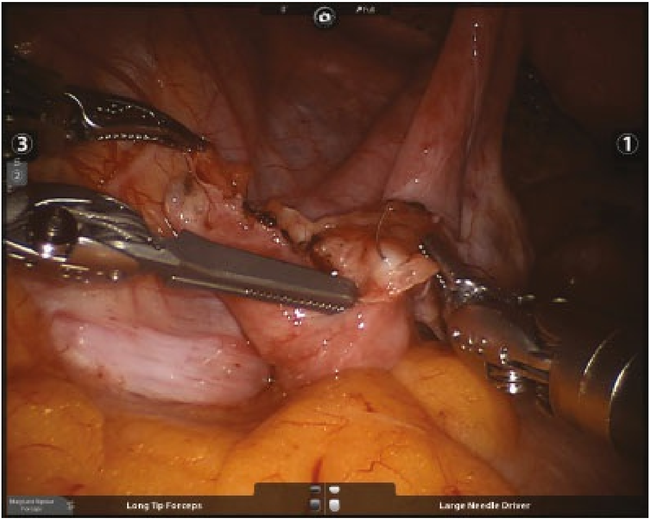
Tech Figure 4.2.6. Inspecting the inside of the tube for normal red mucosa. This tube shows only a moderate amount of mucosa remaining, but is suitable to repair.

Suture the tubal edges to the outer ampullary serosa

- Once repair of the tube has been judged to be feasible, the fimbrial leaflets should be sutured back to the outer tubal serosa. Small absorbable braided or monofilament suture may be used. A smaller diameter suture facilitates knot tying and may minimize the inflammatory response and adhesion formation. A preferable size suture would be a 5–0 monofilament absorbable suture (Monocryl®/Biosyn™) on a small tapered needle, such as an RB-1 (Ethicon Inc., Somerville, NJ) or CV-23 (Covidien, Medtronic Minimally Invasive Therapies, Minneapolis, MN) size, respectively (**Tech Fig. 4.2.7**).
- Fold the leaflet outward so as to identify the outer suture placement location on the serosa. Start by passing the suture shallow at this point, just through the outer serosal layer of the tube. Now pass the suture through the apex of the tubal leaflet, suturing in an outside to inside direction, through the outer serosa and muscular layers. Avoiding passing through the mucosal layer, though if the tubal wall is thin, this may not be possible. Tie the suture and cut the ends short near the knot (**Tech Fig. 4.2.8**).

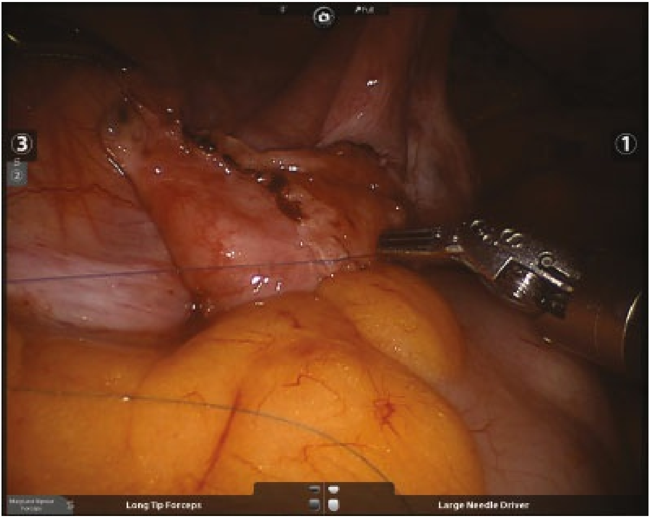


Tech Figure 4.2.7. Placement of initial suture through outer serosa at the point where the tubal leaflet edge will evert to.



Tech Figure 4.2.8. Passing suture through the leaflet edge. In this case the tube wall was thin, necessitating a full thickness pass.

- Repeat this process with each leaflet as well as at any location around the new opening that appears to be relaxed back toward the inside of the tube. The number of sutures required may vary from three to six in order to fully evert all of the edges. Tubes with significant inflammation may have thicker walls that are more difficult to roll outward. These may need two to three sutures on each leaflet to keep the edges everted (**Tech Figs. 4.2.9** and **4.2.10**).



Tech Figure 4.2.9. Tying initial suture.

Tech Figure 4.2.10. Completed neosalpingostomy after placing as many sutures required to maintain patency (five in this instance).

Adhesion prevention

Careful dissection with limited trauma and judicious use of electrocautery are key in the prevention of future adhesion formation. All adhesion barriers have limitations as to their effectiveness, though for this procedure, we prefer to use Interceed® (Ethicon Inc., Somerville, NJ). Use ½ of a standard 3 × 4-in sheet to wrap around the distal portion of the tube to form a tubal "sock" The remaining ½ sheet is then used to wrap under the ovary, making an effort to separate the tube from both the ovary and pelvic sidewalls during the healing process.

PEARLS AND PITFALLS

INTRAOPERATIVE DECISION-MAKING

- ○ Presence of viable tubal mucosa must be assessed as well as the overall postrepair tubal–ovarian interaction.
- ○ In cases of irreparable or nonviable tubes, a salpingectomy should be performed.
- ✗ Repeated attempts at tuboplasty are associated with low conception rates and should not be performed.

SURGICAL TECHNIQUE

- ○ Limit use of electrocautery to avoid vascular damage and postoperative adhesion formation.
- ○ Open distal tube to form three to four "leaflets" which are everted and sutured open to the outer portion of the tube.

POSTOPERATIVE CONCEPTION

- ○ If unable to conceive in 3 to 4 months, an HSG can be performed to verify tubal patency.
- ✗ Postoperative tubal patency does not necessarily imply normal tubal function.
- ✗ Risk of ectopic pregnancy is 10% to 13%.[3]

POSTOPERATIVE CARE

- The patient can attempt to conceive immediately following surgery. However, if Interceed® is placed, this can be expected to persist for 1 month after surgery (per manufacturer's insert). A postoperative HSG can be performed if the patient is unable to conceive within 3 to 4 months following surgery to verify tubal patency. It should be noted that tubal patency does not necessarily imply tubal function.
- If unable to conceive after 6 to 12 months of appropriate timed intercourse, the patient should consider IVF.

OUTCOMES

- Chance of conceiving is related to the severity of tubal damage (based on amount of dilation, thickness of tubal walls, and presence or absence of viable tubal mucosa) and tubo-ovarian adhesions.[3]
- Pregnancy rates are very low in patients with a prior history of ectopic pregnancy or prior tubal surgery.
- Live birth success rates are approximately 14% to 23% after 1 year, and 20% to 34% after 2 years.[3]
- Risk of ectopic pregnancy is 10% to 13% following neosalpingostomy. Patients should be cautioned to have close follow-up after conceiving due to this increased risk.

COMPLICATIONS

- Reclosure of tubal end necessitation repeat surgery with salpingectomy.
- Postoperative adhesion formation limiting tubal function.
- Ectopic pregnancy after conception.

KEY REFERENCES

1. Zeyneloglu HB, Arici A, Olive DL. Adverse effects of hydrosalpinx on pregnancy rates after in vitro fertilization–embryo transfer. *Fertil Steril.* 1998;70:492–499.

2. Saunders RD, Nakajima ST, Myers J. Experience improves performance of hysterosalpingo-contrast sonography (HyCoSy): a comprehensive and well-tolerated screening modality for the subfertile patient. *Clin Exp Obstet Gynecol.* 2013;40(2):203–209.

3. Audebert A, Pouly JL, Bonifacie B, et al. Laparoscopic surgery for distal tubal occlusions: lessons learned from a historical series of 434 cases. *Fertil Steril.* 2014;102(4):1203–1208.

Chapter 4.3

Tubal: Salpingectomy

Travis W. McCoy

GENERAL PRINCIPLES

Definition

Salpingectomy involves removal of a fallopian tube due to multiple reasons. These could include desire for sterility; treatment of ectopic pregnancy; hydrosalpinx; or irreparable damage due to adhesions, endometriosis, or other pelvic pathology.

IMAGING AND OTHER DIAGNOSTICS

- Severe tubal damage may be apparent by hysterosalpingogram (HSG), or by the obvious presence of hydrosalpinx on ultrasound.

PREOPERATIVE PLANNING

- Preoperative establishment of the severity of tubal damage, if possible, can allow for discussion with the patient on whether to attempt repair of the tube or perform a salpingectomy.
- Presence of a hydrosalpinx can lower fertility rates due to backflow of fluid into the uterine cavity.[1] For this reason, hydrosalpinges should be completely excised, or if the tube is unable to be completely removed, at least detached from the cornua of the uterus. If a salpingectomy is performed for treatment of an ectopic, the entire tube should be removed as any remaining portion can develop into a functional hydrosalpinx.

SURGICAL MANAGEMENT

- Performance of a salpingectomy has been associated with reports of diminishing ovarian function.[2] This has been theorized to occur due to damage to mesosalpinx collateral vascular flow. Other studies have reported no effect.[3] Due to this possible connection, it is prudent to attempt to limit damage to mesosalpinx vessels while performing the procedure. Transection of the mesosalpinx should be kept as close to the body of the tube as possible.
- Instruments used should allow dissection near the tube with use of limited electrocautery. A harmonic scalpel is ideal for this situation, but a simple monopolar scissor (20 to 25 W setting) can work as well.

Positioning

The patient should be placed in the normal standard dorsal lithotomy position as for other laparoscopic gynecologic procedures. An intrauterine manipulator capable of allowing chromotubation is helpful to fill the occluded tubes to delineate the tubal boundaries when extensive adhesive disease is present. Appropriate intrauterine manipulators include the ClearView® (Clinical Innovations, Murray, UT), HUMI® (Cooper Surgical, Trumbull, CT), ZUMI™ (Cooper Surgical, Trumbull, CT), or Kronner Manipujector® (Cooper Surgical, Trumbull, CT). Use of a very dark chromotubation solution consisting of 10 mL of indigo carmine 0.8% solution (two ampules) mixed in 100 mL of saline is helpful in outlining the tubes.

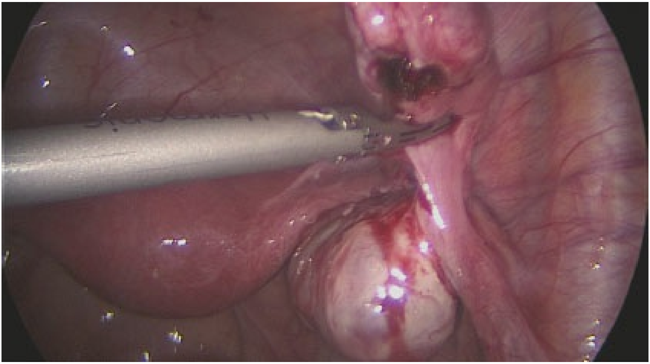
Procedures and Techniques

Determine approach

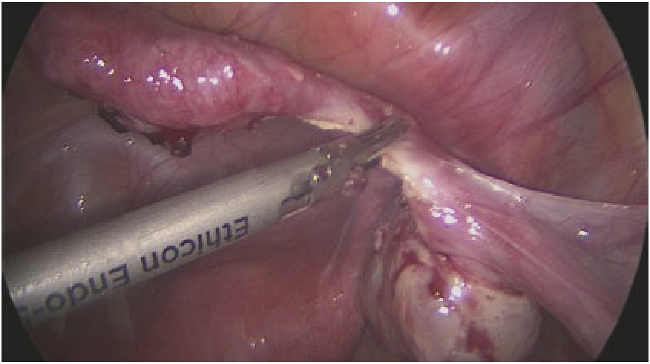
- Salpingectomy may be performed starting at the proximal or distal end. Starting distally and progressing proximally may limit the likelihood of accidently entering the ovarian blood flow where the mesosalpinx and the infundibulopelvic (IP) ligament merge.
  - In cases of significant distal damage or distortion, starting proximally may allow better delineation as the tube is gradually excised.

Distal to proximal approach

- Grasp the fimbriated or distal end and elevate it toward the anterior abdominal wall. This provides the most separation from the ovary to delineate the mesosalpinx. Use the Harmonic scalpel or scissor to ligate/cut as close as possible to the tubal lumen (**Tech Fig. 4.3.1**).
- Continue medially, staying as close to the body of the tube as possible (**Tech Fig. 4.3.2**).

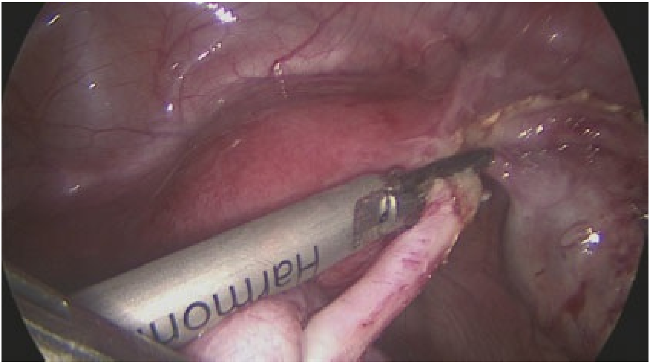


Tech Figure 4.3.1. Elevating distal portion of tube to transect mesosalpinx.



Tech Figure 4.3.2. Transecting mesosalpinx in a proximal direction, staying close to body of the tube.

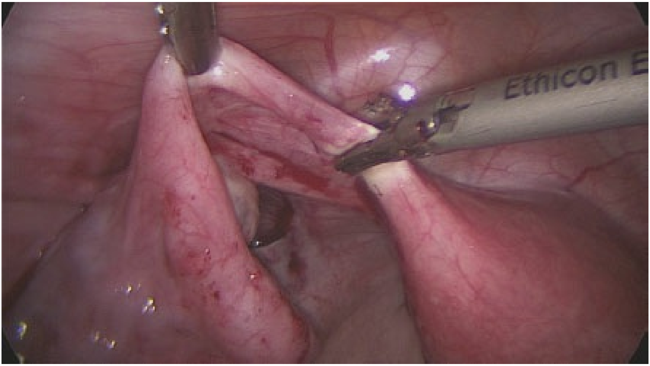
- Continue all the way to the cornua of the uterus, where the tube is then transected (**Tech Fig. 4.3.3**).



Tech Figure 4.3.3. Transecting tube at uterine cornua.

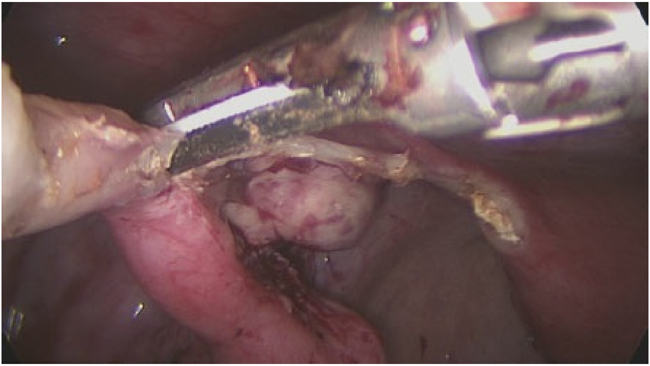
Proximal to distal approach

- In cases where the distal end is significantly damaged or scarred, it may be easier to approach the salpingectomy from proximal to distal.
- Transect the tube near the cornua, then grasp and elevate the transected tube. Care should be taken as the mesosalpinx can be fragile and tear easily while elevating the tube, leading to bleeding (**Tech Fig. 4.3.4**).

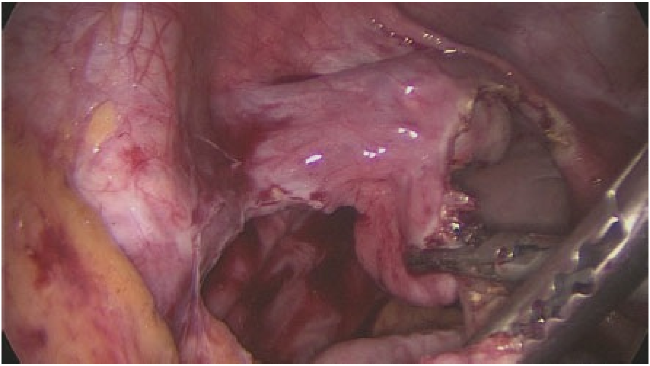


Tech Figure 4.3.4. Transecting tube at cornua for a proximal to distal approach.

- Dissect laterally along the tube, staying as close to the body of the tube as possible (**Tech Fig. 4.3.5**).
- As the ampulla is neared, regrasping and elevating at that point can provide more directed traction. Traction on the tube medially can assist in keeping the area of dissection away from ovarian vessels (**Tech Fig. 4.3.6**).
- Take care in the last 1 to 2 cm of the tube, as the mesosalpinx can merge with the IP ligament, particularly if the tube is scarred close to the ovary. Damage of ovarian vessels at this point can result in bleeding that is difficult to control without sacrificing the ovarian blood flow.



Tech Figure 4.3.5. Elevating tube and transecting mesosalpinx close along body of tube.



Tech Figure 4.3.6. Traction medially on tube helps to clarify distal mesosalpinx and keep dissection away from ovarian vessels.

Obtaining mesosalpinx hemostasis

- After the tube is removed, the mesosalpinx should be observed for bleeding. This can often be venous oozing, so lowering the intra-abdominal pressure can help to visualize this.
- Use pinpoint cautery either with monopolar or bipolar forceps to obtain full hemostasis.

Cases of severe adhesions

- In some settings, the distal aspect of the tube can be involved in dense adhesions to the ovary, bowel, uterus, or pelvic sidewall. Clearly finding a plane between the tube and other organs may be difficult to discern.
- In these cases, use a medial to lateral approach to remove as much of the tube as possible. Open the remaining distal portion of the tube lengthwise, exposing the lumen. Excise the majority of the tubal structure that can be identified, leaving a small portion remaining. This can be a safer approach to prevent damage to surrounding structures, while opening the tubal lumen, preventing recurrent hydrosalpinx formation.

PEARLS AND PITFALLS

- Excise the complete tube, do not leave a proximal or distal segment
- Keep the dissection plane as close to the tube as possible to limit ovarian collateral vessel damage.
- Care should be taken to avoid the ovarian vessels at the distal end of the tube where the mesosalpinx joins the IP ligament.
- In cases of severe adhesions and concern for distorted anatomy, removal of the proximal portion of the tube, separating it from the uterus may be performed, leaving a distal segment. If this is done, open the distal segment lengthwise and excise as much identified tube as possible to prevent recurrent hydrosalpinx formation.

POSTOPERATIVE CARE

- If only one tube is removed, the patient can attempt to conceive again immediately. If both tubes are removed, the patient should proceed with an in vitro fertilization cycle.

COMPLICATIONS

- Excessive damage to mesosalpinx–ovarian blood flow, possibly diminishing ovarian function.
- Injury to the ovarian blood supply during removal of the distal portion of the tube, where the mesosalpinx can merge with the IP ligament.

KEY REFERENCES

1. Zeyneloglu HB, Arici A, Olive DL. Adverse effects of hydrosalpinx on pregnancy rates after in vitro fertilization–embryo transfer. *Fertil Steril.* 1998;70:492–499.

2. Gelbaya TA, Nardo LG, Fitzgerald CT, et al. Ovarian response to gonadotropins after laparoscopic salpingectomy or the division of fallopian tubes for hydrosalpinges. *Fertil Steril.* 2006;85(5):1464–1468.

3. Xi W, Gong F, Tang Y, et al. Ovarian response to gonadotropins after laparoscopic salpingectomy for ectopic pregnancy. *Int J Gynaecol Obstet.* 2012;116(2):93–96.

Chapter 4.4

Tubal Reanastomosis

Travis W. McCoy

GENERAL PRINCIPLES

Definition

- Tubal reanastomosis, also known as a tubal reversal, is a fertility-restoring procedure that involves surgically reattaching the distal and proximal portions of a fallopian tube.

Nonoperative Management

- In vitro fertilization (IVF) is an alternative to a tubal reanastomosis to achieve pregnancy in patients who have had a tubal sterilization or other interruption of the fallopian tubes.

IMAGING AND OTHER DIAGNOSTICS

- Imaging studies are generally not helpful in determining candidates for a tubal reanastomosis. An HSG can show the level of occlusion and length of the proximal segment, but this information has only a limited role in decision-making. It is reasonable to perform a standard transvaginal ultrasound to evaluate for other pathology such as fibroids prior to proceeding with surgery.

PREOPERATIVE PLANNING

- The most important factor in determining the suitability of a patient for this procedure is the type of sterilization performed. It is important to review the operative and pathology report from the procedure to confirm the type of procedure and lengths of tubal segments excised, if applicable.
- In general, the smaller amount of tube removed/destroyed, the better the odds of having a successful reversal and subsequent functional success. As the lumen of the tube is tapered proximally, the more tube that is removed, the larger the discrepancy in size of the tubal ends. This size discrepancy makes the reanastomosis more challenging, and the shorter length of tube likely limits the tube's interaction with the ovary and the overall functionality of the tube. The postreversal tubal length correlates with pregnancy rates, though even with shorter lengths, pregnancies can occur.[1]
- Due to the inconsistent amount of tube that is destroyed with cautery, reversals in these patients can be very difficult and they have a lower success rate. These patients may be better suited to undergo IVF.
- In cases where operative reports are not available, performing a diagnostic laparoscopy prior to the procedure may be more cost effective than just attempting the reversal without knowledge of the tubal status.

SURGICAL MANAGEMENT

- Tubal reanastomosis can be performed through a mini-laparotomy or laparoscopically. The surgical steps are the same whether the procedure is done through an open or laparoscopic route.

Positioning

- For mini-laparotomy, the patient may be placed supine or in stirrups in the dorsal lithotomy position. In both situations, a uterine manipulator should be placed to allow for chromotubation during the procedure. Appropriate intrauterine manipulators include the ClearView® (Clinical Innovations, Murray, UT), HUMI® (Cooper Surgical, Trumbull, CT), ZUMI™ (Cooper Surgical, Trumbull, CT), or Kronner Manipujector® (Cooper Surgical, Trumbull, CT).

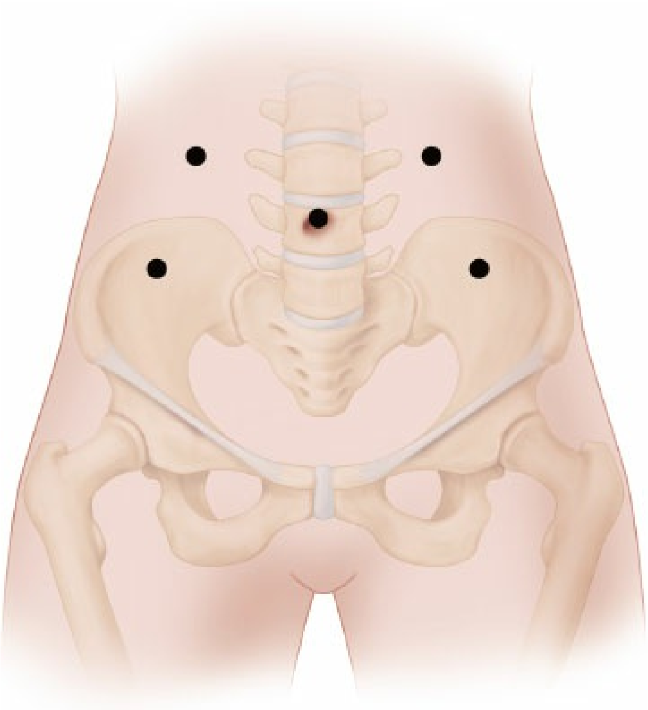
Approach

- A laparoscopic approach offers an easier recovery to the patient, but may require longer surgical times and a higher level of laparoscopic surgical skill. The laparoscopic approach may also involve the use of robotic assistance. Mini-laparotomy is typically done as an outpatient procedure. Both routes are reasonable options and require microsurgical skills, though a laparoscopic approach requires a more skilled laparoscopic surgeon. Both routes have similar fertility outcomes, though mini-laparotomy may be more cost effective.

Procedures and Techniques

Exposure and setup

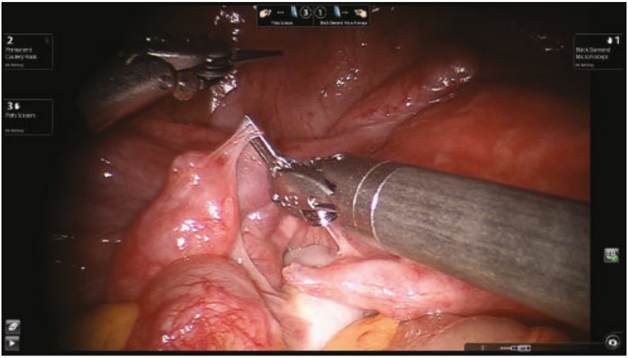
- For mini-laparotomy, a small 6 to 8 cm transverse skin incision is made. Overweight or obese patients may require a slightly larger incision. A vertical fascia incision is made which may result in less postoperative pain, aiding in the patient discharge soon after the procedure. A self-retaining wound retractor (Alexis® Wound Retractor, Applied Medical, Rancho Santa Margarita, CA) aids in exposure. The exposure to each side can be made easier by suturing the round ligament of that side to the midline of the lower incision skin edge, thus retracting the uterus slightly to one side.
- For laparoscopy, four ports are typically used (two on each side) in addition to an umbilical camera port. In a robotic-assistance case, one of these will be used as an assistant port, using an 8-mm trocar to allow easier passage of sutures (**Tech Fig. 4.4.1**).



Tech Figure 4.4.1. Location of the laparoscopic ports on the abdomen. If robotic assistance is used, the right upper quadrant port can be the assistant port.

Lysis of adhesions and mobilization of tubal ends

- Any tubal adhesions should be carefully lysed. The divided tubal ends should be freed up to allow approximation (**Tech Fig. 4.4.2A**).
- The mesosalpinx should be freed up so that it can be brought together to help approximate the tubal ends. The mesosalpinx does not need to be dissected away from the tubal end (**Tech Fig. 4.4.2B**).



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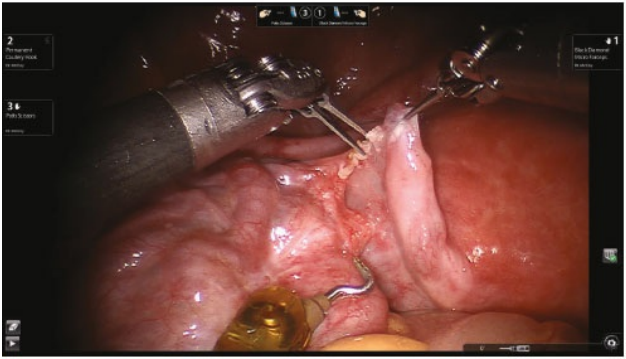
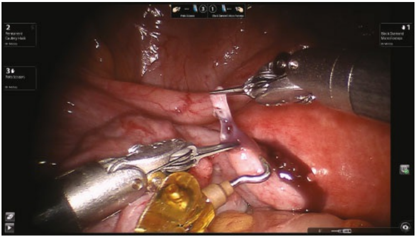


B

Tech Figure 4.4.2. A: Lysis of adhesions near distal tubal segment. **B:** Cutting mesosalpinx to free tubal ends.

Opening of tubal ends

- The proximal portion of the tube should be opened first, to verify patency prior to distal end preparation. Attempting to perform chromotubation at this point will often cause the distal end of the tube to push outwardly as well as stain with the blue dye (**Tech Fig. 4.4.3A**).
- The end of the tube can be grasped with a forceps, pulled distally, and then the tube is cut (usually requiring 1 to 2 mm to remove scar tissue and reach the tubal lumen). If the lumen is not reached, subsequent cuts are made until the open lumen is reached and no scar tissue is visualized. Bleeding usually comes from small vessels in the muscular portion of the tube and can be cauterized by using micro-bipolar forceps, or pinpoint monopolar cautery, using as low of a setting to achieve hemostasis (often 10 to 12 W) (**Tech Fig. 4.4.3B**).
- In many cases, the opening location on the distal end is not clearly defined as with the proximal segment. Gentle passage of a small catheter (5-F pediatric feeding tube) through the fimbriated end toward the proximal occlusion can serve to delineate the desired point for tubal opening. The distal opening should be opened just enough to approximate the size of the proximal tubal opening (**Tech Fig. 4.4.3C**).
- Both tubal ends should be made fully hemostatic in preparation for approximation.



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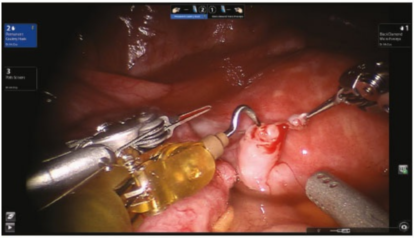

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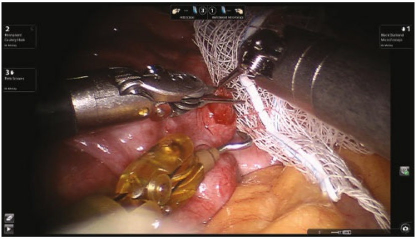
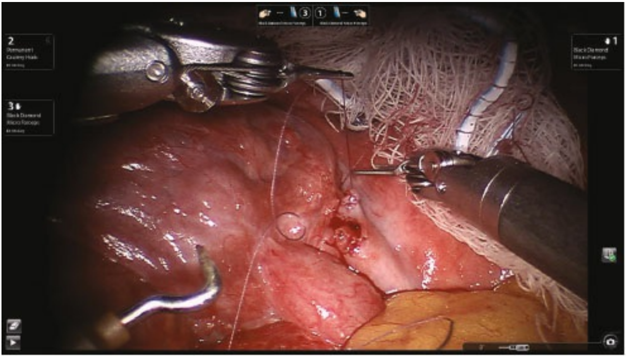


C

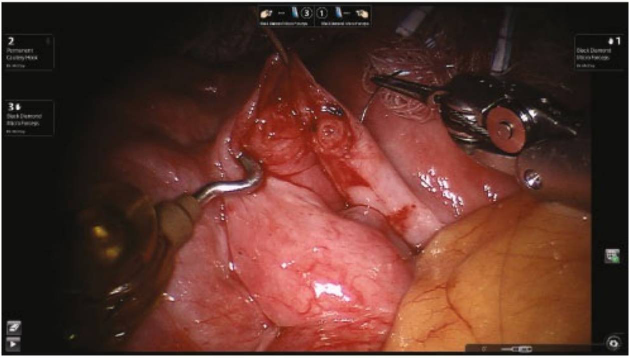
Tech Figure 4.4.3. A: Opening proximal tubal end, with free flow of dye. **B:** Using pinpoint cautery (monopolar) to cauterize subluminal vessel. **C:** Opening of distal tubal segment. Initial cut opened serosa, this second cut enters lumen.

Approximation of tubal ends

- The mesosalpinx is sutured to fold the edges together to approximate the tubal ends. A small diameter suture such as a 7-0 monofilament suture is well suited (Monocryl® or PDS®, Ethicon, Inc., Somerville, NJ) (**Tech Fig. 4.4.4A**).
- This suture should not be over tightened so as to pull the tubal ends past each other. The suture can then be tied, leaving it in place so that it can be used at the end to reapproximate the serosa/tubal muscularis in a continuous running fashion.
- At this point the tubal ends should be near each other, and ready to reattach (**Tech Fig. 4.4.4B**).



A

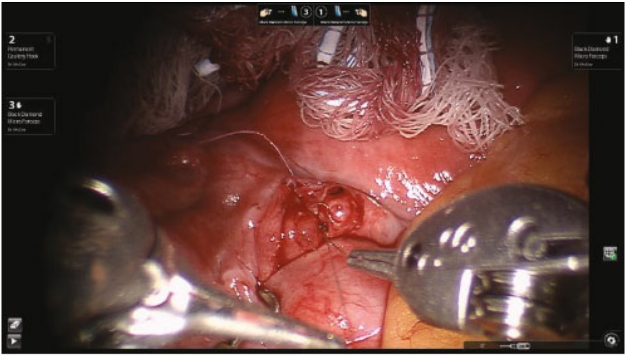


B

Tech Figure 4.4.4. A: Approximation of tubal ends by placing suture in mesosalpinx edges. **B:** Tubal ends reapproximated, ready to place lumen sutures.

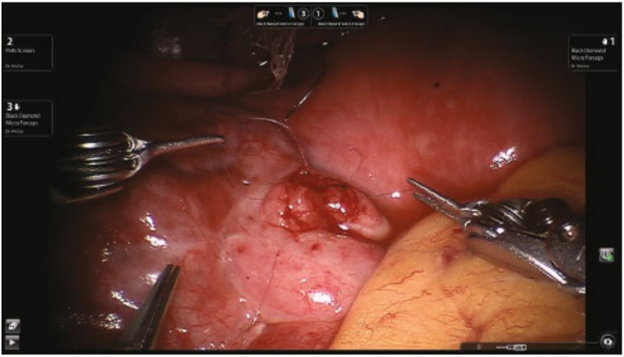
Placement of tubal lumen sutures

- Sutures for tubal approximation should be small and nonreactive. 8-0 Ethilon® nylon or Prolene® (Ethicon, Inc., Somerville, NJ) on a small taper needle (needle length of 6 to 8 mm) is a good choice. The contrast of the black nylon suture aids in visualization during suture tying.
- Each suture should be placed outside-to-inside, then inside-to-outside, allowing the knot to lie away from the lumen. Care should be taken to tie flat square knots.
- For smaller diameter tubes, such as in an isthmic–isthmic reanastomosis, four sutures may suffice. For larger size openings seen in the distal isthmus/early ampulla, five or six sutures may be required. These should be spaced evenly around the lumen, using as many as is deemed necessary to fully close the tube.
- Sutures should be placed through a small portion of the muscularis and a portion of the lumen. If possible, it is preferable to not pass completely through the lumen. This is easily accomplished in the isthmic portion where the muscularis and lumen are more prominent, but may be difficult to do on the distal segment, where the suture may need to pass into the lumen.
- Ensure that the tubes are lying in a natural anatomic position and not rotated in respect to each other. The most inferior suture is usually placed first, on the side of the tube adjacent to the mesosalpinx (**Tech Fig. 4.4.5A**). This first suture is then tied, as it will become difficult to reach after placement of the other sutures. The knot should be tightened just enough to bring the tube edges together. Such fine sutures only require three to four throws to secure the knot. Ends should be cut very short.
- The remaining sutures are then placed equally spaced around the remaining tube. Ends should be cut to approximately 2 to 3 cm and laid out lengthwise to keep them organized. After the remaining sutures are all placed, the sutures are now ready to be tied (**Tech Fig. 4.4.5B**).



2
Permanent Cautery Hook
3
Black Diamond Micro Forceps
1
Black Diamond Micro Forceps

A



2
3
Black Diamond Micro Forceps
1
Black Diamond Micro Forceps

B

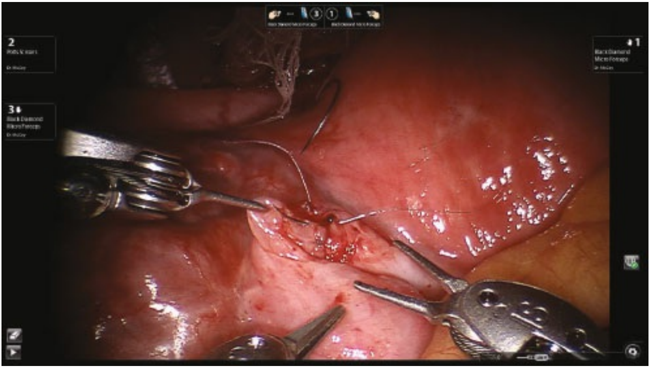
Tech Figure 4.4.5. A: First lumen suture placed at inferior edge of tube, suturing outside to in, then inside to out, leaving knot away from tube. This suture is tied first. **B:** Placement of three additional sutures to approximate the tubal lumens. The three sutures were all placed before tying any of them.

Tying lumen sutures/closure of tubal lumen

- The remaining sutures are tied sequentially from posterior to anterior around the tube.
- After tying the sutures, any openings between sutures can be reinforced with an additional suture. Care should be taken in placing these additional sutures so that they stay shallow and do not enter the lumen.
- After tying all sutures, chromotubation should be performed to demonstrate a freely patent tube. Any significant leakage at the anastomosis point can be reinforced with an additional suture.

Reinforcement of tubal muscularis, if needed

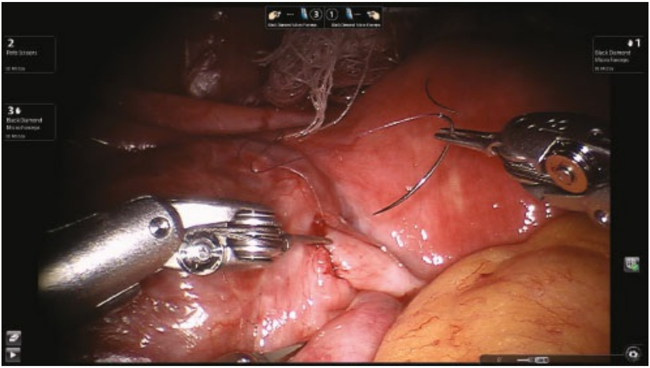
- After satisfactory closure of the tubal lumen, interrupted sutures are placed in the muscular portion of the tube. These serve to provide the tube strength, while the lumen sutures were only for luminal approximation (**Tech Fig. 4.4.6**).
- This can be performed with the same 8-0 nylon suture, or a slightly larger 7-0 PDS® (Ethicon, Inc., Somerville, NJ) suture. Generally, three to five sutures may be required to reinforce the tube.



Tech Figure 4.4.6. After lumen is closed, additional sutures are placed in muscularis for reinforcement.

Closure of serosa

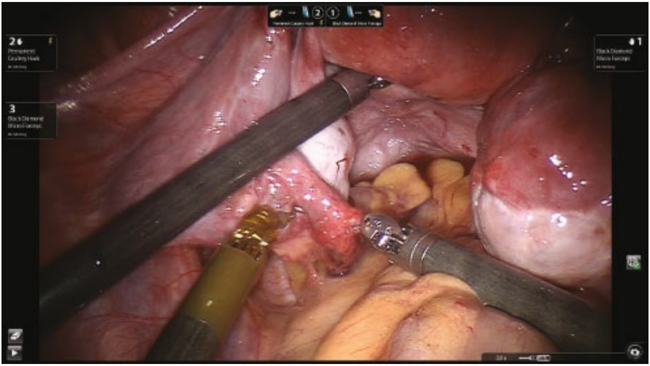
- With the tube anastomosis in place, the same suture from the mesosalpinx approximation is used to close the tubal serosa. A separate suture may be used as well. The tubal serosa can be closed in a running fashion starting in the mesosalpinx, going around the tube, and ending at the other side of the mesosalpinx, where the suture is tied off (**Tech Fig. 4.4.7**).



Tech Figure 4.4.7. Closure of tubal serosa with a running suture around the entire tube.

Confirmation of patency

- After completion, patency of the tubes is confirmed with chromotubation using gentle pressure (**Tech Fig. 4.4.8**).



Tech Figure 4.4.8. Confirming tubal patency with chromotubation after reanastomosis.

Contralateral procedure

The same procedure is performed on the opposite side. To accomplish chromotubation, the first tube may need to be occluded at the cornua. A clamp or grasper should not be used to directly close the tube. The blunt end of an instrument can be used to fold the tube back against the uterus near the cornua, obstructing the open tube.

PEARLS AND PITFALLS

- Preoperative patient counseling is important to determine type of tubal ligation performed and to provide estimates as to chances of conceiving.
- Careful microsurgical techniques should be utilized, including obtaining meticulous hemostasis, gentle handling of tissues, and avoiding tissue trauma.
- Open proximal segment first, then create a distal segment opening similar in size as that of the proximal segment.
- Use four to six sutures of 8-0 nylon or Prolene® suture for approximation of lumen.
- Reinforce the muscular portion of the tube with separate sutures prior to serosa closure.

POSTOPERATIVE CARE

- Patients should be able to go home after the procedure. For a mini-lap reversal, infiltration of the fascia and subcutaneous tissue with a long-acting local anesthetic (0.25% bupivacaine hydrochloride) can be beneficial.
- Patients may try to conceive during their next menstrual cycle.
- Patients should be cautioned to seek early evaluation after conceiving due to an increased risk for an ectopic pregnancy.

OUTCOMES

- In a large report of 1,118 cases of microsurgical bilateral tubal reversal, 55% of women had a live birth within 5 years of follow-up.[1] Delivery rates vary from 42% to 65%, based on patient age and surgical outcomes. Tubal patency rates were calculated to be 88%. Mean time to conception was approximately 8 months. The ectopic pregnancy rate was approximately 4%.

COMPLICATIONS

- Postoperative scarring may lead to tubal closure at the anastomosis site or tubo-ovarian adhesions.

KEY REFERENCE

1. Kim SH, Shin CJ, Kim JG, et al. Microsurgical reversal of tubal sterilization: a report on 1,118 cases. *Fertil Steril.* 1997;68(5):865–870.

5

Ovary

Chapter 5.1

Ovary: Cystectomy

Travis W. McCoy

GENERAL PRINCIPLES

Definition

Ovarian cysts are common pelvic abnormalities. They may be due to functional causes such as ovulatory follicles or corpora lutea, though functional cysts should ultimately resolve with observation or central gonadotropin suppression. Pathologic cysts can be due to collections of endometriosis or neoplasms.

Differential Diagnosis

Cystic structures in the pelvis that can be mistaken for ovarian masses include hydrosalpinges and pelvic adhesions causing fluid loculation (pseudocyst formation).

Nonoperative Management

Ovarian cysts can generally be observed for a period of 4 to 8 weeks, in which time functional cysts should resolve. Urgent surgical management is necessary in cases involving ovarian torsion or hemorrhagic cysts causing a hemoperitoneum.

IMAGING AND OTHER DIAGNOSTICS

Transvaginal ultrasonography is the first-line imaging study for ovarian masses. In cases of an unclear origin or inadequate visualization, an MRI may be beneficial.

PREOPERATIVE PLANNING

- Imaging should be performed to guide expectations of surgical findings. Endometriomas will often be encountered with implants of pelvic endometriosis and adhesions, often at an advanced stage. In this case, excision of the associated endometriosis should be planned at the same time.
- Patients should be counseled as to the known effect of cystectomy on ovarian reserve. This risk is higher in cases of endometriomas.[1]

SURGICAL MANAGEMENT

- Surgical ovarian cystectomy should be considered in cases of persistent ovarian masses that do not have suspicious features for malignancy. This procedure often follows a period of conservative management and follow-up imaging.

Positioning

- The patient should be placed in the normal standard dorsal lithotomy position as for other laparoscopic gynecologic procedures. An intrauterine manipulator may assist in positioning the uterus.

Approach

- Laparoscopy is the preferred route for management of ovarian masses. Robotic assistance may be beneficial in cases of large masses and associated advanced endometriosis.
- In most cases, three laparoscopic ports are needed in addition to a camera port. This is typically using a right and left lower quadrant port along with a suprapubic port. This allows two instruments to grasp the ovary and a third instrument to provide traction on the cyst wall.

Procedures and Techniques (Video 5.1.1)

Lysis of surrounding ovarian adhesions

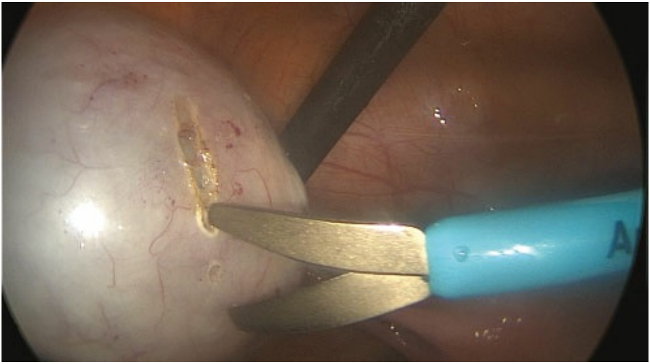
- If the ovary is adhered to the pelvic sidewall, any adhesions should be lysed. Often the ovary can be bluntly separated from the sidewall. In the case of dense adhesions, specific bands should be cut with scissors.

Planning entry point into ovary

- In the case of endometriomas, these most often occur from endometriosis implants between the ovary and pelvic sidewall, leading to invagination into the body of the ovary. These cysts are those that rupture upon elevation of the ovary out of the pelvis. The site of this rupture opening can be extended slightly as needed to facilitate cyst wall excision. The cyst wall will merge with the ovarian cortex at this opening, and at this point, the wall may not be apparent at this edge.
- In other cysts, they are most easily opened where the cyst is most translucent, which will limit damage to normal ovarian cortex that appears as more dense white tissue.
- In cases of vary large cysts that have a large translucent area, opening at the junction of the white cortex and the thin cyst wall can assist in dissection, as much of the thin translucent cyst wall covering may ultimately be resected with the cyst wall.

Opening of outer ovarian surface

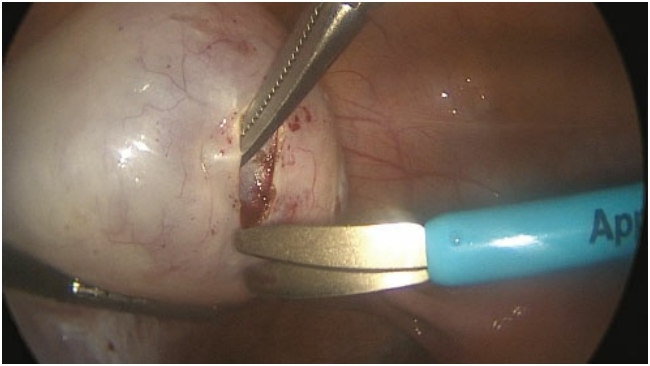
- The outer ovarian surface can be opened using monopolar scissors. By opening up the blades and using just one tip, the outer surface can be carefully opened using a cutting current (**Tech Fig. 5.1.1**). Ideally, only the outer surface is opened to allow for the creation of a plane between the outer ovary and the cyst wall. In most cases, the cyst wall cannot be clearly delineated until the cyst itself is entered.



Tech Figure 5.1.1. Opening of ovary using monopolar scissors with cutting current.

Developing plane between outer ovary and cyst wall

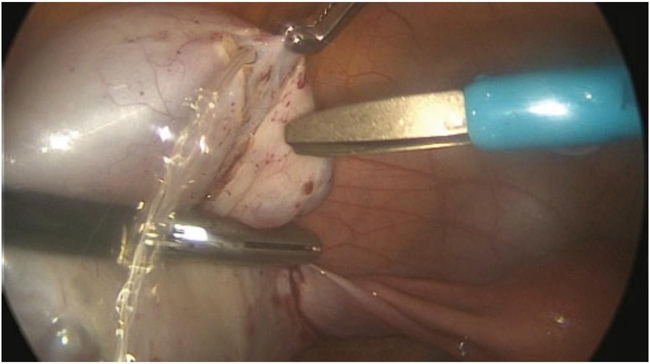
- A Maryland grasper or other fine tip forceps can be used to bluntly dissect between the ovary and cyst wall (**Tech Fig. 5.1.2**). If the plane does not develop easily, the level of dissection may be too shallow. The outer incision is further opened as needed.



Tech Figure 5.1.2. Blunt dissection between ovary and cyst wall.

Opening of the cyst

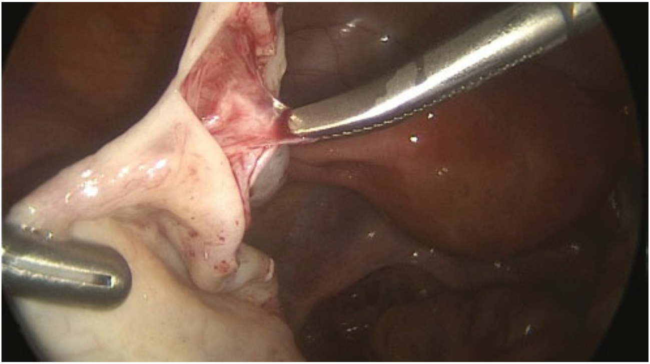
- Ideally a cyst would be excised fully without rupture by bluntly dissecting in the proper plane, but often this cannot be accomplished. If a clean plane between the ovary and believed cyst wall is not easily found, the cyst may be purposefully opened, if not already accidently opened (**Tech Fig. 5.1.3**). Cyst contents should be aspirated and irrigated from the pelvis. Care should be taken with dermoid cysts to prevent unnecessary spillage of contents as this can lead to peritonitis and adhesion formation.[2] In the case of a dermoid, it is recommended to use a large volume of fluid (>3 L normal saline) to lavage the abdomen and pelvis to reduce adverse sequela.



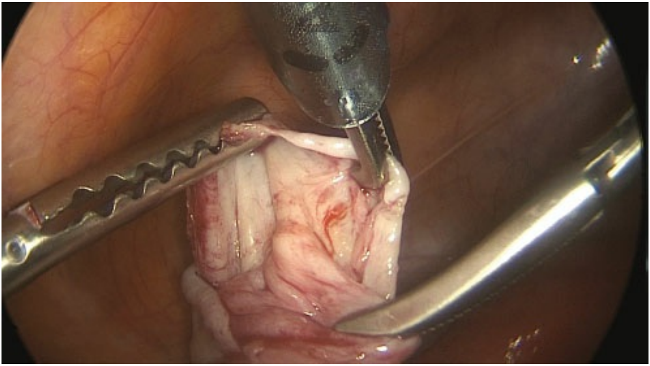
Tech Figure 5.1.3. Opening and draining of cyst contents.

Dissecting cyst wall

- Two graspers are used to hold the edge of the ovary while using a Maryland dissector to grasp the cyst wall and begin to carefully pull it away from the ovary wall (**Tech Fig. 5.1.4**). It is important during the dissection to keep the graspers close to the area of dissection to promote the cyst peeling in the proper plane (**Tech Fig. 5.1.5**). Small areas of bleeding can be cauterized with pinpoint monopolar or bipolar cautery.

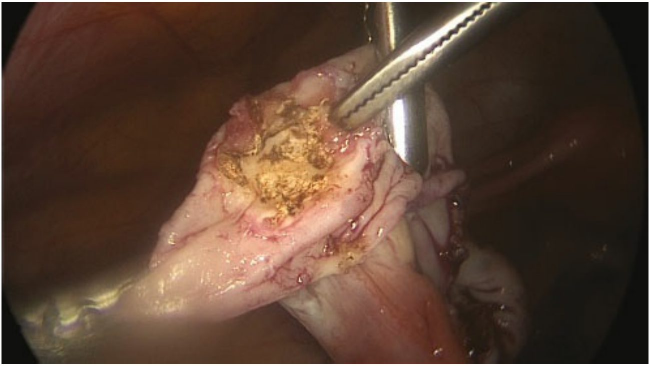


Tech Figure 5.1.4. Starting to pull cyst wall away from ovary.



Tech Figure 5.1.5. Maintaining close proximity of graspers to dissection plane.

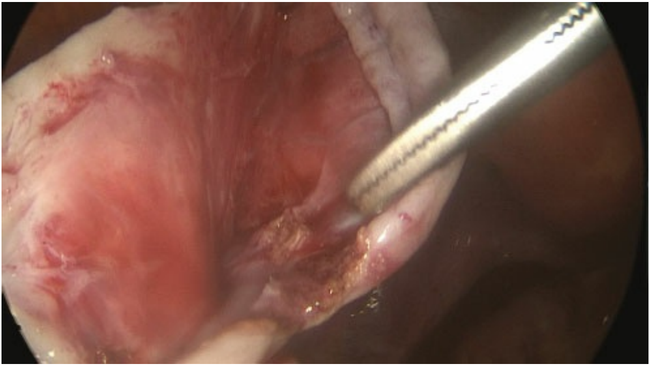
- Any significant bleeding suggests that the dissection has shifted away from the proper plane. In these cases, attempts should be made to develop a plane closer to the cyst side. If a shallower plane is not easily identifiable, focus can shift to dissecting at another location. Difficult areas of dissection often are easier to manage if the dissection shifts to another side of the cyst. Approaching from another angle often allows restoration of the proper dissection plane.
- Large areas of bleeding can be treated with bipolar electrocautery or suturing. Both methods are suitable and the superiority of one method over another in regards to the effect on ovarian reserve is conflicting.[3,4] If electrocautery is used, judicial use is recommended.
- In some cases, an area of the cyst wall may not be able to be separated from the ovary without significant ovarian injury. In these cases, it may be prudent to separate the cyst wall as much as possible, excise the cyst, and then use electrocautery to destroy the remaining segment of cyst wall (**Tech Fig. 5.1.6**).



Tech Figure 5.1.6. Cauterized cyst wall remnant that could not be safely separated from ovary after majority of cyst was excised.

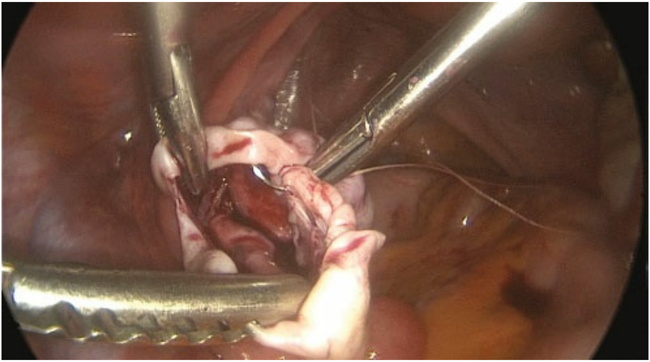
Final hemostasis and closure

- Irrigation and inspection of the ovary is performed to ensure that the cyst wall bed is fully hemostatic (**Tech Fig. 5.1.7**). Pinpoint cautery is used to obtain complete hemostasis.

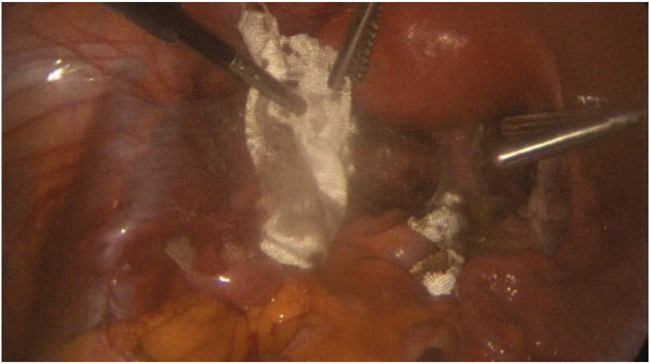


Tech Figure 5.1.7. Cyst wall bed after excision.

- A small absorbable suture (4-0 Vicryl®, Ethicon, Inc., Somerville, NJ) is used to close the dead space after removal of a large cyst. The suture can also reapproximate the edges of the ovary to lessen the exposure of raw edges to other pelvic structures and subsequent adhesion formation[5] (**Tech Fig. 5.1.8**).
- To help reduce the formation of adhesions, a barrier such as Interceed® (Ethicon, Somerville, NJ) is used to cover the ovary and incision (**Tech Fig. 5.1.9**).[6]



Tech Figure 5.1.8. Suture closure of ovary edges.



Tech Figure 5.1.9. Covered left ovary and tube with Interceed® after cystectomy.

PEARLS AND PITFALLS

- The goal of a cystectomy is to remove the pathology while causing the least amount of damage to the normal ovarian tissue.
- Incise the ovary in the most translucent area, where there is the least amount of functional ovarian tissue.
- While enucleating the cyst wall, keep all graspers close to the plane of dissection to assist in maintaining the correct dissection plane.
- Use minimal cautery to achieve hemostasis. Suturing or bipolar cautery can be used for larger vessels.
- After removal of the cyst and ensuring hemostasis, close the ovary edges with an absorbable suture.
- Cover the ovary and incision with antiadhesion material, such as Interceed®.
- Copious irrigation of the pelvis and abdomen is important in cases of cyst rupture, particularly those involving a dermoid or an endometrioma.

POSTOPERATIVE CARE

- Patients desiring to conceive should consider that absorbable antiadhesion agents such as Interceed® can take up to 4 weeks to dissolve, and could interfere with normal tube–ovary interaction while still present.

COMPLICATIONS

- Destruction of normal ovarian tissue resulting in a decrease in ovarian reserve
- Pelvic adhesion formation
- Recurrence of the cyst

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4. Asgari Z, Rouholamin S, Hosseini R, et al. Comparing ovarian reserve after laparoscopic excision of endometriotic cysts and hemostasis achieved either by bipolar coagulation or suturing: a randomized clinical trial. *Arch Gynecol Obstet*. 2016;293(5):1015–1022.

5. Pellicano M, Bramante S, Guida M, et al. Ovarian endometrioma: postoperative adhesions following bipolar coagulation and suture. *Fertil Steril*. 2008;89(4):796–799.

6. Keckstein J, Ulrich U, Sasse V, et al. Reduction of postoperative adhesion formation after laparoscopic ovarian cystectomy. *Hum Reprod*. 1996;11(3):579–582.

Chapter 5.2

Laparoscopic Ovarian Drilling

Miriam S. Krause, Steven T. Nakajima

GENERAL PRINCIPLES

Definition

- Laparoscopic ovarian drilling (LOD), also known as a modified ovarian wedge resection, ovarian diathermy, ovarian cautery, or "whiffle ball" surgery, is a surgical procedure performed in patients with polycystic ovary syndrome (PCOS) to lower the level of circulating androgens and to help establish ovulatory cycles. It is usually performed in patients with PCOS who desire fertility and do not respond to medical treatment options or prefer surgical treatment.
- Ovarian drilling replaces the surgical procedure bilateral ovarian wedge resection (BOWR) through a laparotomy incision originally described in 1935. The traditional BOWR is no longer performed secondary to side effects of postoperative adhesion formation and loss of functional ovarian tissue.

Differential Diagnosis

- The differential diagnosis for PCOS is broad and includes other endocrinopathies such as thyroid dysfunction, hyperprolactinemia, androgen-producing tumors of the ovary and adrenal glands, decreased ovarian reserve, unexpected pregnancy, late-onset congenital adrenal hyperplasia, and Cushing syndrome.

Anatomic Considerations

- It is important to know whether the patient has undergone previous pelvic surgery or has had a previous pelvic infection, as these can cause adhesions that could make this procedure more difficult.

Nonoperative Management

- Nonoperative management options are preferred and should be utilized prior to LOD. They include ovulation induction using selective estrogen receptor modulators (SERM) such as clomiphene citrate, aromatase inhibitors such as letrozole, or insulin sensitizers such as metformin. In many overweight or obese patients, lifestyle modifications including weight loss can also lead to spontaneous ovulatory cycles.

IMAGING AND OTHER DIAGNOSTICS

- Radiologic studies are not necessary in order to perform the described procedures.
- Transvaginal ultrasound is usually performed prior to the procedure to make the diagnosis of polycystic ovaries. Polycystic ovaries are defined as having at least 12 follicles measuring less than 10 mm in mean diameter, or a volume of greater than 10 cm^3. This only has to apply to one ovary but can apply to both.[1]
- PCOS is defined as at least two of the following: Oligo- or amenorrhea, clinical or laboratory evidence of hyperandrogenemia, and polycystic ovarian morphology.[1]

PREOPERATIVE PLANNING

- As with any surgery, informed consent needs to be obtained. This includes discussion of the procedure as well as the indications, risks, benefits, and alternatives (**Table 5.2.1**). Besides the general risks of surgery, this procedure specifically includes the risk for postoperative decreased ovarian reserve and adhesion formation.
- Prior to performing the ovarian drilling, an appropriate fertility evaluation needs to be completed. It is important to rule out any other fertility factors (such as tubal obstruction and semen abnormalities) that would require additional surgery or a different treatment approaches such as in vitro fertilization (IVF).
- Preconception counseling needs to be addressed in order to ensure a healthy pregnancy, including any contraindications for pregnancy in general.

SURGICAL MANAGEMENT

- Androgens are produced in the ovarian stroma, whereas the ovarian follicles are located in the ovarian cortex. In LOD, either a laser or needle electrode (mono- or bipolar) is used to cause thermal damage to the ovarian stroma, while attempting to protect the follicles. This leads to changes in the intraovarian steroid environment (mainly androgens and inhibin) with restoration of ovulation function by increasing follicle stimulating hormone (FSH).[2] LOD may increase ovarian blood flow in addition, and potentially improve insulin sensitivity.[3]

Table 5.2.1 Obtaining Informed Consent for Laparoscopic Ovarian Drilling (LOD)

Discuss with the patient the procedure, indications, risks, benefits, and alternatives
General risks include: • Infection • Damage to adjacent structures requiring further surgery • Bleeding requiring blood transfusion with risk for infection with blood borne pathogens and transfusion reaction • Anesthesia complications • General postoperative complications (venous thromboembolism)
Specific risks include: • Adhesion formation • Decrease in ovarian reserve
Benefits: • Increase in the incidence of spontaneous ovulatory cycles • Less risk for multiple gestation compared to ovulation induction with medications
Alternatives: • Lifestyle changes with weight loss in obese patients • Ovulation induction with medications

Positioning

- The patient is positioned in the dorsal lithotomy position. To prevent any positioning injuries, the arms should be tucked along the patient's side, with the arms adducted and pronated, and the feet slightly flexed with thighs parallel to the abdomen. Foam or egg-crate cushions can be used to protect fingers, hands, knees, and ankles.
- Sequential compression devices (SCDs) should be placed on the lower extremities to avoid any thromboembolic events.
- Ensure that the patient will not slide back on the table once she is placed in Trendelenburg during the case. Placing the patient on an egg-crate foam or a surgical gel pad that is taped to the operating room table can assist in preventing the patient from sliding backward. Fixing the patient on the bed with a safety strap or tape across surgical towels can also be utilized. Patients can also be placed in a Bean Bag Positioner (AliMed Inc., Dedham, MA) that is initially fixed to the operating room table. The patient is then positioned in the bean bag and the bag conforms to the shape of the patient's upper body and shoulders when desufflated with suction. Equally, undue pressure on the sacrum should be avoided as well.
- A Foley catheter should be placed to ensure bladder decompression during the suprapubic port placement.
- The patient should be supine for initial trocar placement to avoid injury to blood vessels upon entry into the abdomen.

Approach

The standard approach is via laparoscopy. Two types of equipment can be used, which include a diathermy probe (monopolar or bipolar needle electrode, with the bipolar needle being potentially safer) or the CO_2 laser. Different power settings are described in various studies noted in the Procedures and Techniques section.

Procedures and Techniques

Laparoscopic entry

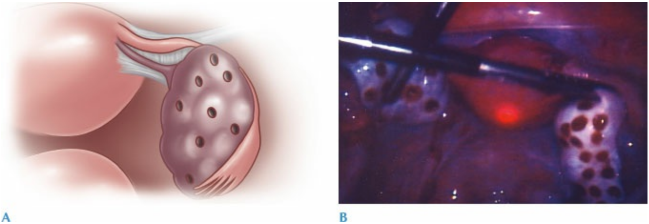
- The abdomen is entered laparoscopically in the usual standard fashion. If the CO_2 laser is used, a 10-mm umbilical incision (for the laparoscope and CO_2 laser) as well as a 5-mm suprapubic incision (for the suction irrigator) are necessary. If a diathermy needle is used, a 5-mm umbilical incision suffices for the camera, but one additional incision for the diathermy needle (usually in the right or left lower quadrant) will be necessary.

Exploration of the pelvis

- The pelvis is inspected, any adhesions or other abnormalities (such as endometriosis) removed and a chromopertubation performed, if indicated.

Ovarian drilling

- Daniell and Miller[4] report using the CO_2 laser (**Tech Fig. 5.2.1A**). 25 to 40 punctures are placed on each ovary by applying 25 W continuous pulse for 5 to 10 seconds, leading to drainage of all visible follicles (**Tech Fig. 5.2.1B**).
- Muenstermann and Kleinstein[5] used the CO_2 laser with a power density of 10^5 W/cm^3. All visible small follicles were disrupted until a fluid spurt was noted from the follicle, with 10 to 30 follicles evaporated on each ovary.



Tech Figure 5.2.1. A: Illustration of the laparoscopic ovarian drilling (LOD) procedure. **B:** Ovarian surface of a patient who had the LOD procedure performed.

- Gjønnaess in 1984 utilized a unipolar biopsy or sterilization forceps, in combination with a Siemens Radiotom electrosurgical unit, frequency setting of 1.75 MHz and thereby generating 200 to 300 W. The forceps was pushed against the ovary for 2 to 4 seconds, creating cautery areas measuring 3 × 3 mm, with 3 to 8 cautery points per ovary.[6]
- Liu et al. report using a monopolar electrosurgical needle (Kirgen Co., Shanghai, China). After the ovary was stabilized laparoscopically, four to six punctures were placed in each ovary, by applying 4 seconds of 40 W monopolar energy. The monopolar needle was placed into the ovary to a depth of 7 to 8 mm, and the diameter of the cautery area measured 3 to 5 mm.[7]
- If a diathermy needle is used, the ovary is usually cooled off using irrigation with 200 to 500 mL of sterile saline

Inspection of the pelvis

- The pelvis is irrigated and inspected to ensure good hemostasis and document no damage to adjacent structures.

Laparoscopic closure

- Abdominal incisions are closed in the usual standard fashion.

ALTERNATIVE PROCEDURES AND TECHNIQUES

Office Microlaparoscopic Ovarian Drilling (OMLOD)

- This technique described by Salah and colleagues[8] is performed in the office under local anesthesia and was found to have the same effects as regular LOD.

PEARLS AND PITFALLS

PEARLS

- One-time treatment
- Risk for multiple gestation is decreased compared to ovulation-inducing medications
- Benefits may be variable. In one study, 19% (31/165) of subjects followed 10 years later were still ovulatory[9]

PITFALLS

- Surgical procedure with all associated risks
- Not 100% successful, but may help patients respond better to fertility medications

POSTOPERATIVE CARE

- Postoperative care should be performed in the standard fashion for a laparoscopic procedure.

OUTCOMES

- Only a small number of randomized controlled trials are available, comparing different techniques of ovarian drilling, different energy doses, and studying few patients. This makes it difficult to give a statement on the success and short- as well as long-term safety of this procedure.
- Spontaneous ovulation is achieved in up to 70% of clomiphene-resistant or anovulatory women with hyperandrogenemia.[4]
- Of 165 women originally treated with ovarian drilling, 31 followed 10 years later were still ovulatory.[9]
- Success of spontaneous ovulation needs to be weighed against the risk for complications during surgery, postoperative adhesion formation, and risk for diminished ovarian reserve.
- Women with hyperinsulinemia,[10] luteinizing hormone greater than 10 IU/L,[11] and women with BMI less than 25 kg/m[2 12] seem to respond better than women with a BMI greater than 35 kg/m[2], total testosterone greater than 130 ng/dL, or infertility for greater than 3 years.[11]
- Pregnancy rates at 12 and 18 months after ovarian drilling for women with PCOS were 55% and 70%.[13]
- Unilateral ovarian drilling may be as efficacious as bilateral ovarian drilling.[14]
- Only one study[15] evaluated the extent of ovarian adhesion formation 4 to 6 weeks after LOD and found adhesions to be present in 60% of patients, with more severe adhesions developing on the left ovary and amount of adhesions independent of the number of ovarian punctures.
- There are not many randomized controlled trials comparing ovarian drilling to medical treatment. Liu et al.[7] report 141 women with Clomiphene-resistant PCOS and similar baseline characteristics who underwent either 2.5 mg of letrozole up to 6 cycles or LOD. Higher clinical pregnancy rates and life birth rates (40.8% and 38% versus 27.1% and 22.9%, respectively) were noted in the letrozole group; however, these differences were not statistically significant, and patients with a BMI of ≥26 were excluded from the study.
- A prospective randomized trial by Abdellah[16] evaluated 140 clomiphene-resistant women with PCOS that were either treated with 5 mg of letrozole for up to 6 cycles or underwent LOD with a monopolar diathermy needle. The author reports an ovulation rate of 59% with letrozole versus 47.5% with LOD, and a higher pregnancy rate with letrozole (35.7% vs. 28.6%), which was not statistically significant.
- A Cochrane review[17] found no significant difference in regard to clinical pregnancy, live birth, or miscarriage in women with clomiphene-resistant PCOS who underwent LOD, compared to other medical treatments such as letrozole or gonadotropins. There are concerns for long-term complications; however, the decreased risk for multiple gestation makes LOD an attractive option.

COMPLICATIONS

- Complications include the general complications associated with laparoscopic surgery, in addition to the risks of decreased ovarian reserve and adhesion formation.

SUMMARY

- There is no established standard way of performing an LOD procedure. Authors have used laser and monopolar versus bipolar needles, at various power settings. If a standard procedure or technique could be adopted, meaningful data may be able to be generated for comparisons to medical therapy for ovulation induction.

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6

Peritoneal Cavity

Chapter 6.1

Removal of Endometrial Implants via Excision and Vaporization

Azadeh Nezhat, Lucia Di Francesco, Camran Nezhat

GENERAL PRINCIPLES

Definition

- Endometriosis is a common chronic gynecologic disorder in which endometrial glands and stroma are present outside of the uterus.
- Endometriosis is predominantly found in the pelvis but can occur anywhere in the body.
- Peritoneal endometriosis lesions may appear in different shapes and sizes. They can appear as whitish opacifications, blue-brown or reddish-blue irregularly shaped islands or translucent blebs.[1]
- Symptoms of endometriosis can range from being asymptomatic to causing incapacitating pain, dysmenorrhea, dyspareunia, and infertility.
- Treatment of endometriosis depends upon severity of disease, location of ectopic lesions, desire for future childbearing, and the goal of treatment.

MEDICAL MANAGEMENT

- Medical management includes analgesic and hormonal therapy.

SURGICAL MANAGEMENT

- Surgical treatment is either conservative or definitive.
- Definitive treatment consists of hysterectomy with or without bilateral salpingo-oophorectomy.
- The most common conservative surgical approach is excision, ablation, or both.
- Excision is referred to removal of diseased tissue and can be performed with scissors, laser, or monopolar electrosurgery.
- Ablation (vaporization) is destruction of lesion using electrocoagulation, laser, plasma energy, or an ultrasonic cutting and coagulation device like the harmonic scalpel (Ethicon Inc., Somerville NJ).
- We prefer CO_2 laser and hydrodissection for both excision and vaporization. The use of CO_2 laser, along with hydrodissection, allows for safe surgical treatment of endometriosis over sensitive areas such as ureter and blood vessels.[2]
- When using CO_2 laser and hydrodissection, the fluid will provide a protective barrier between the lesion and underlying ureter and blood vessels, as CO_2 laser does not penetrate water.
- Advantages of the CO_2 laser include:
  - Precise application
  - Minimal tissue damage
  - Minimal risk of thermal damage to adjacent structures
  - Excellent hemostatic properties for small vessels.
- Hydrodissection allows for:
  - Separation of peritoneum from underlying structures
  - Protecting underlying structures from penetration and potential damage by the CO_2 laser beam.

Preoperative Planning

- Patients should be counseled on both the choice between conservative or definitive surgery.
- As part of the evaluation, a pelvic ultrasound should be done to detect any existing ovarian endometrioma, or a rectovaginal or bladder nodule.
- A pelvic exam that includes rectovaginal exam, palpation of uterosacral ligaments, and posterior cul-de-sac should be done.
- If there is evidence of deeply infiltrative endometriosis (DIE), the bowel, ureters and bladder should be evaluated further by either trans-rectal ultrasound (TRUS), CT scan, or MRI.
- Informed consent including the risks of surgery and all alternative treatment options should be reviewed with patient.

Positioning[3]

The patient is in supine position. The thighs are not flexed so that the suprapubic and lateral trocars can be maneuvered. Nasogastric or an oral gastric tube is placed before the procedure. Proper alignment of head and neck is crucial. The location of fingers, toes, face, and chest should be observed for any unintentional pressure. The blood pressure cuff is then placed on the right arm and placed high enough that it is away from the ulnar nerve. The eyes are covered with tape, in order to avoid any corneal abrasions. When securing the arm, ensure the oxygen saturation probe is free and able to be moved, should there be a need. The arm is secure and the fingers are visualized. The fingers should always be visible when positioning the patient on the bed. The buttocks are hanging 2 to 3 inches off the table. A warming device may be placed just beneath the breast line.

Procedures and Techniques[2,3] (Video 6.1.1)

- This procedure requires an umbilical incision to accommodate the video camera and/or laser laparoscope, in addition to three accessory trocars (two lateral 5-mm trocars and one 5-mm suprapubic trocar).
- The initial step is exploration of pelvis and abdomen to identify the presence, location, and extent of endometriosis. Lesions of endometriosis are evaluated for their depth of invasion and are classified as superficial or deep lesions.
- We routinely start by inspecting the diaphragm, upper abdominal walls, and liver in supine and reverse steep Trendelenburg position.
- Next while patient is in Trendelenburg position, in a clockwise fashion, the pelvis including all reproductive organs are thoroughly evaluated. These include the anterior cul-de-sac, round ligaments, the ureter, bowel, uterosacral ligaments, posterior cul-de-sac, and appendix.
- Once the depth of the lesion and nodularity are assessed, the choice of instrument and mode of treatment are determined. Treatment options include: Excision versus ablation. The decision is often determined by the proximity of the endometriosis to adjacent structures such as ureter and large vessels.
- The small superficial implants found on the surface of ovaries and peritoneal surfaces can be efficiently removed by either excision with unipolar cutting current or ablation using the CO_2 laser held 1-3 mm from the surface of the lesion.
- The superficial endometriosis lesions proximal to vital structures such as ureter, major blood vessels, and superficial bowel lesions can be safely excised using hydrodissection by making a small opening superficially in the normal peritoneum with either scissors or CO_2 laser. Fluid is then injected beneath the lesion, which separates and lifts the disease away from the underlying structures. The tissue is then carefully dissected away from proximal structures and excised.
- Since normal-appearing peritoneum may contain nonvisualized lesions up to 27 mm from the lesion, wide excision of peritoneum is recommended.[4]
- In contrast to superficial endometriosis, deep endometriosis is difficult to ablate with either electrosurgery or laser, because the energy cannot reach deeper layers and ablation of the lesion may cause thermal damage to the underlying structures and organs.
- In the case of deep endometriosis that is adjacent vital organ, a complete resection with careful dissection of the lesion off the underlying structures is preferred.

PEARLS AND PITFALLS

Lateral pelvic wall lesions

- In the lateral pelvic wall, the ureter and internal iliac artery become more evident after peritoneal mobilization using hydrodissection.

CO_2 laser

- The use of CO_2 laser and hydrodissection is correlated with minimal tissue damage and minimal risk of thermal damage to adjacent structures

Electrosurgery

- The degree of thermal spread to the adjacent normal tissue is correlated with instrument type, the power setting, and the duration of contact with tissue.

Monopolar diathermy

- Should be used with caution because comparative studies with other devices such as bipolar and harmonic scalpel demonstrates the highest temperatures and greatest degree of thermal spread with monopolar diathermy.[5]

OUTCOMES

- Excision and vaporization provide the same outcomes for patients. One advantage for excision is the preservation of a tissue specimen for a histologic diagnosis.

COMPLICATIONS

- Complications may include all those inherent in any surgical procedure under anesthesia.
- Use of an electrosurgical device can lead to tissue necrosis and poor tissue healing due to lateral thermal spread inherent in this technique.
- Use of an electrosurgical device can present with delayed necrosis and/or direct injury to adjacent organs such as the ureter, bladder, and bowel.
- These complications can be mitigated with surgical experience, knowledge of anatomy, and a thorough understanding of the potential thermal spread from specific electrosurgical devices.

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Chapter 6.2

Ovarian Cystectomy of an Endometrioma

Ariel Revel, Azadeh Nezhat, Camran Nezhat

GENERAL PRINCIPLES

Definition

Endometriosis is a condition in which functional endometrial tissue is present outside the uterus. It is often confined to the pelvis involving the pelvic ligaments, cul-de-sac, and the uterovesical peritoneum. When endometriosis involves the ovary it is referred to as an endometrioma. Between 17% and 44% of women with endometriosis will have endometrioma.[1] Endometriotic patients have lower BMI than age- and smoking-status–matched controls, independent of confounding variables.[2] Endometriosis poses significant public health concerns. It not only affects health, well-being, and the quality of life of patients, but it also has great impacts on daily life, work absenteeism, and healthcare consumption.

Types (Three Main Phenotypes)

1. Peritoneal surface = superficial peritoneal endometriosis [SUP].
2. Subperitoneal (e.g., rectum) = deep infiltrating endometriosis [DIE].
3. Ovarian cysts = ovarian endometrioma (OMA): Contains thick, old blood that appears as a brown fluid ("chocolate cysts").

Endometriosis is a disease known to be detrimental to fertility.[3] In a recent large series of patients with histologically proven endometriosis,[2] significant risk factors for presentation for endometriosis-related infertility were:

- Age
- Previous surgery for endometriosis
- SUP endometriosis phenotype

After multivariate analysis OMA was not selected as a significant risk factor for presentation for infertility.[2]

Pathophysiology of OMA related to infertility:

- Mechanical stretching of the ovarian cortex distorting tubo-ovarian anatomy.
- Inflammatory[4]
- Oxidative damage[5] resulting in poor oocyte quality.[6]

The severity of endometriosis is graded according to the location, the extent, and the depth of penetration of the lesions.[7]

Pathogenesis of an Endometrioma (Three Main Theories)

1. Invagination of ovarian cortex secondary to bleeding of a superficial implant.[8]
2. Invagination of ovarian cortex secondary to metaplasia of coelomic epithelium in cortical inclusion cysts[9]
3. Endometriotic transformation of functional cysts.[10]

Classification of an Endometrioma

See **Table 6.2.1**.

Differential Diagnosis of an Endometrioma

- Hemorrhagic ovarian cyst
- Ovarian dermoid cyst: fat sequences on magnetic resonance imaging (MRI)
- Cystic neoplasm
- Tubo-ovarian abscess

IMAGING AND OTHER DIAGNOSTICS

- Laparoscopy is the gold standard for diagnosis of an endometrioma. Histologic confirmation of the diagnosis is recommended.[11]
- Sonography appearance: Homogenous low-level internal echos (ground glass appearance), 1 to 4 compartments and no papillary structures with detectable blood flow.[12]
- Color Doppler: Typical peripheral blood flow.
- MRI: T1 instead of T2-weighted sequences differentiates endometrioma from mature teratoma.[13]

SURGICAL TREATMENT OF ENDOMETRIOMAS

When endometriosis is identified at laparoscopy, clinicians are recommended to surgically[14] treat it ("see and treat") as this is effective for reducing endometriosis-associated pain.[15] In infertile women with American Fertility Society/American Society for Reproductive Medicine (AFS/ASRM) Stage I/II endometriosis, clinicians may consider CO_2 laser vaporization of endometriosis, instead of monopolar electrocoagulation, since laser vaporization is associated with higher cumulative spontaneous pregnancy rates (PR).[16]

Table 6.2.1 Classification of an Endometrioma[10]

Type	Size	Removal	Histology
I	Small (<2 cm) superficial	Difficult	Were always endometriomas
II	Large	Easily removed	Usually luteal cysts
III	Large	Walls adherent adjacent to superficial endometriosis	Endometriomas or functional (luteal or follicular)

Both the presence of OMA and surgical excision of OMA appears to damage ovarian reserve. Surgery is the predominant treatment of endometriomas. Although cystectomy increases PR, it reduces ovarian reserve.[17] Nevertheless, whether the presence of an endometrioma adversely affects in vitro fertilization (IVF) outcomes is controversial.[18] In some hands, surgical excision of an endometriosis (but not OMA) appeared to improve IVF outcomes.[19,20] Future research is needed to better identify surgical techniques. Potential procedures may include aspiration with sclerotherapy and drainage with cyst wall ablation using plasma or laser energy,[21] which may cause less ovarian damage.

Compared with women without the disease, women with OMA have a similar live birth rate although they have a lower mean number of oocyte retrieved, require higher FSH dosage for ovarian stimulation, and have a lower AFC, suggesting that their ovarian reserve is diminished prior to IVF. There is not one dogmatic recommendation as to whether women with OMA should or should not have surgical intervention prior to IVF, but based on current evidence, consideration should be given to individualize the care of these patients.[22]

Infertile Patients Who Benefit from Proceeding Directly to IVF

- Older
- Asymptomatic
- Diminished ovarian reserve
- Bilateral endometriomas
- Prior surgical treatment

Patients Who Benefit from Surgery

- Younger
- Pelvic pain
- Intact ovarian reserve
- Unilateral cysts
- Sonographic features concerning for malignancy
- Not planning on pursuing IVF

PREOPERATIVE PLANNING

Considerations to take into account for the decision whether to operate on OMA:

- OMA recurrence after laparoscopic excision[23]
- Reproductive performance lower after repetitive versus primary surgery[24]
- Repetitive surgery for OMA does not increase PR[25]
- Surgery before first IVF does not increase fertility results[26]
- Should women with a small endometrioma undergo an operation?[27]
- Delaying attempts to conceive after OMA surgery lowers PR[28]
- Ovarian reserve may be reduced due to surgery rather than to an OMA

Endometrioma Cystectomy

Cystectomy is a conservative surgical procedure to remove the OMA cyst.
Laparoscopic approach is preferable due to:

- Lower risk of subsequent pelvic adhesions[29]
- Delicate nature of the repair required
- Robotic assisted laparoscopic approach can be used[30,31]

Technical Procedures

- Stripping technique
- Drainage
- Fenestration and coagulation (Ablative surgery)
- Combined approach[32]
  - Stripping technique to excise large part of the cyst wall
  - Then using CO_2 laser on the remaining endometrioma approaching the difficult part.[14]
- Three-step approach (requires two laparoscopies instead of one).[9]

1. Laparoscopic drainage
2. GnRH analogue for 3 months
3. Laparoscopic CO_2 laser vaporization

- Meta-analysis: Stripping better than drainage or ablation for pain and recurrence.[33–35]
- European Society for Human Reproduction and Embryology (ESHRE) guidelines: Excision preferable than drainage and electrocoagulation.[18,33]

Positioning[37]

The patient should be placed in the normal standard dorsal lithotomy position as for other laparoscopic gynecologic procedures. An intrauterine manipulator capable of allowing chromotubation is helpful if tubal patency is planned. Devices such as the ClearView® (Clinical Innovations, Murray, UT), HUMI® (Cooper Surgical, Trumbull, CT), ZUMI™ (Cooper Surgical, Trumbull, CT), or Kronner Manipulator® (Cooper Surgical, Trumbull, CT) allow manipulation. Saline can be used for flushing.

Stripping Technique[14,35,36] (Video 6.2.1)

Step 1

General anesthesia.

Step 2

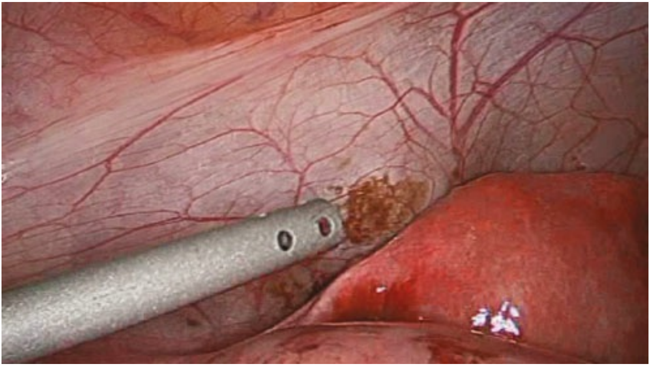
Laparoscope introduced through the umbilicus.

Step 3

Three accessory 5-mm trocars placed in the suprapubic region.

Step 4

- Initial diagnostic evaluation of the pelvis and abdomen.
  - See **Tech Figure 6.2.1**.



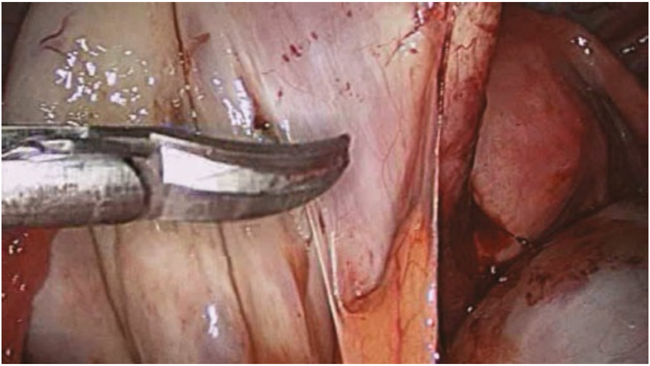
Tech Figure 6.2.1. Initial diagnostic evaluation of the pelvis and abdomen.

Step 5

Saline washing.

Step 6

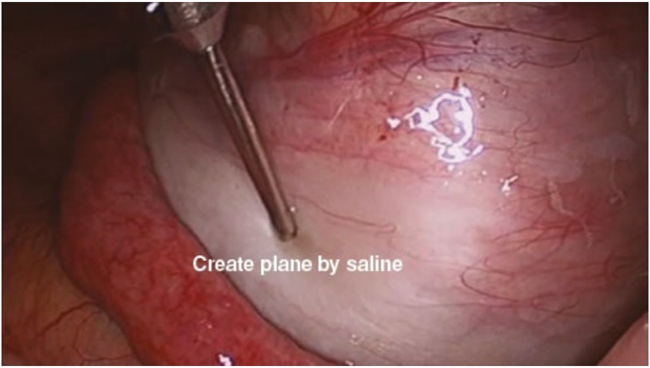
- Adhesiolysis.
  - See Tech Figure 6.2.2.



Tech Figure 6.2.2. Adhesiolysis.

Step 7

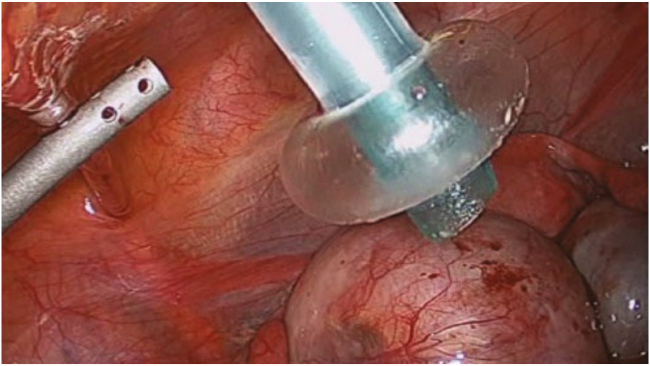
- Create plane between endometrioma and ovarian cortex using saline.
  - See **Tech Figure 6.2.3**.



Tech Figure 6.2.3. Create plane between endometrioma and ovarian cortex using saline.

Step 8

- Ovarian cyst punctured with trocar and contents are aspirated.
  - See **Tech Figure 6.2.4**.



Tech Figure 6.2.4. Ovarian cyst punctured with trocar and contents aspirated.

Step 9

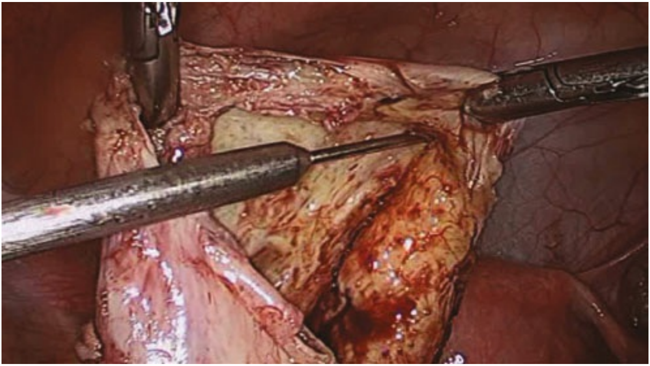
Inner wall of the cyst checked for possible vegetation.

Step 10

If vegetation found perform a frozen section.

Step 11

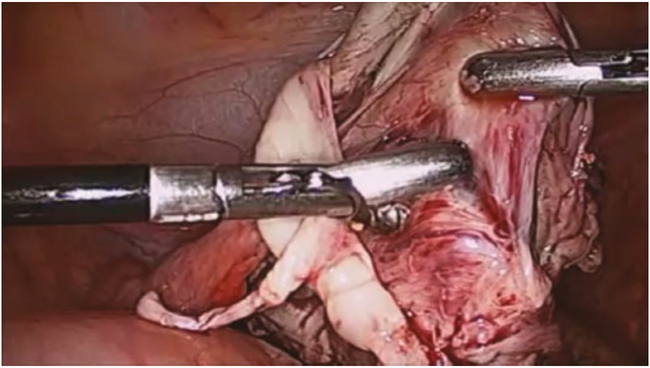
- Identification of the cleavage plane between cyst wall and ovarian cortex.
  - See **Tech Figure 6.2.5**.



Tech Figure 6.2.5. Identification of the cleavage plane between cyst wall and ovarian cortex by injection of saline.

Step 12

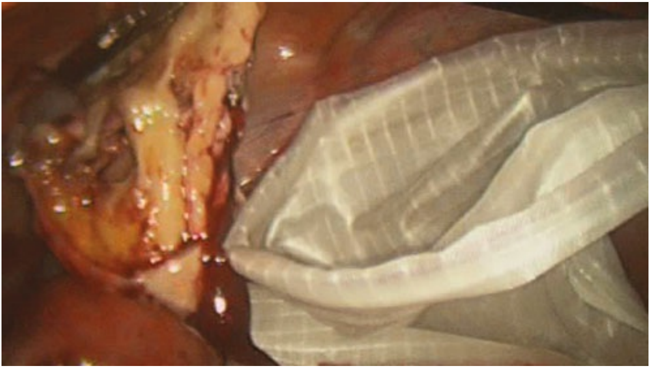
- Cyst wall stripped off the remaining ovarian parenchyma through traction exerted in opposite directions by using two atraumatic grasping forceps.
- See **Tech Figure 6.2.6**.



Tech Figure 6.2.6. Cyst wall stripped off the remaining ovarian parenchyma through traction exerted in opposite directions by using two atraumatic grasping forceps.

Step 13

- Remove cyst wall through trocar or in bag.
  - See **Tech Figure 6.2.7**.



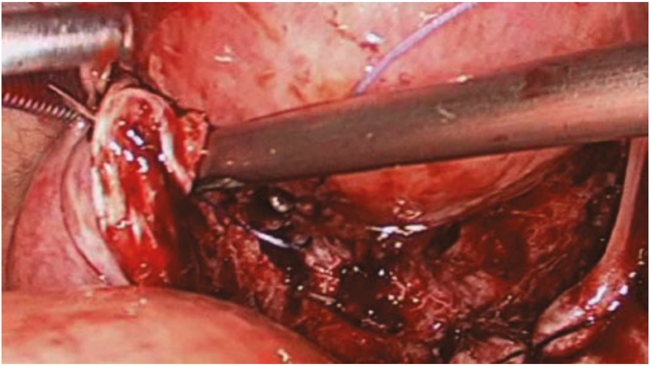
Tech Figure 6.2.7. Remove cyst wall through trocar or in bag.

Step 14

Hemostasis obtained with suture or sealant. Bipolar desiccation for hemostasis may harm ovarian reserve.[37,38]

Step 15

- Sutures may be placed for approximation of the ovarian edges.
- See **Tech Figure 6.2.8**.



Tech Figure 6.2.8. Sutures may be placed for approximation of the ovarian edges.

Step 16

Washing and aspirating saline.

Step 17

Eliminating pneumoperitoneum.

Step 18

Removing trocars and closure of the skin incisions.

PEARLS AND PITFALLS

INTRAOPERATIVE DECISION-MAKING

- Exclude malignancy by frozen section[39,40]

SURGICAL TECHNIQUE

- Limit use of electrocautery to avoid vascular damage and postoperative adhesion formation
- Minimize the removal of the ovarian cortex tissue
- In pregnant patients, entry above the umbilicus and using open entry laparoscopy (Hasson cannula) is recommended to avoid uterine puncture.[40]

POSTOPERATIVE CONCEPTION

- If unable to conceive in 3 to 4 months, a hysterosalpingogram (HSG) can be performed to verify tubal patency

POSTOPERATIVE CARE

The patient can attempt to conceive immediately following surgery. If unable to conceive after 6 to 12 months of appropriate timed intercourse, the patient should consider IVF.

OUTCOMES

PRs in women with endometriomas (**Table 6.2.2**).[41]

Table 6.2.2 Pregnancy Rates in Women with Endometriomas[41]

Expectant management	12%
Cystectomy	54.2%
IVF first	32%
Cystectomy and IVF	64%

COMPLICATIONS

- Bleeding
- Inadvertent cyst rupture intraoperatively: 6% to 27% with subsequent spread of the endometriosis to other parts of the pelvis[30,42]
- Damage to ovarian reserve
- Infection
- Adhesions

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Chapter 6.3

Laparoscopic Excision of Bowel Endometriosis

Azadeh Nezhat, Camran Nezhat

GENERAL PRINCIPLES

Definition

- "Bowel Endometriosis" is referred to the subserous fat or adjacent neurovascular branches of bowel wall that are affected by endometrial-like glands and stroma. Furthermore, endometriotic foci found on the bowel serosa is referred to as peritoneal endometriosis and not bowel endometriosis.[1]
- Endometriosis of bowel typically involves the serosa and muscularis propria, rarely involves the submucosa or mucosa.
- The rectosigmoid colon is the most common site of bowel endometriosis in 70% to 80% of cases, followed by sigmoid colon, rectum, ileum, appendix, and cecum.[2]
- Rectovaginal or bowel involvement is estimated to be present in 3% to 37% of women with endometriosis.[3]
- Disease limited to the bowel serosa may be asymptomatic.
- Nonspecific symptoms may include: pelvic pain, lower back pain, and dyspareunia.
- Symptomatology more specific to bowel endometriosis includes dyschezia and/or tenesmus, cyclic hematochezia, and change in bowel habits.
- Rectal bleeding may occur with rare mucosal involvement.

Differential Diagnosis

- Gastrointestinal carcinoma, lesions especially firm and obstructive can be mistaken as bowel endometriosis.
- Inflammatory bowel diseases such as Crohn disease, diverticulitis, radiation colitis, ischemic colitis, and stricture.

Nonoperative Management

- GnRH agonist, have been used with success in selected cases.[4]
- Norethisterone acetate alone or in combination with letrozole also has been reported to improve symptoms of rectovaginal endometriosis.[5]
- In patients with severe symptoms, medical therapy may not yield satisfactory long-term solution. Surgical intervention may be necessary to dissect and resect the involved area.

IMAGING AND OTHER DIAGNOSTICS

- Physical findings associated with bowel endometriosis are variable and may well depend upon the specific location and size of implants.
- Rectovaginal exam may reveal nodularity and localized implants.
- Colonoscopy is mainly utilized to rule out alternative source of pathology such as colorectal cancer, inflammatory bowel diseases, extrinsic compression, or a fixed area of narrowed lumen suggestive of endometriosis.
- Both transvaginal sonography (TVUS) and transrectal sonography (TRUS) can detect bowel endometriosis as irregular hypoecoic nodules, with or without hypoecoic or hyperechoic foci throughout intestinal wall.
  - In the TVUS the most important limitations are the impossibility of evaluating the depth of rectal wall involvement and of detecting the distance of the rectal lesion from the anal margin.
  - In contrast, TRUS does not visualize the upper part of the colon and is strictly correlated to the sonographer's experience. TRUS can evaluate the involvement of the muscularis mucosa and the distance of the rectal lesion from the anus.
- Double contrast barium enema (DCBE) often demonstrates nonspecific findings suggestive of bowel endometriosis. These findings include extrinsic mass effect with fine mucosal crenulations (serrated, wavy outline of colonic mucosa).
- Magnetic Resonance Imaging (MRI) can detect endometriotic lesions with areas of hemorrhage, but is limited in detecting fibrotic lesions. It also lacks sensitivity in detecting the depth of infiltration of endometriotic lesions.[6]

PREOPERATIVE PLANNING

- These procedures are clean-contaminated and require intravenous prophylactic antibiotics 30 to 60 minutes before incision.
- We do recommend a clear liquid diet the day before surgery and three enemas the night before surgery to decompress the rectum and allow the better visualization of the posterior cul-de-sac.
- The need for mechanical bowel preparation is controversial as studies have shown that this may increase the likelihood of spillage of bowel content and meta-analysis has shown no advantage to bowel preparation.

SURGICAL MANAGEMENT

- Surgical treatment has been considered the mainstay of therapy for rectovaginal or bowel endometriosis.
- Surgical management of bowel and rectovaginal endometriosis is determined by the location, size, and depth of infiltration of endometriosis.

Positioning

- The patient is placed in the dorsal lithotomy position with arms abducted.
- Trendelenburg positioning and right tilt may facilitate mobilization of small bowel loops, exposing the pelvis and to further expose the base and posterior attachments of the meso-sigmoid colon to the retroperitoneum.

Procedures and Techniques

- This procedure requires an umbilical incision to accommodate the video camera and laser laparoscope, in addition to three accessory trocars (two lateral 5-mm trocars and one 5-mm suprapubic trocar.
- Bowel endometriosis at sites other than rectosigmoid are treated by shaving or superficial excision of lesion, full thickness disc resection, or bowel resection.[7]

Laparoscopic shaving of superficial bowel endometriosis lesions (Video 6.3.1)[8]

- The superficial lesion involving the serosa or the adventitia is grasped with grasping forceps at the junction of fibrotic endometriosis and yellow or pink soft tissue. The lesion is lifted and excised with CO_2 laser or sharp dissection. We prefer CO_2 laser for its precise application, excellent hemostatic properties, and minimal thermal damage to adjacent tissue.
- Generalized oozing or bleeding is controlled with dilute vasopressin or the bipolar electrocoagulator.
- Bleeding caused by dissection or vaporization of a vessel should be controlled by clips or the bipolar electrocoagulator.
- The use of cautery in this area must be done with extreme caution as thermal damage to bowel may result in delayed necrosis and fistula formation.
- Proctoscopy should be performed at the end of the procedure to ensure no evidence of air leak.

Laparoscopic full thickness disc resection (Video 6.3.2)[9]

- When submucosal fibrosis is present and the lesion constricts the lumen but the lesion is not circumferential, full thickness disc resection is performed.
- The rectosigmoid colon needs to be completely mobilized after identifying the ureters.
- The pararectal area is entered bilaterally, ureterolysis is performed to identify ureters, and the colon is separated from adjacent organs.
- Full thickness disc resection is done starting above the area of visible lesion until normal tissue is identified.
- The lesion is held at its proximal end with grasping forceps and an incision is made through the bowel serosa and muscularis. The lumen is then entered.
- The lesion is then excised entirely.
- Two traction sutures are placed to both sides of the bowel defect, transforming it into a transverse opening. The bowel lumen is then closed in two layers. The mucosa is closed with continuous 3–0 Vicryl® suture (Ethicon, Inc., Somerville, NJ) and submuscularis with interrupted 2–0 Vicryl® (Ethicon, Inc., Somerville, NJ) or silk sutures in 0.4- to 0.6-cm increments.
- Proctoscopy should be performed at the end of the procedure to ensure no evidence of air leak.

Laparoscopic bowel resection (Video 6.3.3)[10–13]

- Bowel resection is usually recommended when the following conditions exist: A single lesion ≥3 cm in diameter, single lesion infiltrating ≥50% of the bowel wall, and if more than three lesions infiltrating the muscular layer are present.[14]
- The medial aspect of the peritoneum covering the mesosigmoid is then cut open from the sacral promontory up to the origin of the colic artery.
- The entire rectum is mobilized; the lateral rectal pedicles are coagulated.
- Both perirectal space is developed and ureters are identified.
- The branches of the inferior mesenteric vessels of bowel segment to be resected are coagulated and cut.
- Hollow of sacrum is visualized in the presacral space and rectovaginal space is developed.
- The rectum is stapled and transected proximal to the lesion using the Endo GIA™ 45 mm (Covidien, Medtronic Minimally Invasive Therapies, Minneapolis, MN).
- Mini-laparotomy is then performed, so proximal bowel can be exteriorized.
- Anvil from a 29 mm EEA™ stapler (Covidien, Medtronic Minimally Invasive Therapies, Minneapolis, MN) is secured to the proximal end of the bowel.
- Distally the 29 mm EEA™ stapler is introduced through the rectum and the pin is advanced.
- The anvil is engaged to the pin. The stapler is closed and fired.
- Proctoscopy should be performed at the end of the procedure to ensure no evidence of air leak.

PEARLS AND PITFALLS

SEGMENTAL BOWEL RESECTION
○ Should be reserved for symptomatic patient who is not responding to other treatments, especially when endometriosis is affecting rectal bulb and when lesion is close to dentate line and anal verge.[11]
EXPECTANT MANAGEMENT
○ Should be balanced with the severity of symptoms and feasibility of follow-up.

OUTCOMES

- Significant pain improvement has been shown with surgical treatment but potential benefit should be weighed against the individual-specific surgical risk.

COMPLICATIONS

The complications of the surgical treatment of rectovaginal and bowel endometriosis may include urinary retention caused by denervation of the bladder at the time of colorectal resection, bladder dysfunction, formation of a rectovaginal fistula, bowel anastomotic leakage, and abscess formation.

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Chapter 6.4

Excision of Endometriosis: Segmental Bladder Resection

Azadeh Nezhat, Camran Nezhat

GENERAL PRINCIPLES

Definition

- The genitourinary system is involved in about 1% to 2% of endometriosis cases.[1] The bladder is most commonly involved, followed by ureter and kidney, with a ratio of 40:5:1 or with the respective prevalence of 85%, 10%, and 4%.[2,3]
- Symptoms of bladder endometriosis include suprapubic pressure, dysuria, urgency, frequency, and hematuria. These are often, but not always, concurrent with menstruation.
- Bladder endometriosis may be extrinsic, involving the bladder serosa, or intrinsic, involving the detrusor muscle. Intrinsic disease is far more likely to be symptomatic.
- Fifty percent of patients with bladder endometriosis will have a tender anterior vaginal wall and palpable pelvic mass on physical exam. Ninety percent will have an abnormal cystoscopy with endometriotic lesions, visible within the bladder mucosa.[4,5]
- The combined cystoscopic and laparoscopic approach is needed for definitive surgical resection.

Differential Diagnosis

- Urinary tract infection, interstitial cystitis, and bladder malignances should be ruled out.

Nonoperative Management

- Treatment of genitourinary endometriosis depends in part on the extent of disease, both within the genitourinary system and in other locations, as well as future fertility desires of the patient.
- Medical management includes oral contraceptive pills (OCPs), progestins, danazol, and gonadotropin-releasing hormone (GnRH) therapy.

IMAGING AND OTHER DIAGNOSTICS

- Bladder lesions may also sometimes be seen on ultrasound, magnetic resonance imaging (MRI), or as a filling defect on a cystogram.
- Cystoscopically, bladder lesions appear as solitary submucosal lesions that are slightly raised with surrounding mucosal edema in the absence of concomitant cystitis or infection.
- Transurethral biopsy or resection may be inadequate for histologic diagnosis because of the submucosal nature of the lesion.
- Extravesically, the lesion can be identified by laparoscopy and direct biopsy.

SURGICAL MANAGEMENT

- Surgical management is preferred in intrinsic disease of the bladder, due to high rate of recurrence with medical management.[6–8]
- Shaving off the endometriotic lesion extending to the muscularis but without mucosal involvement can be treated laparoscopically, and any residual or deeper lesions may be treated successfully with postoperative hormone therapy.[9]

Positioning

The patient is in the dorsal lithotomy position with access to the perineum and vagina. The thighs are not flexed so that the suprapubic and lateral trocars may be maneuvered. Nasogastric tube is placed before procedure. Proper alignment of head and neck is crucial. The location of fingers, toes, face, and chest should be observed for any unintentional pressure. The blood pressure cuff is then placed on the right arm and placed high enough that it is away from the ulnar nerve. The eyes are covered with tape, in order to avoid any corneal abrasions. When securing the arm, ensure the oxygen saturation probe is free and able to be moved, should there be a need. The arm is secure and the fingers are visualized. The fingers should always be visible when positioning the patient on the bed. The buttocks are hanging 2 to 3 in. off the table. A warming blanket device may be placed just beneath the breast line.

Procedures and Techniques (Video 6.4.1)

- This procedure requires an umbilical incision to accommodate the video camera and laser laparoscope, in addition to three accessory trocars (two lateral 5-mm trocars and one 5-mm suprapubic trocar).
- Bilateral ureteral stents are placed.
- The bladder is mobilized superiorly with monopolar cautery and careful dissection. Extensive dissection is required to develop the vesicovaginal space.
- Cystotomy is performed under concurrent laparoscopic and cystoscopy visualization, in close proximity to the lesion.
- The lesion is carefully everted. The lesion is excised sharply to prevent compromise of blood supply and facilitate healing.
- The ureteral stents are visualized and the lesion is excised in it entirely with good margins.
- The cystotomy is closed with full thickness V-lock sutures in running fashion, the efficacy of which has recently been demonstrated in the urologic literature.[10,11]
- Upon closure, the cystoscopy is again performed, ensuring bladder wall integrity and lack of ureteral compromise.
- A portion of the omentum is brought down over the bladder incisions to prevent fistula formation.

PEARLS AND PITFALLS

THE EXTENT OF VESICAL INVOLVEMENT

- A combined laparoscopic and cystoscopic approach is needed

SURGICAL TECHNIQUE

- Cystotomy is closed with a full thickness V-lock sutures in a running fashion

URINARY FOLEY CATHETER

- Keep Foley in place for 10–14 days. Remove when the voiding cystourethrogram or retrograde cystogram demonstrates no leakage

POSTOPERATIVE THERAPY

- Antibiotic prophylaxis is recommended for indwelling catheter
- Anticholinergics such as oxybutynin may be useful during early recovery to minimize bladder spasms

OUTCOMES

- In the case of intrinsic bladder endometriosis, segmental bladder resection resolves a majority of patient symptoms.

COMPLICATIONS

- Postoperative vesicle hematoma and vesicovaginal fistula formation, although rare, can occur.[12]

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Chapter 6.5

Video-Assisted Thoracoscopic Surgery for Endometriosis

Azadeh Nezhat, Camran Nezhat

GENERAL PRINCIPLES

Definition

- Thoracic endometriosis is an uncommon condition characterized by the presence of functioning endometrial tissue in pleura, lung parenchyma, diaphragm, and airways with an overwhelming occurrence in the right hemithorax (88% to 100%).[1,2]
- Bilateral thoracic endometriosis is exceedingly rare but has been reported.[3]
- The exact pathophysiology of thoracic endometriosis remains unclear, but the Sampson theory of retrograded menstruation is the most supported theory of the dissemination of endometrial cells into the peritoneal cavity.[4]
- Thoracic endometriosis syndrome (TES) encompasses mainly of four clinical entities: catamenial pneumothorax (80%), catamenial hemothorax (14%), catamenial hemoptysis (5%), and lung nodules.[5,6]
- The symptoms of thoracic endometriosis are typically catamenial, occurring within 72 hours of the onset of menstruation (rarely 96 hours).[2]
- Chest pain is the most common symptom, occurring in 90% of patients, while dyspnea occurs in approximately one-third.[5] These symptoms and signs are intermittent and can occur around the time of menses.
- Patients may also present with recurrent catamenial pneumothorax, hemothorax, or hemoptysis.
- Endometriosis implants can be seen grossly as raised red or as purple, gray, black lesions. They can be single or multiple lesions that vary in size from 1 to 3 mm and up to 10 mm on pleurodiaphragmatic, pericardial, and tracheobronchial surfaces.[2,7,8]
- Histologically endometrial glands and stroma that stain positively with estrogen and/or progesterone receptors are presents in tissue samples. These often contain fibrous tissue, blood, and cysts.[2,7,8]
- Diaphragmatic perforations are also usually seen grossly at the central tendon as circular or elliptical defects in various sizes with implants at the edges of perforations.[2,7,8]
- Concurrent pelvic endometriosis is seen in approximately 50% to 80% of cases.[5,9]

Differential Diagnosis

- Malignancy, infection, and other pathology such as lymphangioleiomyomatosis (LAM), which usually presents with characteristic cysts and angiomyolipoma in young females should be ruled out.

Medical Management

- Medical management of thoracic endometriosis has long been considered the first step in the management.
- Danazol, progestins, oral contraceptive pills, and gonadotropin releasing hormone (GnRH) analogs have all been widely used.[7]

IMAGING AND OTHER DIAGNOSTICS

- Diagnosis of thoracic endometriosis is mainly based on clinical suspicion, when women with history pelvic endometriosis present with catamenial or noncatamenial pneumothorax.
- Chest radiograph, computerized tomography (CT), magnetic resonance imaging (MRI), thoracocentesis, and bronchoscopy are useful in patients presenting with pneumothorax, hemothorax hemoptysis, or a lung nodule. These procedures help rule out malignancy, infection and other pathology.[10,11]
- Serum cancer antigen 125 (CA 125) and CA19–9 concentrations may be elevated in patients with thoracic endometriosis but are poorly sensitive and nonspecific diagnostically.[12,13]

PREOPERATIVE PLANNING

- Contrast-enhanced computerized tomography (CCT) done while patient is symptomatic (i.e., during menses) helps locate the lesions prior to surgery and rule out other etiologies.
- A multidisciplinary team of cardiothoracic surgeons, laparoscopic surgeons and an anesthesiologist are needed for the successful surgical treatment.

SURGICAL MANAGEMENT

- Surgical treatment of thoracic endometriosis is required if symptoms persist despite hormonal suppression of ectopic endometrium.
- Thoracocentesis and chest tube placement are initial therapeutic interventions in the emergency room until further action is taken.
- Secondary prevention of recurrent pneumothorax due to thoracic endometriosis is treated using blebectomy, pleurodesis, and diaphragmatic repair.
- Video-assisted thoracoscopic surgery (VATS) and combined laparoscopy in a single session was first described by Nezhat et al.[14] in 2009, and his findings confirmed the necessity of exam of abdominal side of the diaphragm for complete treatment of TES.

Positioning for Video-Assisted Thoracoscopic Surgery

- Patient is positioned for a posterior-lateral thoracotomy for complete visualization of diaphragm.

Positioning for Laparoscopy

- The patient should be placed in the dorsal lithotomy position.

Procedures and Techniques (Video 6.5.1)

- For all surgical cases, a double-lumen endotracheal tube is used for single-lung ventilation during the VATS procedure. A bronchial blocker is used to isolate the lung when the double-lumen endotracheal tube cannot be inserted. If the VATS procedure is performed first, the patient is placed in either the left or right decubitus position, depending on the laterality of the suspected thoracic endometriosis. A trocar is inserted through a midaxillary incision. The camera is then placed into the thoracic cavity, and the cavity is explored. Additional ports are placed posteriorly and anteriorly as needed for visualization and creation of the desired operative angle.
- If there is evidence of endometriosis, it is treated via ablation, excision, or resection. Smaller lesions are ablated or excised with a carbon dioxide (CO_2) laser or plasma jet energy.[15]
- Deep diaphragm lesions are treated with a diaphragm resection, either via an endoscopic stapling device or by excision and manual suturing.[2,16]
- For extensive diaphragmatic perforation that necessitate resection, use of various mesh or bovine pericardial patches has been reported.[17]
- A silastic flexible drain is then placed in the pleural space to release the pneumothorax and is attached to a water seal. The incisions are closed in layers, and the chest tube is secured to the skin using silk suture. If the opposite chest cavity is to be examined as well, the patient is repositioned, with repeat skin preparation, draping, and the procedure is repeated on the opposite side.
- Once the VATS is completed, attention is turned to the abdomen for traditional laparoscopy. The patient is undraped and repositioned on a beanbag in the dorsal lithotomy position with the arms adducted. Care is taken to ensure that there are no pressure points, especially at the shoulders. The abdomen is entered using a closed-entry technique with a Veress needle and concurrent CO_2 gas insufflation.[18] In patients with prior abdominal surgery with a high likelihood of intraabdominal adhesions, a 20-gauge spinal needle attached to a syringe half filled with normal saline solution is inserted next to the Veress needle for "mapping."[19] The plunger is drawn back, and if CO_2 gas from the pneumoperitoneum easily appears in the syringe, intraperitoneal insufflation is likely, with minimal surrounding adhesions. This is repeated in a full range of directions anticipated for trocar entry. After establishment of pneumoperitoneum, a 10-mm camera port is placed at the umbilicus. Thereafter, additional ports are placed in the right and left lower quadrants and suprapubically under laparoscopic visualization.
- Initially, the pelvis and diaphragm are explored with the patient in the steep Trendelenburg

position to assess the extent of intra-abdominal disease and identify abnormalities or distortions. The patient is then placed in the steep reverse Trendelenburg position to evaluate the upper abdominal walls, liver, and diaphragm for the presence of endometriosis. The liver is pushed caudally with a grasper or liver retractor to view the adjacent diaphragm. A surgical plan is constructed to optimally restore normal anatomy and excise all areas of endometriosis. The abdominopelvic and visceral diaphragmatic endometriosis is treated via hydrodissection followed by excision or ablation with monopolar or bipolar current.

PEARLS AND PITFALLS

THE PHRENIC NERVE, PERICARDIUM, AND SUPERIOR VENA CAVA

- ✖ Should be clearly identified and avoided

THE CHEST TUBE

- ○ Should be left in place until postoperative day 1 or 2, once the patient has recovered from the iatrogenic pneumothorax and there is minimal drainage from the pleural space.

POSTOPERATIVE TREATMENT

- ○ Most patients with an endometriosis-related pneumothorax should be treated with 6–12 months of hormonal suppression.

OUTCOMES

- Recurrence of endometriosis-related pneumothorax despite surgical and hormonal treatment has been seen in 8% to 40% of patients and is higher than nonendometriosis-related pneumothorax (5%).[6]

COMPLICATIONS

- This may include the associated complications of surgery, surgical pleurodesis, and hormonal treatments.

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Section II

Assisted Reproductive Technology Procedures

7

Transvaginal Oocyte Retrieval

Darcy E. Broughton, Kenan R. Omurtag

GENERAL PRINCIPLES

Definition

Transvaginal oocyte retrieval (TVOR) is the method utilized to obtain oocytes to be utilized for in vitro fertilization (IVF) after controlled ovarian hyperstimulation (COH). This involves transvaginal aspiration of ovarian follicles under ultrasound guidance. Historically, oocyte retrieval was performed laparoscopically or transabdominally with ultrasound guidance.[1] The transvaginal approach was pioneered in 1985 and is associated with improved safety, patient acceptability, and IVF outcomes.[2–5]

IMAGING AND OTHER DIAGNOSTICS

- The timing of TVOR is dependent upon the patient's ovarian response to stimulation with gonadotropins. In the 2 weeks preceding TVOR there are frequent transvaginal ultrasounds for monitoring of follicular development (**Fig. 7.1**). This imaging, in combination with measurement of estradiol levels, guides changes in dosing and ultimately the timing of the hCG trigger injection. Criteria for trigger and retrieval vary by IVF center; in our clinic hCG is administered when there are ≥2 follicles measuring 18 mm or greater. TVOR is typically performed 36 hours following the hCG injection.[6]

PREOPERATIVE PLANNING

- TVOR must be performed under anesthesia, most commonly general anesthesia (GA; propofol) or conscious sedation (CS; benzodiazepines and ketamine or systemic opioid).[7,8] Other less utilized options include regional anesthesia under spinal/epidural blockade or local anesthesia with paracervical block.[8,9] Worldwide, CS is used in 60% to 70% of TVORs.[10] In an RCT comparing GA with CS, pain scores were lower in the GA group, but the procedure was still considered tolerable in the CS group.[11] The administration of GA has the benefits of rapid onset and recovery as well as less postoperative nausea and vomiting, but requires the presence of specially trained anesthesia staff and more intensive monitoring that may be prohibitive in stand-alone IVF clinics.[12] Local anesthesia alone is likely inadequate, but has been used in situations where anesthesia may be contraindicated. In a prospective study of TVOR under paracervical block, 28% of women needed administration of a sedative.[9] There is no evidence that route of anesthesia affects embryo quality or pregnancy rates (PRs).[13,14]

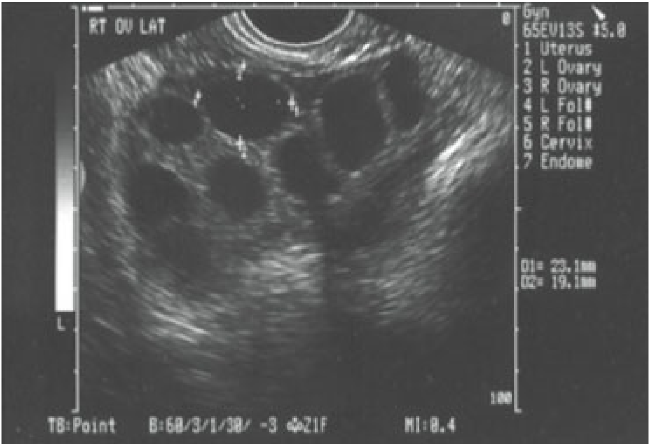


Figure 7.1. Ultrasound image of a hyperstimulated ovary with multiple follicles.

- The ability to access the ovaries via the transvaginal route should be assessed prior to TVOR. The ovaries may be difficult to access in patients with extensive adhesive disease due to endometriosis or prior surgery, large fibroids, prior ovarian transposition due to radiation therapy, or anomalies such as Mullerian agenesis. Monitoring ultrasounds performed prior to and during stimulation can alert the clinician to potential challenges.[6]
- It has become standard of care to administer a dose of prophylactic IV antibiotics at the time of TVOR. There is no quality prospective data that prophylaxis decreases the incidence of pelvic infections, perhaps because this is an extremely rare complication of TVOR.[15] Studies have shown that implantation and PRs are lower when embryo transfer catheters have positive microbial cultures.[16–18] The proportion of patients with colonized catheter tips decreases when antibiotics are given at the time of TVOR.[19] There is no standard choice of antibiotic; the first line is most commonly a cephalosporin such as cefazolin or cefoxitin, similar to other gynecologic procedures.
- The patient should be asked to empty her bladder immediately prior to the procedure; a full bladder can position the ovaries away from the transvaginal probe.[6]

SURGICAL MANAGEMENT

Positioning

The patient is positioned in low lithotomy with adjustable stirrups and her arms out to the sides.

Approach

- Almost all TVORs can be completed with a transvaginal approach. However, as mentioned above, one or both ovaries will be inaccessible in 1% to 2% of cases.[20] Options include passing the needle through the cervix and/or myometrium to enter the ovaries if feasible. This technique does not appear to adversely impact PRs.[20] Care should be taken to avoid the fundal endometrium, the most common site of subsequent implantation.[20] Another oft-used technique is to provide abdominal pressure to bring the ovaries into the pelvis to facilitate a vaginal approach. If the ovaries, still, cannot be reached from the vagina, a transabdominal approach with ultrasound guidance can be used, using the same probe and needle.[21] This strategy yields comparable numbers of oocytes retrieved, fertilization, and PRs.[22]

Preparing the patient

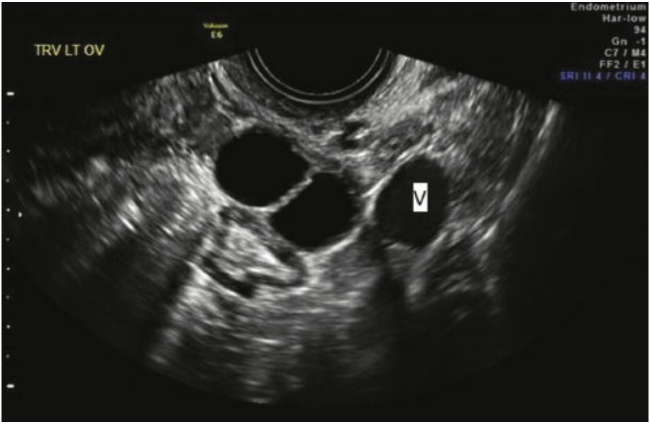
- The vagina should be rinsed with saline or a povidone-iodine solution to decrease the bacterial load. If a povidone-iodine solution is used, copious flushing of the vagina must be performed after this due to potential toxic effects on oocytes.[7] As a result of the latter, we prefer saline universally.

Preparing the equipment

- A sterile operating table should be available with tubes of culture media in a warming tray. The vaginal ultrasound probe should be prepared with a sterile cover and needle guide attached.
- The retrieval needle is commonly 17 gauge (range 15–18), attached to an electric vacuum aspirator controlled with a foot pedal. The vacuum should be tested prior to the procedure with aspiration of culture media. The preferred negative pressure setting varies by center; in our practice we routinely use 125 mm Hg. The majority of centers use a range of 120 to 140 mm Hg, but values from 80 to 200 mm Hg appear in the literature.[23–25] Needles can be either single lumen or double lumen.

Ultrasound-guided assessment of the pelvis

The transvaginal ultrasound probe is inserted with the needle guide firmly attached. A survey of the pelvis should be performed, with identification of ovaries and surrounding structures including bladder, bowel, and iliac vessels. The ovaries should be visualized in both transverse and longitudinal axes to help differentiate follicles from blood vessels, which can appear similar on cross-section (**Tech Fig. 7.1**).[6] Color Doppler can also be employed for this purpose.[7]



Tech Figure 7.1. Iliac vessel (V) in cross-section, mimicking an ovarian follicle.

Follicular aspiration

The needle is then passed first through the guide and then through the vaginal wall in either the left or right fornix to enter the respective ovary. Once a follicle has been entered, the vacuum is activated and the follicular fluid and oocytes are aspirated into the warmed tubes of culture media. The probe is maneuvered to bring follicles in close proximity to the needle, avoiding multiple punctures to the vaginal wall. All follicles of a reasonable size should be entered and aspirated.[6] This process is repeated on the contralateral side, taking care to maintain correct orientation of the probe.

Follicular flushing

More than 50% of IVF practitioners employ a technique of flushing each follicle with culture media, with the goal of increasing oocyte yield.[26] This is accomplished with a double-lumen retrieval needle and one or more flushes of the follicle with repeated aspiration.[27] Initial studies showed a potential increase in oocyte yield, but subsequent randomized trials have not demonstrated this.[28–30] Flushing increases procedural time by a range of 3 to 15 minutes.[24,29] It has been postulated that flushing may be of benefit in certain patient populations with anticipated low oocyte yield, including poor responders and those undergoing natural cycle IVF, but prospective data is limited and has not borne this out.[24,31,32] There does not appear to be a difference in fertilization or implantation rates between oocytes obtained from aspiration before or after flushing.[24,26] Ultimately, follicular flushing may not be practical in high volume fertility centers performing many oocyte aspirations per day.

Identification of oocytes

- The tubes of culture media containing aspirate are passed through to the embryology lab. They are poured onto culture plates where the embryologist identifies and grades the oocytes.

Concluding the procedure

- The needle is removed and flushed with culture media. The posterior cul-de-sac should be inspected for collection of free fluid that may indicate bleeding prior to the removal of the probe. A speculum should be placed and the vaginal puncture sites inspected for hemostasis.

PEARLS AND PITFALLS

- ✖ Ovaries difficult to access transvaginally
  - ○ Transabdominal pressure can be applied in caudad direction[20]
  - ○ Patient can be placed in reverse Trendelenburg or lateral tilt[20]
  - ○ A tenaculum can be used for uterine manipulation when ovary posterior to uterus[33]
  - ○ Consider transmyometrial or transabdominal retrieval as last resort
- ✖ Endometriomas present
  - ○ Attempt to avoid puncturing during TVOR
  - ○ Can aspirate if obstructive, flush contents and drain endometrioma. Consider broadening or extending course of the antibiotic administered.
- ✖ Empty follicle syndrome
  - ○ Check UPT 12 hours following trigger, redose if needed
  - ○ Use antagonist cycle with gonadotropin releasing hormone (GnRH) agonist trigger
  - ○ Use recombinant instead of urinary hCG

POSTOPERATIVE CARE

- The patient should be monitored in a recovery area after the procedure. IVF staff should note any vital sign derangements, heavy vaginal bleeding, or intractable abdominal pain. Postoperative pain should be treated, with up to 3% of patients reporting severe pelvic pain following the procedure. Up to 20% of patients will report moderate pain 2 hours postprocedure, and this is directly related to number of oocytes retrieved.[34]

OUTCOMES

- PRs in IVF cycles are highly correlated with number of oocytes initially retrieved.[7] This outcome depends upon many patient characteristics, including response to ovarian hyperstimulation, adequate sedation, habitus, or other anatomic challenges.

COMPLICATIONS

- Vaginal bleeding:
  - Vaginal bleeding is reported in 2% to 10% of patients following TVOR.[34] The vast majority of this can be managed by holding direct pressure to the puncture sites in the vagina for >1 minute. Rarely, a suture will need to be placed in the vagina. Vaginal bleeding exceeds 100 mL in <1% of cases.[15]
- Intra-abdominal bleeding:
  - Significant intra-abdominal bleeding is a rare complication of TVOR, occurring in 0.1% of cases.[15,34] This can be caused by small follicular vessels on the ovary or injury to iliac vessels or sacral veins.[35,36] Patients present in the postoperative period with pain out of proportion to the procedure and possible signs of hypovolemia. Ultrasound may show free fluid in the cul-de-sac, but absence of fluid does not rule out a retroperitoneal bleed.[6,36] Further imaging with CT scan may be necessary in a stable patient. Most intra-abdominal bleeding following TVOR is self-limiting and the patient can be managed conservatively with serial exam and hemoglobin measurement.[7] Rarely, laparoscopy or laparotomy may be indicated to identify and treat the source of bleeding. If the IVF team is not performing the surgery, it is important that they communicate with the surgical team. Many gynecologists may not be familiar with the appearance of hyperstimulated ovaries, and unnecessary cystectomies and oophorectomies have been performed.[6] All patients should be consented for possible oophorectomy in the case of ovarian source bleeding that cannot be controlled. If the enlarged ovaries are anterior to the uterus, an open laparoscopic entry or left upper quadrant entry should be considered to avoid ovarian trauma.[37]
- Pelvic infection:
  - The rate of pelvic infection following TVOR is exceptionally low.[15] Some patients are at higher risk for infectious complications. Women with endometriomas that are entered at the time of TVOR may be a nidus for infection and extended antibiotic coverage should be considered.[6,38] In our practice we routinely prescribe triple therapy, single preoperative doses of ampicillin, gentamicin, and clindamycin. If possible, endometriomas should be avoided during TVOR given infection risk and high rate of recurrence.[39] Women with significant tubal disease may also be predisposed, although the majority with clinically evident hydrosalpinges will have been removed prior to IVF.
- Empty follicle syndrome:
  - Empty follicle syndrome (EFS) occurs when there is normal follicular development but oocytes cannot be aspirated at the time of TVOR. This is postulated to be due to low bioavailability or bioactivity of hCG, which causes luteinization of the follicles allowing the cumulus–oocyte complexes to detach from the follicular wall.[40] The timing of TVOR should

be 36 to 38 hours following hCG administration, follicular rupture occurs at 39 to 41 hours following injection.[41] In patients with EFS in a prior cycle, options include switching from urinary to recombinant hCG or using an antagonist cycle to allow a GnRH agonist trigger.[42,43] If hCG is used, the patient can check a sensitive urine pregnancy test to confirm bioavailability 12 hours following trigger injection. If the test is negative, an additional injection can be given and the TVOR timing adjusted.[44]

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8

Embryo Transfer

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GENERAL PRINCIPLES

Definition

The embryo transfer (ET) procedure is the culmination of an in vitro fertilization cycle that involves transfer of embryo(s) from culture in the laboratory to the intrauterine environment.

PREOPERATIVE PLANNING

- Prior to ET a decision must be made about number of embryos to transfer. The American Society for Reproductive Medicine (ASRM) and the Society for Assisted Reproductive Technology (SART) have published guidelines for embryos' transfer number.[1] This rubric takes into account patient age and prognosis, but the decision should be further individualized and discussed with the patient in detail prior to transfer.
- Studies support the documentation of a trial embryo transfer (TET) prior to the actual procedure.[2] This involves passage of a catheter into the uterine cavity to the fundus, with the purpose of recording the depth of uterine cavity and the direction and degree of flexion at the uterocervical junction. Other helpful information can also be elucidated, including the presence or absence of cervical stenosis and optimal speculum size. There are practice variations in the timing of trial transfer, which can include prior to the start of stimulation, at the time of egg retrieval, or immediately prior to the actual transfer. The rationale for trial transfer at the time of retrieval or ET is that stimulation may alter the position or length of the uterus.[3] If a trial transfer is to be performed at the time of ET, we recommend use of the afterloading technique. This involves using a firm outer sheath to navigate only to the level of the internal os, then passing a soft catheter with the embryos loaded into the uterine cavity, avoiding disruption of the endometrium.[4]
- If cervical stenosis is identified at the time of trial transfer, the data supports performing a dilation procedure well in advance of ET.[5] Studies have shown lower PRs with dilation performed within 5 days of ET, perhaps due to alterations in the receptive endometrium.[6,7] There are many techniques for overcoming stenosis, which can include simple dilation with Hegar dilators to 7 to 9 mm, placement of osmotic dilators (laminaria), hysteroscopic shaving of any endocervical ridge that may be present, or placement of a Malecot catheter for a 7- to 10-day period with antibiotic prophylaxis.[8–11]

SURGICAL MANAGEMENT

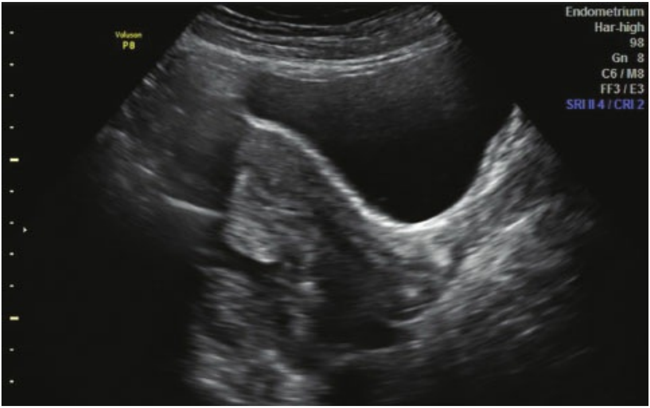
- ET is performed at the conclusion of both fresh and frozen IVF cycles. It can be performed in either the clinic or procedure room setting with intimate access to the IVF laboratory.
- Transcervical ET is most often performed without anesthesia and is generally well tolerated. For patients with anxiety related to a history of a difficult transfer, an oral benzodiazepine can be administered 30 to 60 minutes before the procedure. General anesthesia with propofol can be considered in rare situations when a very difficult transfer is anticipated or the patient has been unable to tolerate transfers despite oral medication.[12]
- No antibiotic prophylaxis is given prior to ET. Pelvic infection following the procedure is quite rare, and oral antibiotics have not been shown to increase PRs.[13,14] The use of an antimicrobial solution (povidone-iodine or chlorhexidine) to cleanse the vagina and cervix is not recommended due to potential toxicity to embryos.

Positioning

- The patient is positioned in low lithotomy. Either an exam table/chair or a gynecologic stretcher is sufficient, and patient comfort should be optimized.

Approach

- The evidence supports the use of transabdominal ultrasound guidance during ET.[15,16] Visualization of the transfer catheter allows easier navigation of the cervical canal and optimizes the location of embryo deposition. It can also be helpful in patients with challenging anatomy due to uterine fibroids or cesarean section scars.[3] The patient should have a full bladder to allow transabdominal imaging and help to straighten the cervicouterine angle.[17]
- See **Tech Figures 8.1** and **8.2**.



Tech Figure 8.1. Transabdominal ultrasound guidance showing anteverted uterus.

Tech Figure 8.2. Transabdominal ultrasound guidance showing retroverted uterus.

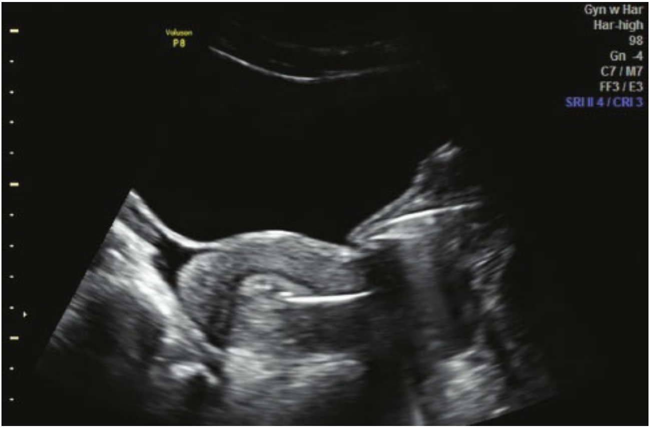
Procedures and Techniques (Video 8.1)

Cervical preparation

- After appropriate positioning and confirmation of uterine visualization on ultrasound, a speculum is placed and the cervix brought into view. The vagina and cervix should be cleansed with saline or culture medium to decrease bacterial contamination of the transfer catheter.
- Cervical mucous can occlude the tip of the transfer catheter or displace embryos upon catheter withdrawal. Mucous at the external os can be removed with a cotton ball during the above cleansing procedure. We also support aspiration of mucous from the endocervical canal prior to transfer, which can be done using a small suction pipelle or syringe attached to a transfer catheter. Care should be taken not to go beyond the internal os to avoid disrupting the endometrium.[18]

Choice of transfer catheter

- There are multiple commercially available transfer catheters, which fall into two broad categories, soft and firm. Popular soft catheters include the Cook (Cook Medical, Bloomington, IN) and Wallace (Smiths Medical International, Dublin, OH) catheters. Examples of firm catheters include TDT® (Irvine Scientific, Santa Ana, CA) and Frydman® (Irvine Scientific, Santa Ana, CA). Firm catheters are associated with higher rates of uterine contractions and blood on the catheter tip, both of which correlate with decreased PRs.[19,20] Randomized studies have confirmed better outcomes with use of soft catheters.[21–23] There appears to be no advantage of a certain soft catheter over another.[24] The afterload technique can be used to navigate the tortuous cervical canal while maintaining use of a soft catheter.[25] The afterload technique begins by placing the a mock soft catheter or the outer sheath of a soft catheter with an inner rigid stylet to the level of the lower uterine segment just beyond the internal os. The inner catheter or stylet is withdrawn while the outer catheter is held in place within the uterus. A soft inner catheter with the loaded embryo(s) is then fed into the outer sheath and the inner catheter is advanced to the desired final depth in the uterus.
- See **Tech Figure 8.3**



Tech Figure 8.3. Wallace® transfer catheter being passed into cervical canal.

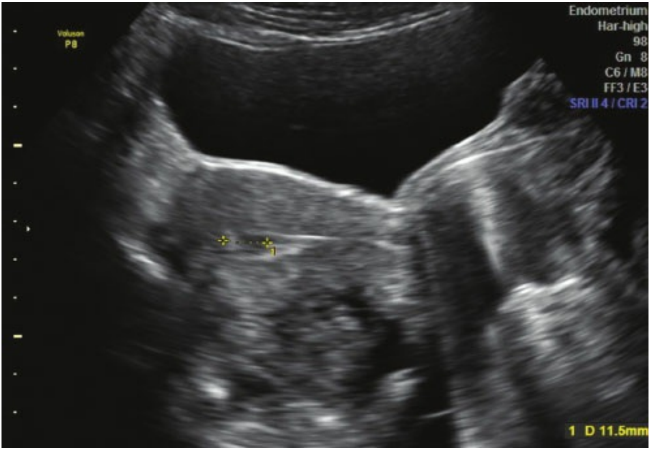
- More recently, "ecodense" transfer catheters have been introduced that are more echogenic and easier to visualize with ultrasound. Comparison with standard soft catheters has not shown definitive improvement in pregnancy rates.[26]

Loading the embryos

- The embryologist loads the embryo(s) into the transfer catheter in the laboratory. The embryo is drawn up in ~20 μL of media, with the majority of the fluid proximal to the embryo to facilitate expulsion. The “air–fluid” technique is often used, in which the fluid containing the embryo(s) is bracketed on both sides by a small amount of air. The air–fluid interface is easily visualized with ultrasound and confirms location of deposition. Studies have not shown any detriment of this technique on PRs.[27] Loading of embryos in less than 10 μL or more than 60 μL has been associated with lower PRs.[28,29]
- The team should attempt to minimize the time interval between loading and deposition of the embryos to prevent prolonged exposure to environmental factors. The body of evidence is mixed, and an optimal time to deposition has not been established.[30]

Deposition of embryos (Video 8.2)

- The transfer catheter is handed to the clinician by the embryologist, who guides the catheter into the uterine cavity, assisted by ultrasound guidance. Deposition of the embryos should ideally be in the mid-lower portion of the uterine cavity, within 15 to 20 mm of the uterine fundus.[31–33] Placement within 5 mm of the fundus has been associated with lower PRs and higher rates of ectopic pregnancy.[34]
- See **Tech Figure 8.4**
- The clinician then depresses the plunger on the transfer catheter, and if the air–fluid method is used, the deposition of the embryos can be visualized on ultrasound. The plunger should be continued to be depressed as the catheter is removed to avoid negative pressure suction that could result in retained embryos.[3] If an outer sheath has been utilized it should be removed with the inner soft catheter.[12]
- Some advocate delayed removal of the transfer catheter for 30 to 60 seconds to decrease the risk of retained embryos. The data has not shown definitive benefit of this technique, but no adverse effect on PRs has been demonstrated.[35]



Tech Figure 8.4. Transabdominal ultrasound showing ET catheter positioned 11.5 mm from fundus.

- The catheter is then passed back to the embryologist, and it is flushed with media and then examined for any embryos that may have been retained. If embryos are retained, they should be reloaded into a fresh catheter and re-deposited. Studies have shown that there is likely no negative effect of retained embryos on subsequent PRs.[36]

Cervical pressure

Some centers routinely apply pressure to the cervix after removal of the transfer catheter, with loosening of the speculum causing the blades to close over the cervix, occluding the cervical canal for a period of 5 to 7 minutes. One randomized study has shown improvement in PRs with this technique, although it is not currently widely employed.[37]

PEARLS AND PITFALLS

- ✖ Extreme degree of uterine anteflexion
  - ○ At time of egg retrieval, a suture stitch can be placed on anterior cervical lip for traction during ET. This avoids placement of a tenaculum, which can induce contractions.[12]
- ✖ Cervical stenosis
  - ○ Dilation procedure in advance of ET
- ✖ Retroverted uterus
  - ○ Consider ET with a low volume or empty bladder to minimize cervicouterine retroflexion.
- ✖ Extremely difficult transfers, persistent cervical stenosis
  - ○ Transmyometrial transfer can be considered with transvaginal ultrasound guidance (Towako method).[38]
  - ○ Zygote intrafallopian transfer (ZIFT) as a last resort.

POSTOPERATIVE CARE

- The data does not support any particular length of bed rest following ET. Prolonged bed rest, however, up to 24 hours has been shown to have detrimental effects on pregnancy rates.[39] A recent randomized study demonstrated lower PRs in patients who rested for 10 minutes following transfer compared to those who immediately ambulated.[40] If providers or patients desire a period of bed rest postprocedure, we recommend less than 15 minutes.
- There is no evidence that intercourse following ET results in lower PRs.[41]

OUTCOMES

- There is convincing data that the ease of transfer correlates with subsequent pregnancy rates.[2,42] Difficult transfers are often more time consuming, require use of a firmer catheter, or employ use of cervical traction with a tenaculum.[3]
- Fundal contact and cervical manipulation have been shown to induce uterine contractions, which decrease rates of implantation and clinical pregnancy.[43]
- The most commonly cited reasons for a difficult transfer are cervical stenosis and a large degree of anteversion or retroversion.[44]

TRAINING IN EMBRYO TRANSFER

- Evidence suggests that ET technique is critical to success, with large variability in PRs seen between providers in the same practice.[45]
- Fellowship training can provide the basis for development of good technique, although a large proportion of fellows graduate without performing an ET, up to 50% based on national surveys. The optimal time to proficiency has not been established. Studies have demonstrated a learning curve, with improvement in PRs noted over the first 25 to 100 ETs, with significant heterogeneity among fellows.[46,47]
- Studies have examined the requirement to perform a minimum number of trial transfers or inseminations prior to ET, but benefit in PRs has not been demonstrated.[47] It has also been shown that PRs are not significantly reduced after a lapse in training when fellows return from their research rotation.[48] The data supports that live ETs are the best training modality, but it remains a challenge to incorporate this without negatively impacting pregnancy rates. Use of the afterload technique may be a potential solution, allowing fellows to insert the transfer catheter into the cavity prior to the loading of embryos.[49]

COMPLICATIONS

- The rates of ectopic pregnancy after ET appear to approach that of the baseline risk.[50] However, deposition of embryos close to the fundus does appear to increase this risk, which can be minimized with the use of ultrasound guidance.
- The risk of heterotopic pregnancy after IVF is low, but significantly higher than the baseline risk, as would be anticipated with multiple ET.[51]

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Section III

Office Procedures

9

Imaging of Reproductive Organs

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GENERAL PRINCIPLES

Definition

- In addition to regular transvaginal or transabdominal pelvic ultrasound, reproductive imaging can be accomplished in several different ways. This chapter covers the following office procedures: hysterosalpingogram (HSG), saline infusion sonogram (SIS) or sonohysterogram (SHG), hysterosalpingo-contrast-sonography (HyCoSy), and the Parryscope technique (PS).

Differential Diagnosis

- The described imaging modalities give information on different structures in the female reproductive tract. The SIS mainly evaluates the endometrial cavity and HSG focuses more on the fallopian tubes with a more limited assessment of the endometrial cavity, whereas the HyCoSy and the PS technique are more comprehensive and give information on the endometrial cavity and fallopian tubes.
- All of these imaging procedures have advantages and disadvantages. The best test to order depends on patient history, weight, and expected pathology. Other factors include resource availability and the balance of accuracy, gentleness, convenience, cost, and safety with patient preference.

Anatomic Considerations

- Adjustments may have to be made depending on the parity of the patient. In a nulliparous patient, cervical dilation may be necessary. However, using a 2.5-mm flexible hysteroscope for the PS technique makes dilation unnecessary in most patients.
- Whereas a tenaculum should be placed on the cervix during an HSG to obtain the necessary traction on the uterus, this is usually not necessary for SIS, HyCoSy, or the PS. For these modalities, a tenaculum would actually make the procedure more difficult and would have to be removed prior to reinsertion of the transvaginal ultrasound probe.

Nonoperative Management

Reproductive imaging is mostly diagnostic, but can also be therapeutic in the case of an HSG. Performing an HSG may work in multiple ways to increase fertility: either by spontaneously correcting a temporary blockage of a fallopian tube or, in case of oil-based contrast, stimulation of the tubal cilia or inhibition of macrophage adherence to the fallopian tube epithelium.[1] Unpublished data suggest the PS technique also to be associated with subsequent spontaneous pregnancy, though the magnitude of therapeutic benefit from both HSG and PS technique is relatively low.

Hysterosalpingogram

- The HSG procedure allows visualization of the uterine cavity and fallopian tubes via injection of radiographic contrast material through the cervix and taking radiographs of the pelvis.
- There are two indications for performing an HSG: (1) to document tubal patency in patients with infertility, and (2) documentation of tubal occlusion in patients who have previously undergone Essure™ placement. In addition, the HSG gives information about the shape of the endometrial cavity and can detect congenital uterine abnormalities as well as acquired abnormalities such as endometrial polyps, fibroids, or synechiae, though this approach is less informative than with other modalities.
- Although there are known risk factors for tubal disease (such as a history of pelvic inflammatory disease, or previous pelvic surgery), high rates of tubal abnormalities have been found in couples with male factor infertility, especially in low-risk women over the age of 35 years.[2]
- The Essure™ transcervical permanent birth control system consists of two 4 cm long and 0.8 cm wide microinserts made of a stainless steel inner coil, a nitinol (nickel titanium) expanding outer coil and PET (polyethylene terephthalate) fibers. These microinserts are placed hysteroscopically into the fallopian tubes and anchor themselves into the surrounding tissue, where they elicit a benign tissue response which over time causes occlusion of the fallopian tubes. The Essure™ confirmation test is usually performed 90 days after placement of the coils, to document both satisfactory location of the microinserts and bilateral tubal occlusion. With bilateral tubal occlusion documented, the patient may discontinue any additional contraception method. Three months after placement 96.5% of patients will show bilateral tubal occlusion, the remainder will be occluded 6 months after placement.[3,4]

Saline Infusion Sonogram

- In addition to the information obtained from a transvaginal ultrasound about the uterine and adnexal structures, a SIS provides information about lesions projecting into the uterine cavity, such as fibroids or endometrial polyps. By filling the endometrial cavity with sterile saline, the interface between fluid and tissue delineates endometrial abnormalities.
- The most common indication for performing a SIS is abnormal (either heavy or irregular) uterine bleeding. The SIS procedure is comparable with hysteroscopy in the detection of focal lesions, with a sensitivity of 96% for both.[5] A SIS is also usually performed prior to an in vitro fertilization (IVF) or frozen embryo transfer (FET) cycle to ensure a normal uterine cavity. Some argue that hysteroscopy may be the preferred method of evaluation prior to IVF or FET.[6] However, the therapeutic benefit of pre-IVF hysteroscopy may relate to "endometrial scratching" rather than the hysteroscopy itself.
- The SIS procedure can give indirect evidence of tubal patency, if newly accumulated free fluid is visible in the posterior cul de sac after the injection of saline. It is not possible, however, to distinguish the laterality of tubal patency.
- A SIS can be enhanced with 3D sonography to identify congenital uterine malformations (such as a septate or bicornuate uterus) since it is able to document both the outer and inner uterine contour.

Hysterosalpingo-Contrast-Sonography

- The HyCoSy procedure gives more complete information about the pelvic organs compared to transvaginal ultrasound and SIS, without any radiation exposure. In addition to imaging the uterine and adnexal contours and any abnormalities of the endometrial lining, the HyCoSy is also able to evaluate patency of the fallopian tubes. These are usually not seen on a regular transvaginal ultrasound unless they are abnormal,[7] but can be visualized using certain kinds of contrast medium.
- The most common and least expensive contrast medium is a mixture of air and sterile saline (see below). Other contrast media that are in use include Echovist-200 (Schering AG, Berlin, Germany; a suspension of galactose and air microparticles), ExEm gel (Gynaecologic BV, Delft, The Netherlands; hydroxyethyl cellulose and glycerol),[8] or Hyskon (Pharmacia Laboratories, Piscataway, NJ).[9] Echovist and ExEm gel are currently not FDA approved for use in the United States. Some consider the name HyFoSy (hysterosalpingo-foam-sonography) interchangeable with HyCoSy.
- The HyCoSy has been shown to be as accurate as an HSG in predicting tubal patency,[10] and has been supported for use as first-line technique in the standard fertility workup.[11] It may favor the onset of spontaneous pregnancy in one study,[11] but that was not confirmed in another.[12]
- The HyCoSy is usually performed in patients undergoing fertility treatment to document fallopian tube patency.

The Parryscope Technique

- The PS technique is a way of assessing the endometrium and tubal patency through office hysteroscopy. Hysteroscopy is the gold standard for intracavitary assessment. Though studies have not been performed comparing the surgical gold standard with concurrent head to head data for PS with HyCoSy or HSG (i.e., three concurrent tests for tubal patency), based on available crossover data for PS with surgery the technique has 96% sensitivity and 89% specificity, which seems comparable to, if not better than, HSG and HyCoSy.[13] Of note, accuracy can be further improved by combining hysteroscopic assessment with ultrasound, since ultrasound can assist in identifying the type of pathology distal to the internal tubal ostia.
- Because PS simply requires the addition of a few air bubbles during hysteroscopy to assess tubal patency, there is no additional cost beyond that normal to office diagnostic hysteroscopy.
- Advantages include decreased pain relative to HSG in a crossover trial where 90% of patients expressed strong preference for PS to HSG and 7.5% of patients somewhat preferred the PS technique.[13] In that study, 40% of patients having HSG reported extreme discomfort compared to 0.4% of those undergoing PS testing for an odds ratio of 100 ($P < 0.000001$).

Contraindications

Contraindications are overall similar for an HSG, SIS, HyCoSy, and PS. They are listed in Table 9.1 and include active vaginal bleeding (increased risk for infection and artifacts from menstrual blood), active pelvic infection, known or suspected pregnancy, or known or suspected endometrial cancer.[14] An HSG should not be performed if a contrast allergy has been documented (for more information, see below). All procedures should not be performed if the transvaginal ultrasound is suggestive of a hydrosalpinx (sausage-like structure indicating occluded distal fallopian tube), due to potential peritonitis if infectious material were to egress through the distal fallopian tubes. If a hydrosalpinx is identified during testing, a postprocedural course of antibiotics is reasonable. Similarly, preprocedural treatment with antibiotics for patients at risk for hydrosalpinges should be considered (see section on antibiotic use) and low pressure for uterine distention may reduce the probability of expelling infectious material from a hydrosalpinx.

Informed Consent

- Prior to performing any of the mentioned procedures, informed consent needs to be obtained including signed affirmation from the patient. Important items to discuss are listed in **Table 9.2**. The procedure itself, the indications, risks, benefits, and alternatives should be discussed. Common side effects include cramping, leakage of the contrast material and vaginal spotting. Risks include vasovagal reaction, pelvic infection, bleeding, and uterine perforation.
- In case of an HSG, risks associated with radiation exposure are usually considered low since the maximal average radiation exposure to the gonads is estimated to be 5 mGy.[15] If oil-based contrast media is used for an HSG, granuloma formation and oil embolism can occur.

Table 9.1 Contraindications for HSG, SIS, HyCoSy, and PS

Documented contrast allergy (for HSG only)
Active pelvic infection
Active uterine bleeding
Known or suspected pregnancy
Known or suspected endometrial cancer (for HSG and HyCoSy only, secondary to possibility of disseminating cancer cells)

Table 9.2 Obtaining Informed Consent for HSG, SIS, HyCoSy, and PS

Discuss the procedure step by step, the indication, risks, benefits, and alternatives
Common side effects include:
Uterine cramping
Vaginal spotting
Leakage of contrast post procedure
Shoulder pain (primarily for HyCoSy)
Risks include:
Vasovagal syncope (lightheadedness, hypotension, bradycardia, sweating, nausea)
Pelvic infection
Vaginal or uterine bleeding
Uterine perforation possibly requiring further surgery
Radiation exposure (HSG only)
Granuloma formation and oil embolism (HSG only, if oil-soluble contrast is used)

- For the HyCoSy specifically, the patient may notice shoulder pain caused by the intraperitoneal air that can irritate the diaphragm. This pain usually resolves within 24 hours and is improved when lying down, compared to when sitting or standing up.
- For PS, a 0.4% incidence of vasovagal episodes was observed, which is less than that typically associated with other techniques.[13] Postprocedural discomfort did not occur in a prospective series of 250 patients apart from one patient already having an IBS flare at the time of her hysteroscopy.

Timing

As listed in **Table 9.3**, any of the imaging studies involving catheterization of the uterine cavity should be performed between cycle days 5 and 10. During this time frame, the endometrial lining is thin, the patient has stopped bleeding (thereby minimizing artifacts from blood clots), and the risk for an early undetected pregnancy is low.[16] A urine pregnancy test should be performed when in doubt. If the patient is taking hormonal contraceptives reliably, the procedure can be performed at any time as long as the patient is not on her period.

Table 9.3 Timing for HSG, SIS, HyCoSy, and PS

Cycle day #5–10 (thin endometrial lining, less artifacts from blood clots, low risk for early occult pregnancy)
If patient is on reliable hormonal contraception, any day of the menstrual cycle as long as not bleeding
When in doubt, perform a urine pregnancy test prior to procedure

Antibiotic Use

- Some controversy exists about whether antibiotics should be given.
- After an HSG, Pittaway et al.[17] reported that 1.4% of patients developed pelvic inflammatory disease after the HSG procedure. All of these patients had tubal dilation found during the procedure. This group was also able to show that by treatment with doxycycline, most pelvic infections can be avoided. The American College of Obstetricians and Gynecologists (ACOG) recommends 100 mg of Doxycycline orally twice a day for 5 days if either the patient has a history of pelvic infection, or if hydrosalpinges are noted on the HSG.[18] Some providers choose to give prophylactic antibiotics to every patient undergoing an HSG for fertility evaluation (not for Essure™ confirmation) in the form of a prophylactic dose, such as doxycycline 100 mg orally twice a day for 3 days (starting the day before the procedure), or doxycycline 100 mg orally once a day for 5 days (starting 5 days before the procedure). If a patient is considered at high risk for a pelvic infection, it may be more appropriate to proceed directly to laparoscopy rather than performing an HSG. Risk factors are considered: (1) previous pelvic surgery for an infection, (2) previous pelvic inflammatory disease, (3) adnexal tenderness at the time of HSG procedure, (4) the presence of an adnexal mass, and (5) history of infertility.[19]
- There are no guidelines for the administration of antibiotics for the SIS procedure. Some providers use the same criteria as outlined by ACOG for the HSG procedure (see above). There are no studies assessing the rate of post-SIS pelvic infections.
- No guidelines exist for antibiotic use during the HyCoSy procedure. Some providers choose to give prophylactic antibiotics to every patient undergoing this procedure comparable to the HSG dosage regimens.
- Although no infections have occurred in published literature for PS,[13] subsequent to data submission, the authors had a patient diagnosed with diverticulitis that may have instead been peritonitis. If this truly was peritonitis, the incidence of infection was less than 0.3% for study participants and the only infection in approximately a thousand office hysteroscopies (0.1%).

Required Equipment

Equipment needed tends to be procedurally specific. Because sonography is standard to gynecologic practice and is considered standard of care for procreative testing, ultrasound based approaches may have the lowest initial costs.

Hysterosalpingogram

The HSG is performed in the radiology suite, with the help of a radiology technologist. Either gynecologists or radiologists can perform the procedure. The following needs to be assembled prior to performing an HSG:

- X-ray equipment standard to radiology suites
- Open-sided speculum, preferably plastic (a plastic speculum does not have to be removed for the imaging, whereas a metal speculum will block the view and needs to be removed)
- Large cotton-tip swabs
- Antiseptic (iodine or chlorhexidine gluconate)
- Local anesthetic spray or gel (such as HurriCaine® spray Beutlich Pharmaceuticals, Waukegan IL) offers debatable benefit
- Single-tooth tenaculum
- HSG catheter (such as the Cook® Silicone Balloon HSG catheter set, Cook Medical, Bloomington IN or a rigid metal cannula). The catheter should be flushed prior to placement to avoid air bubbles in the uterine cavity, which can be mistaken for endometrial polyps or fibroids.
- Contrast media (water or oil soluble, see below)
- Silver nitrate

Saline Infusion Sonogram

The SIS is usually performed in the office. The following instruments are needed:

- An ultrasound with a transvaginal transducer
- Open-sided speculum (to facilitate removal of the speculum without dislocating the catheter)
- Antiseptic (iodine or chlorhexidine gluconate if allergic)
- Large cotton-tip swabs
- SIS catheter (standard intrauterine HSG catheter, latex-free urethane H/S Elliptosphere catheter [Ackrad Laboratories, Cranford, NJ], or a more rigid Goldstein sonohysterography catheter which does not contain an inflatable balloon (Cook® Medical, Bloomington IN)
- Sterile saline in a 30-mL syringe that can be attached to the catheter
- Possibly a tenaculum and dilators

- Possibly silver nitrate (in case of bleeding from tenaculum sites)

Hysterosalpingo-Contrast-Sonography

The HyCoSy procedure is usually performed in the office. The following are required:

- An ultrasound with a transvaginal transducer
- Open-sided speculum (to facilitate removal of the speculum without dislocating the catheter)
- Antiseptic (iodine or chlorhexidine gluconate if allergic)
- Large cotton-tip swabs
- SIS catheter (standard intrauterine HSG catheter, latex-free urethane H/S Elliptosphere catheter [Ackrad Laboratories, Cranford, NJ])
- Sterile saline in a 30-mL syringe that can be attached to the catheter
- Possibly a tenaculum and dilators
- Possibly silver nitrate (in case of bleeding from tenaculum sites)

Parryscope

The PS procedure should be performed in the office. Though it can be performed in the operating room, given the degree of pelvic rotation for air bubbles to rise to the ostia required for some uteri (particularly retroflexed or those associated with advanced adhesive disease), this could potentially result in a paralyzed patient sliding off of an operating room table. Accordingly, the office is preferred. The following are required:

- A flexible ~2.5-mm office hysteroscope. Flexible is preferred to rigid as it decreases discomfort from axis issues when the bladder is emptied so as to anteflex the uterus allowing air bubbles to rise to the ostia. Though hysteroscopes larger than 2.5 mm can be used, these may stretch the nulliparous cervix and increase discomfort. Conversely, for the patulous cervix, a 3.5-mm hysteroscope may be advantageous. Flexible 2.5-mm urologic cystoscopes can also be used, but their length makes the more procedure more awkward, and their axis of flexion may increase discomfort.
- A speculum, though this may be unnecessary if using a vaginoscopic approach
- Antiseptic (iodine or chlorhexidine gluconate if allergic) if a speculum is used
- Large cotton-tip swabs if a speculum is used
- An ultrasound with transvaginal transducer is not required, but can further improve evaluation
- Sterile saline in a 500-mL or 1-L bag and IV tubing with a drip chamber (far less fluid is needed and syringe approaches can be used, but these are less ideal due to surges of pressure that can induce discomfort, causing uterine spasm around the tubes)
- Tenaculum and local analgesia are not needed

Positioning

- Positioning of the patient is usually in the dorsal lithotomy position with the feet in examination table stirrups, comparable to a transvaginal ultrasound or pelvic examination.
- For the HSG, the patient is asked to lie on her back on the examination table, with the feet positioned on the edge of the table.
- For PS, an empty bladder is useful for having air bubbles rise to the ostia. Raising the back of the examination table may be useful for retroflexed uteri. Though most patients only need to subtly roll their hips if at all, letting them know that this may be necessary if air bubbles naturally only go to one side may be useful preparation.

Approach

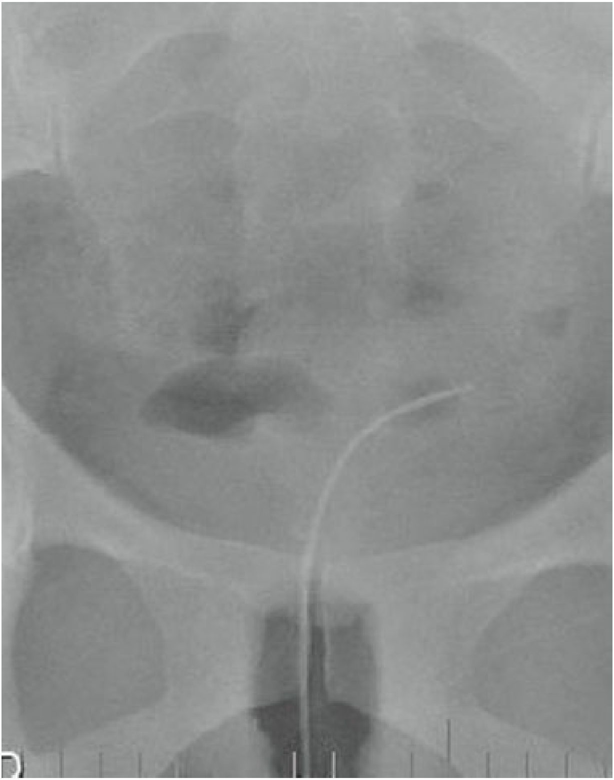
- No anesthesia is necessary.

Hysterosalpingogram

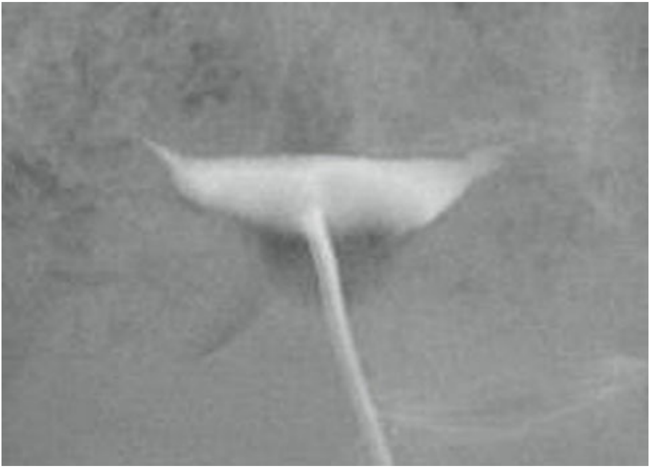
With the exception of a few details, performing the HSG is similar for both the documentation of tubal patency and tubal occlusion.

Hysterosalpingogram for documentation of tubal patency

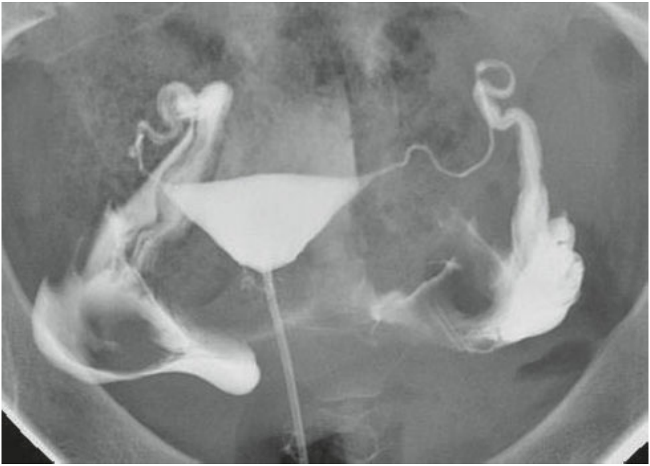
The open-sided speculum is placed in the vagina and the cervix is cleansed with the antiseptic. Local anesthetic spray or gel can be used to minimize discomfort, but can initially sting and the patient may notice a “fruity” taste in her mouth. One study suggested that local anesthetic spray did not change the pain score with the procedure or hasten the resolution of the pain post procedure.[20] The tenaculum is gently placed on the cervix while the patient coughs to distract the patient and minimize discomfort. It should only be closed to the first ratchet instead to possibly decrease discomfort. The flushed catheter is then placed through the cervix, with the outer sheath used as a guide if needed. If a rigid metal cannula is used, it is placed in the cervix and can be locked onto the tenaculum. Pain has been shown to be less with a plastic catheter and balloon compared to the metal cannula.[21] Once the catheter or cannula is in place, the speculum is removed (in case of a metal speculum) and a scout film taken to ensure correct positioning of the pelvic structures (**Tech Fig. 9.1**)—HSG, scout. It is important to put gentle traction on the tenaculum to “straighten” the uterus in order to obtain good pictures of its contour. Contrast is then injected slowly to minimize discomfort associated with uterine distention (**Tech Fig. 9.2**)—HSG, early fill of the uterus. If the contrast media returns from the cervix, the balloon needs to be inflated to create a seal. Usually 5 to 10 mL of contrast are injected, and fill of the fallopian tubes and spill of the contrast into the pelvic cavity can be seen relatively quickly (**Tech Fig. 9.3**)—HSG with complete fill of uterus and tubes with full dispersion of contrast. After fill and spill are noted, the patient will often briefly roll to her side for a view of the uterus and tubes in a different axis, which can sometimes identify previously unvisualized pathology.



Tech Figure 9.1. HSG scout film to ensure correct positioning of the pelvic structures.



Tech Figure 9.2. HSG with early filling of the uterus.



Tech Figure 9.3. HSG with complete fill of uterus and tubes with full dispersion of contrast.

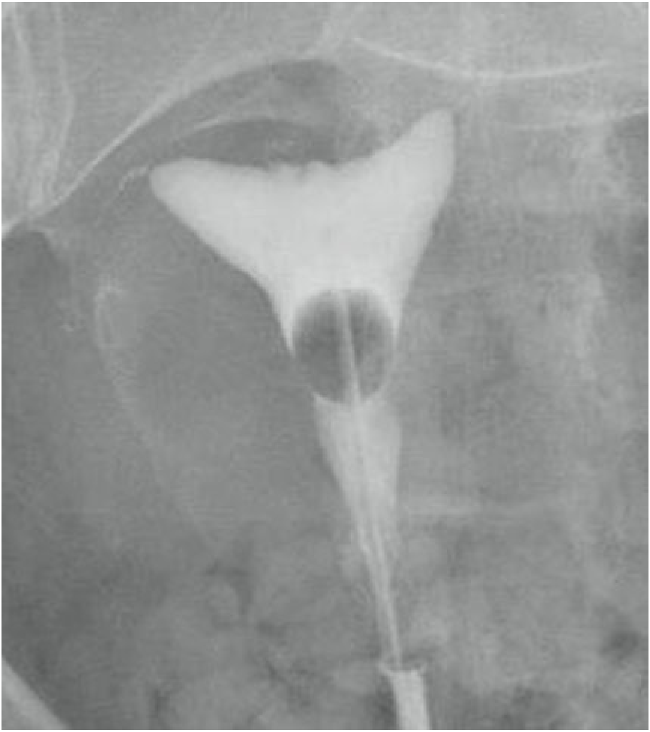
Once all required pictures are taken, all instruments are removed from the cervix. Bleeding from the tenaculum sites can be treated with silver nitrate or pressure with a cotton tip applicator. Many practitioners like to take a final picture after all instruments have been removed from the patient to judge adequate dispersion of the contrast suggesting the absence of pelvic adhesions.

Normal and abnormal findings

Tech Figs. 9.1 to **9.3** show a normal HSG at different stages of the procedure.

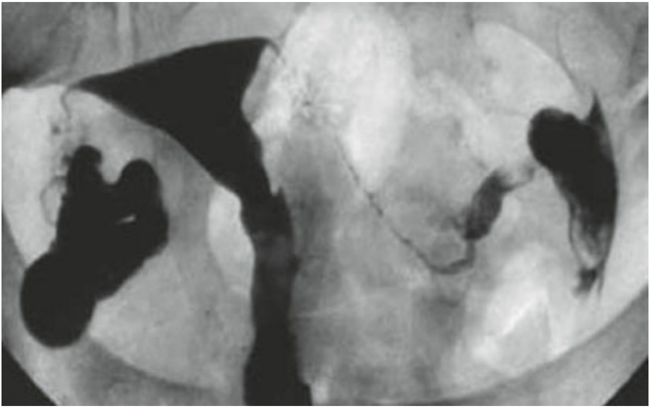
Tubal abnormalities

Proximal tubal obstruction can be either unilateral (**Tech Fig. 9.4**) – HSG, PTO unilateral – or bilateral. It can be either caused by tubal spasm (or more precisely, spasm of the uterus around the fallopian tube) or true tubal obstruction. Tubal spasm is usually caused by overdistention of the uterine cavity. It can be avoided by slowly injecting the contrast material and by using 600 mg of ibuprofen orally 30 minutes prior to the procedure. If the provider were to repeat an HSG at another time, in 60% of cases the repeat HSG would be normal.[22] This is in contrast to true proximal obstruction, which would still be present on a repeat HSG.



Tech Figure 9.4. HSG with proximal unilateral left tubal occlusion.

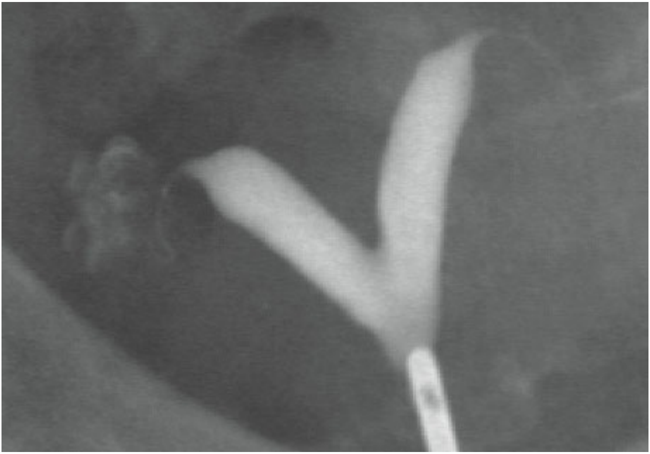
Distal tubal obstruction and hydrosalpinx are usually caused by intraperitoneal adhesions, either from previous pelvic surgery or infection (pelvic inflammatory disease, intra-abdominal infections). Distal obstruction can be mild and sometimes can be removed by flushing of the tubes. Pelvic adhesions may allow normal fill and spill of contrast from the fallopian tubes, but can cause loculation of the contrast, rather than free dispersion throughout the pelvis. A hydrosalpinx is pictured in **Tech Figure 9.5**.



Tech Figure 9.5. Collection of contrast distending the right tubal diameter with no free spill of contrast into the abdominal cavity.

Uterine anomalies

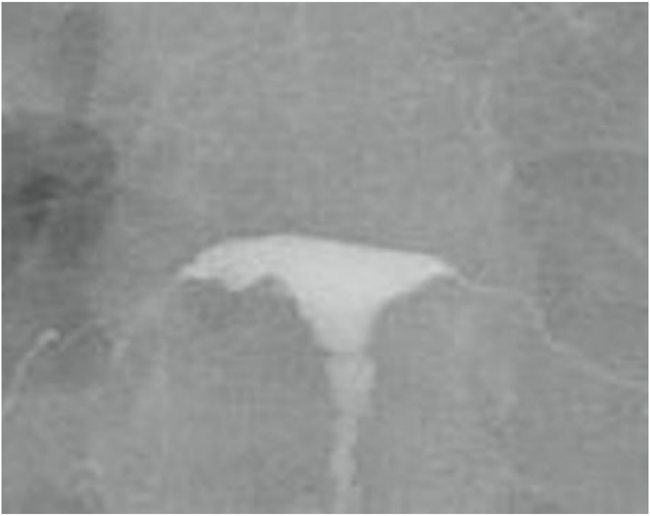
The HSG visualizes the interior shape of the uterine cavity in addition to the fallopian tubes. The most common congenital uterine anomaly is a septate uterus (**Tech Fig. 9.6**)—HSG, uterine septum. Differentiation between an arcuate or septate versus a bicornuate uterus can be difficult to differentiate by HSG (**Tech Fig. 9.7**)—HSG, arcuate uterus. The outer fundal contour, however, can be visualized using the push–pull technique.[23] Moving the attached tenaculum after spillage of contrast into the pelvic cavity has occurred will disperse the contrast around the uterus and help image the external fundal contour.



Tech Figure 9.6. HSG, septate uterus: The uterine septum forms from a failure of reabsorption of the dividing membrane (septum) during embryogenesis.

Tech Figure 9.7. HSG: Arcuate uterus.

Acquired uterine anomalies include endometrial polyps, fibroids, and/or uterine synechiae. They usually present as a filling defect on the HSG (**Tech Fig. 9.8**)—HSG, uterine filling defect). It is important to prime the HSG catheter prior to placement, so that air bubbles in the catheter are not mistaken for intrauterine filling defects. Air bubbles usually change location on subsequent radiographic images, whereas polyps, fibroids, or synechiae remain in the same location. Extravasation of contrast can occur if the intrauterine pressure is too high, and appear as a venogram. The extravasated contrast will be reabsorbed and no additional measures have to be taken.



Tech Figure 9.8. HSG: Uterine filling defect in right cornua. Pathology consistent with endometrial polyp.

Hysterosalpingogram to document tubal occlusion (Essure™ confirmation test)

A detailed description of how to perform an Essure™ confirmation test (ECT) properly can be found at www.accessdata.fda.gov/cdrh_docs/pdf2/P020014c.pdf.

The following goals need to be achieved:

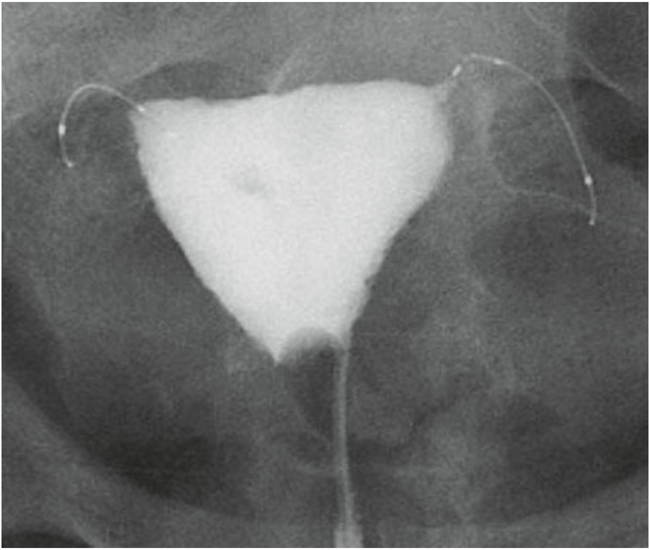
1. The silhouette of the uterine cavity needs to be seen clearly with good filling of the cornua
2. The fluoroscopy beam should be as close to the anterior/posterior projection as possible in regards to the uterus
3. Maintenance of a good cervical seal throughout the procedure is important to ensure good

uterine distention. Accordingly, do not dilate the cervix more than necessary

4. Downward traction with the tenaculum may be needed to obtain ideal images, but the speculum should be removed prior to fluoroscopy to assure best possible visualization of the uterus

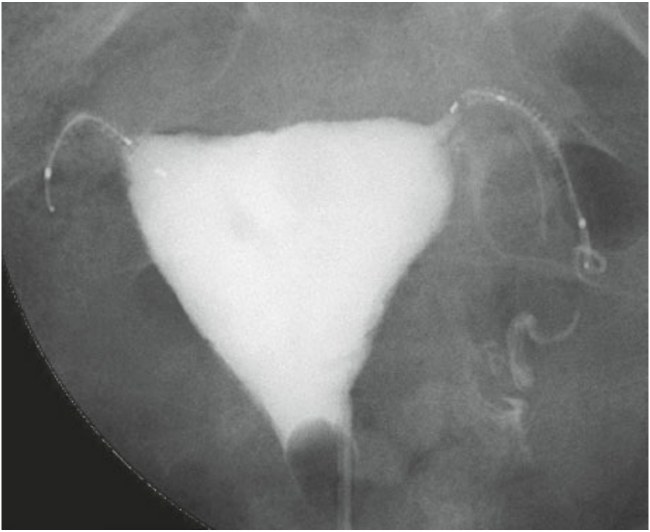
A minimum of six still radiographs should be taken to assess the location of the inserts as well as bilateral tubal occlusion:

1. Radiograph 1: scout film (prior to infusion of the contrast; microinserts should be visualized clearly)
2. Radiograph 2: minimal fill of the uterine cavity (demonstrate adequate seal)
3. Radiograph 3: partial fill of the uterine cavity (uterine cavity should be nearly filled with contrast
4. Radiograph 4: Total fill of the uterine cavity (completely filled to the patient's tolerance or maximum distention of the cornual region, whichever comes first) **Tech Fig. 9.9**—HSG, Essure™, filled cavity
5. Radiograph 5: magnification of the right uterine cornua
6. Radiograph 6: magnification of the left uterine cornua



Tech Figure 9.9. HSG: Essure™ confirmation test with filled uterine cavity.

The ECT HSG should be performed 3 months after the placement of the microinserts. Even with acceptable microinsert placement, initial tubal patency rates have been reported as high as 16.1% and 5.8% at an average of 103 and 192 days after placement[24] (**Tech Fig. 9.10**—Essure™, Patent). Incorrect placement of the inserts often leads to absent occlusion. Tubal patency can result either with faulty placement of the inserts in the cavity (expelled into the uterine cavity) or protruding outside of the cavity.



Tech Figure 9.10. HSG: Essure™ confirmation test demonstrating microinsert placement with distal tubal patency.

Different contrast media

Water-soluble versus oil-based

Water-soluble contrast media is most widely used today. Examples include iothalamate meglumine 30% or 60%. Water-soluble contrast media dissipates quicker than oil-based media, and results in better images with finer details. Oil-soluble contrast media such as Ethiodol® (ethiodized oil) requires delayed films after 1 to 24 hours, and can cause granuloma formation and oil embolism. The manufacturing of Ethiodol® was discontinued in the United States in 2010. In January 2014, a new product called Lipiodol® (ethyl esters of iodized fatty acids of poppy seed oil) was temporarily FDA approved until Ethiodol® will be available again. The use of Ethiodol® has been shown to decrease the post-procedure time to conception interval compared to water-soluble contrast.[25] Another study indicated a possible fertility enhancing effect of unknown origin in unexplained and endometriosis-related infertility with the use of Lipiodol®.[26] Johnson et al.[1] were able to show that the use of oil-based contrast can decrease the adherence of macrophages to the tubal epithelium and thereby increase fertility in patients with unexplained infertility.

Iodine allergy and iodinated contrast

An allergy to iodine is not the same as an allergy to iodinated contrast media. "Iodine allergy" usually refers to an individual being allergic to shellfish or topical iodine solutions. That does not mean that the same individual is also allergic to iodinated contrast. "Non-ionic" contrast is not necessarily not iodinated. It has a lower osmolality than ionic contrast, and consequently a lower risk for an allergic reaction.[27] As per the American College of Radiologists (ACR), a known prior allergic or idiosyncratic reaction to iodinated contrast is a relative contraindication to the procedure.[28] Premedication may be required in the form of prednisone 50 mg orally 13 hours, 7 hours, and 1 hour prior to the procedure and diphenhydramine 50 mg orally 1 hour prior to the procedure.[29] In contrast, the provider may choose to use a different contrast media.

Gadolinium-based contrast (Magnevist) can be used as media if the patient is truly allergic to regular contrast medium.[30] The pictures with Gadolinium have less contrast opacification and therefore are usually not as distinct compared to iodine-based medium.

Saline infusion sonogram

The speculum is placed in the vagina and the cervix is visualized and cleansed with an antiseptic. The SIS catheter is then placed through the cervix. If resistance is met, placing a tenaculum on the cervix and possibly using cervical dilators can help to place the catheter. The speculum is then removed without dislodging the catheter, and the transvaginal ultrasound probe is placed. The slow injection of sterile saline through the syringe separates the anterior and posterior uterine walls. The uterus is scanned in the transverse and longitudinal plane, with the possibility of taking 3D pictures of the uterine cavity as well.

Normal and abnormal findings

Tech Figure 9.11 shows a normal SIS. **Tech Figure 9.12** demonstrates an endometrial polyp. **Tech Figure 9.13** depicts a submucous leiomyoma distorting the endometrial cavity.

Tech Figure 9.11. Saline infusion sonogram with no intracavitary filling defects.

Tech Figure 9.12. Saline infusion sonogram: Endometrial polyp visible as intracavitary filling defect.

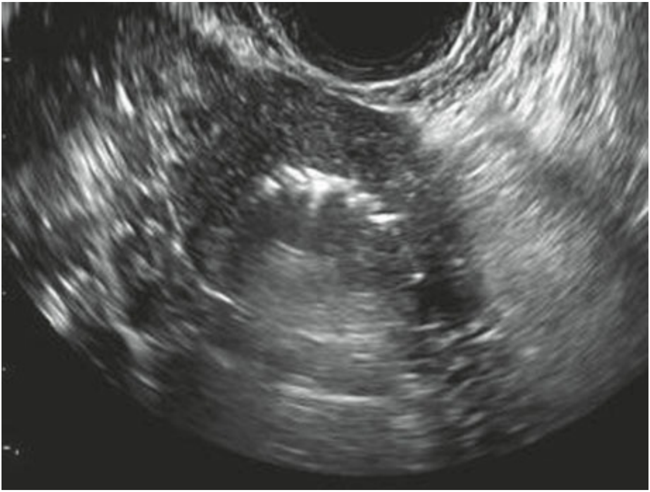
Tech Figure 9.13. Saline infusion sonogram: Submucosal fibroid visible as intracavitary filling defect.

Hysterosalpingo-contrast-sonography

After performing a SIS procedure, the intrauterine balloon is inflated with 3 mL of fluid or air to avoid leakage of air through the vagina. A 20-mL syringe filled half with air and half with sterile saline is connected to the catheter and intermittently tilted to alternatingly infuse small increments of saline and air.[31] Another option is to vigorously shake the syringe filled with air and fluid immediately prior to the injection.[32] In addition to that, a commercial device that mixes the air and saline prior to the infusion is available. The mixture of air and saline can be seen as “scintillations” travelling from the uterus to the distal tubal fimbriae and ovary,[33] and can be documented by taking a short video of the scintillations.

Normal and abnormal findings

A normal HyCoSy is shown in **Tech Figure 9.14** and **Video 9.1A,B**, with scintillations visible in the proximal interstitial portions of both fallopian tubes, the distal fimbriae, and around the ovaries. The absence of any detectable scintillations may represent either true obstruction (secondary to adhesions, uterine fibroids or the presence of large adnexal masses) or spasm in the proximal interstitial tube. Potential false positive tubal patency can occur with (1) the presence of a tubal fistula or (2) missing a distal occlusion if echogenic scintillations are seen in the tube but not over the adjacent ovary.



Tech Figure 9.14. Hysterosalpingo-contrast-sonography. Scintillations visible in the uterus and in the proximal portions of both tubes.

Parryscope technique

The speculum is placed in the vagina and the cervix is visualized and cleansed with an antiseptic. Alternatively, a vaginoscopic approach can be performed. The flexible 2.5-mm hysteroscope is then advanced through the cervix while adjusting to the path of the lumen. Cervical abrasion occurring in spite of visualization makes one appreciate how much cervical trauma can occur with blind placement of catheters, particularly in the undilated nulliparous cervix, which can have a serpentine path. Both cervical dilation and abrasion can cause discomfort and contribute to spasm falsely suggesting tubal occlusion. The rate of saline inflow is usually gauged prior to hysteroscope placement and will project approximately 2 cm beyond a 2.5-mm hysteroscope, though this can be increased for a patulous cervix or decreased if there is anticipated cervical stenosis and/or bilateral tubal occlusion. Overdistention can also contribute to spasm falsely suggesting occlusion, so care should be made to decrease the rate of flow if overdistention is observed or the patient appears uncomfortable. A pressure bag can be used, but excessive flow rates should be avoided.

Upon visualization of the uterine cavity, adequate time is allowed for blood or mucus to disperse if present, as well as to fully inspect the cavity. One advantage of a narrow caliber hysteroscope is that this improves outflow in these settings, which is particularly important if tubal occlusion is present, as then mucus and blood can only egress through the cervix. The other importance of adding at least 5 to 10 seconds of uterine assessment prior to evaluating tubal patency is that this allows pressure equilibration. This matters because if a hydrosalpinx is present, allowing a distally occluded fallopian tube to fully distend before adding air bubbles will eliminate a pressure gradient that would promote air bubble entry past the internal os. (This is a potential weakness to sonosalpingography using a syringe-based approach, particularly during the learning curve, as surges in intratubal pressure can cause briefly visualized tubal air entry. Experience and subsequent confirmation of air around the ovary can offset this potential issue for accuracy.)

When adding air bubbles, a syringe can be used, but it is easier for an assistant to invert the drip chamber allowing ¼ mL of air to enter the line. This translates to an approximately 4-cm column in the line and the duration of inversion depends on the flow rate. The air bubbles are observed as they disperse through the ostia. If only unilateral distribution is observed, the patient is encouraged to roll her hips such that air bubbles gravitate to the contralateral side. In the setting of tubal occlusion, typically 30 to 40 seconds of observation are performed with the air bubbles adjacent to the ostia so as to distinguish true occlusion from spasm. (Beyond gentle technique reducing spasm, this is a potential advantage over sonosalpingography, as a brief relaxation of the ostia can allow clear visualization of patency, relative to the need for a more prolonged scintillation when one might not be sure one is in the proper axis.) A reusable three-way splitter between the IV tubing and the hysteroscope can be opened if there is bilateral tubal occlusion and cervical stenosis, which will reduce rates of flow. By opening the splitter and closing it just as the air bubbles reach the hysteroscope, this can allow air bubbles to rapidly advance along the IV tubing in the setting of otherwise slow rates of flow.

Although the PS technique can be performed accurately without ultrasound, adding ultrasound has several advantages. These include antral follicle count for ovarian reserve, identification of uterine pathology not impinging on the uterine cavity, and the identification of loculations and hydrosalpinges before or after hysteroscopy. Ultrasound can also enhance appreciation for hysteroscopy when one hysteroscopically identifies polyps (particularly cornual) that are not clearly seen on ultrasound in spite of saline remaining in the cavity after hysteroscopy (SIS-like conditions).

Normal and abnormal findings

Video 9.2 is of a normal hysteroscopy with bilateral tubal patency with the PS technique. It documents identified polyps previously missed on HSG and ultrasound.

Video 9.3 demonstrates unilateral tubal occlusion with the PS technique. Subsequent laparoscopy showed a left hydrosalpinx.

PEARLS FOR PERFORMING AN HSG	
Patient discomfort	○ Use NSAIDs such as Ibuprofen 600 mg or Diclofenac 50 mg, both orally, 60 minutes prior to the procedure[34] ○ Only inflate balloon if necessary to create seal around cervix ○ Use contrast medium at body temperature (37°C)[35]
Patient is s/p Essure™ placement	○ No contraindication to magnetic resonance imaging (MRI)[36]
Vasovagal reaction (sweating, dizziness, hypotension, bradycardia)	○ Occurs in less than 5% of patients[37] and usually resolves if patient stays supine ○ Decreased risk with contrast media at body temperature (37°C)[35]
PITFALLS WHEN PERFORMING AN HSG	
Proximal tubal obstruction caused by tubal spasm	✗ Use NSAIDs such as Ibuprofen 600 mg or Diclofenac 50 mg, both orally, 60 minutes prior to the procedure[34] ✗ Give glucagon prior to procedure[38] ✗ Only inflate balloon if necessary to create seal around cervix; use of media at body temperature
Lower uterine segment is obscured by balloon and cannot be evaluated	✗ Use balloon only if necessary to create seal around cervix, use only after imaging of lower uterine segment has been obtained
Air bubbles mimic intrauterine filling defects	✗ Prime catheter with contrast to clear any air bubbles in the catheter
PEARLS FOR PERFORMING AN SIS	
Cramping/discomfort	○ Use NSAIDs such as Ibuprofen 600 mg or Diclofenac 50 mg, both orally, 60 minutes prior to the procedure[34] ○ Only inflate balloon if necessary to create seal around cervix; medium at body temperature
Unable to pass catheter through cervix	○ Repeat procedure after patient has taken 400 µg of misoprostol orally 12 hours prior to the procedure

PITFALLS WHEN PERFORMING AN SIS	
Lower uterine segment is obscured by balloon and cannot be evaluated	✖ Use balloon only if necessary to create seal around cervix, use only after imaging of lower uterine segment has been obtained
PEARLS FOR PERFORMING A HyCoSy	
No scintillations can be seen on one side	○ Ask patient to roll on the opposite site to position the tube in question superiorly
PITFALLS WHEN PERFORMING A HyCoSy	
Proximal tubal obstruction caused by tubal spasm	✖ Use NSAIDs such as Ibuprofen 600 mg or Diclofenac 50 mg, both orally, 60 minutes prior to the procedure[34] ✖ Use medium at body temperature[39]
Obesity (BMI greater than 30 kg/m^2)	✖ Scintillations may be difficult to see[32]; HSG is better option
Use of a Goldstein catheter (no balloon)	✖ Use a different catheter with balloon in order to create seal around cervix to prevent air from escaping
PEARLS FOR PERFORMING PS	
Patient discomfort	○ In general, do not dilate the cervix or overdistend the uterus. Discomfort is greatest in patients with bilateral tubal occlusion and cervical stenosis (who typically have discomfort with any approach). Minimizing inflow, counseling prior to procedure, and use of a three-way splitter to advance air bubbles can help

Origin or location of occlusion	✖ Identifying occlusion does not address the type of pathology distal to the inner tubal ostia (e.g., intraluminal obliteration versus fimbrial agglutination); however, sequential use of ultrasound can overcome this limitation
Proximal tubal obstruction caused by uterine spasm	✖ Spasm is reduced through gentle technique. Observation of air bubbles adjacent to the ostia for 30 to 40 seconds can help distinguish spasm from occlusion
Obesity (BMI greater than 30 kg/m^2)	✖ Findings suggest slightly higher rates of occlusion with an elevated BMI.
Retroflexed uteri	✖ Elevating the back of the examination table and greater rotation of the hips can help overcome this setting, which predisposes air bubbles to egress through the cervix

POSTOPERATIVE CARE

- The patient can go home immediately after the procedure as long as she is feeling well. Occasionally a mild vasovagal reaction can occur with the patient complaining of lightheadedness. In this case, the patient is asked to rest, remain supine, and sit up slowly.
- Instructions should be given to the patient to contact her provider if she experiences worsening abdominal pain, abnormal discharge, fever, malaise, heavy bleeding, or any other concerns.

OUTCOMES

- Normal and abnormal findings are discussed during the above description of the procedures.
- All patients should be counseled that patency cannot guarantee that fallopian tubes are functional. Conversely, "occlusion" can result from spasm or microscopic patency (which HyCoSy and PS are more prone to miss than HSG). Consequently, findings with screening tests are sometimes incorrect and are not definitive for future fecundity.

COMPLICATIONS

- Potential complications are similar for HSG, SIS, HyCoSy, and PS, though they may differ in the degree of risk. Side effects include cramping and spotting as well as leakage of contrast media from the vagina. Patients seem to be bothered less by saline relative to the leakage of other solutions. Complications include vasovagal syncope, pelvic infection, and potential uterine perforation with possible damage to adjacent structures. Specifically for an HSG, additional complications could include an allergic reaction to contrast. Embolic phenomena can occur with all techniques. PS is intended to have low pressure which should reduce this risk. PS also infuses markedly less air compared to the HyCoSy procedure.

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10

Assessment of the Endometrial Lining and Evacuation of the Uterus

Miriam S. Krause, Steven T. Nakajima

GENERAL PRINCIPLES

Definition

- During an endometrial biopsy, a small sample of the uterine lining is obtained in the office setting.
- A manual vacuum aspiration (MVA) facilitates removal of gestational tissue (products of conception) from the uterus with the help of a handheld syringe to create suction, and a flexible plastic cannula (**Fig. 10.1**). The MVA is considered safe to be performed in the outpatient setting.[1]

Indications

- These two procedures have distinct indications, as listed in the following section: Preoperative Planning.

Anatomic Considerations

- It is helpful to know whether the uterus is ante- or retroverted. This can be determined by a bimanual exam or via transvaginal ultrasound exam.
- Cervical dilation is more likely to be necessary in a nulliparous patient compared to a multiparous patient.
- Patients unable to tolerate either of these two procedures in the office would proceed to a formal evaluation via dilation and curettage (D&C) under general anesthesia in the operating room.

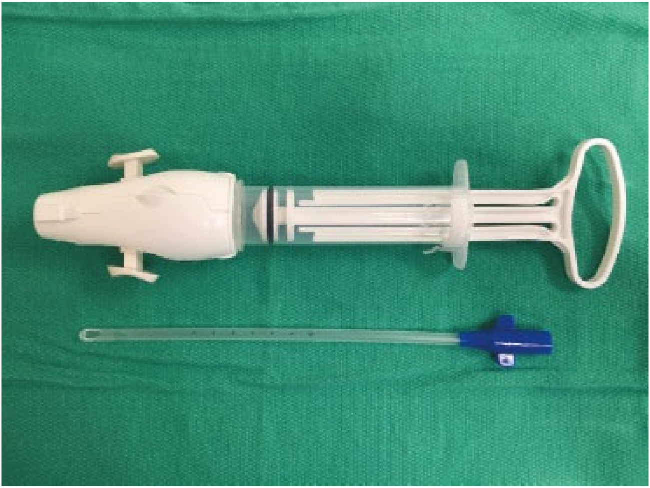


Figure 10.1. Manual vacuum aspiration (MVA) syringe (*above*) with flexible suction cannula (*below*).

IMAGING AND OTHER DIAGNOSTICS

- Radiologic studies are usually not necessary in order to perform the described procedures. If a patient has cervical stenosis, performing a transabdominal ultrasound with a full bladder may help to prevent uterine perforation.
- Transvaginal ultrasound is usually performed prior to an MVA to assess the gestational age and status of an intrauterine pregnancy.

PREOPERATIVE PLANNING

Indications

- An endometrial biopsy can be performed for several reasons:
  1. In patients with chronic anovulation and abnormal uterine bleeding, and in patients with postmenopausal bleeding, an endometrial biopsy can help diagnose either endometrial hyperplasia or endometrial cancer.
  2. In patients with recurrent implantation failure, endometrial “scoring” or “scratching” in anticipation of either a fresh or frozen embryo transfer can increase the success for implantation.[2]
  3. In patients undergoing assisted reproductive techniques, an endometrial sample can help determine the personal window of implantation and whether the patient’s endometrium is “in sync” with the embryo development.[3,4]
  4. In patients with recurrent pregnancy loss, an endometrial biopsy can be used to assess for chronic inflammation, such as chronic endometritis, and the possible need to treat with an antibiotic.
- An endometrial biopsy is no longer performed to determine whether ovulation has occurred, since there are better ways to assess ovulation.
- Indications for performing an MVA include a missed or incomplete abortion. An MVA can also be performed if an office endometrial biopsy does not yield any tissue.

Contraindications

- The only two contraindications for an endometrial biopsy are listed in **Table 10.1**. These include suspected or known pregnancy as well as active pelvic infection. Pregnancy needs to be ruled out prior to performing an endometrial biopsy, especially in patients presenting with chronic anovulation. When in doubt, an in office urine pregnancy test should be performed the same day. Although it is not necessary to screen for infection, if the patient reports symptoms such as increased vaginal discharge and pain, or signs such as cervical motion tenderness, the endometrial biopsy should be rescheduled after infection has been ruled out or treated.

Table 10.1 Contraindications for Endometrial Biopsy and Manual Vacuum Aspiration

Known or suspected intact intrauterine pregnancy
Active pelvic infection

Contraindications for an MVA include a known or suspected intact intrauterine desired pregnancy. An MVA should be performed with caution in the following cases: uterine anomalies, coagulation problems, active pelvic infection, extreme anxiety of the patient, or any condition that could cause the patient to become medically unstable. If there is concern for an ectopic gestation, further testing needs to be performed.

Timing

- An endometrial biopsy can be performed any time of the menstrual cycle as long as pregnancy has been ruled out. If a patient is bleeding heavily, the procedure is less likely to provide an adequate tissue sample and therefore should be rescheduled.
- An MVA is usually performed during the first trimester of pregnancy up to 12 weeks gestational age.

Informed Consent

- Prior to performing an endometrial biopsy or an MVA, the physician needs to obtain written informed consent from the patient, as detailed in **Table 10.2**. This includes discussing the indication for the procedure; how the procedure is performed; and what the risks, benefits, and alternatives are. Side effects of both procedures include cramping and spotting. Risks include vasovagal syncope, pelvic infection, and uterine perforation possibly with damage to adjacent structures such as blood vessels or bladder, in the worst case necessitating surgery. This risk is low (less than 1%), but should be mentioned regardless. For an MVA, an additional risk is incomplete removal of all pregnancy tissue, which may necessitate repeat MVA or a suction D&C in the operating room.

Table 10.2 Obtaining Informed Consent for Endometrial Biopsy and Manual Vacuum Aspiration

Discuss the procedure step by step, the indication, risks, benefits, and alternatives
Common side effects include: Uterine cramping Vaginal spotting
Risks include: Vasovagal syncope (lightheadedness, hypotension, bradycardia, sweating, nausea) Pelvic infection Vaginal or uterine bleeding Uterine perforation possibly requiring further surgery Incomplete removal of pregnancy tissue (for MVA only)

Antibiotics

- Antibiotics are usually not indicated for an endometrial biopsy.[5] If the postprocedure pathology report mentions acute or chronic endometritis, appropriate antibiotics should be prescribed.
- There are no clear recommendations for the administration of antibiotics for an MVA, but the American College of Obstetricians and Gynecologists (ACOG) recommends considering antibiotic prophylaxis for the surgical treatment of a missed or incomplete abortion.[5] Two possible antibiotic regimens include doxycycline 100 mg orally prior to the procedure followed by 200 mg orally after the procedure, or metronidazole 500 mg orally twice daily for 5 days following the procedure.

Pain Management

- Usually no pain medications are necessary for performing an endometrial biopsy. If the patient complains of cramping after the endometrial biopsy, she can take oral ibuprofen (such as 600 mg orally single dose).
- The World Health Organization (WHO) recommends all patients to receive pain medications prior to an MVA.[1] The most common regimen includes a paracervical block with local anesthetic (described in detail later) and a nonsteroidal anti-inflammatory drug (such as ibuprofen 800 mg orally every 8 hours) post procedure. Another regimen includes ketorolac 20 mg orally 1 hour prior to the procedure in combination with a paracervical block, and nonsteroidal anti-inflammatory drugs or acetaminophen post procedure.

Required Equipment

Endometrial Biopsy

The following should be assembled prior to performing an endometrial biopsy:

- Speculum
- Antiseptic (usually iodine; use chlorhexidine gluconate, also known as Hibiclens® [Mölnlycke Health Care, Norcross, GA] if the patient is allergic to iodine)
- An endometrial biopsy device (such as Pipelle® [Cooper Surgical, Inc., Trumbull, CT], Miltex endometrial sampling set [Miltex, York, PA])
- Lidocaine or benzocaine spray or gel (such as HurriCaine® spray, [Beutlich Pharmaceuticals, Waukegan, IL], as long as patient is not allergic)
- Tenaculum
- Large cotton swabs
- Possibly silver nitrate sticks (to stop any bleeding from tenaculum sites)
- Possibly cervical dilators

Different devices are available to perform endometrial biopsies, such as the Pipelle® or Miltex biopsy system. For use in reproductive endocrinology and infertility, the device often used is the Pipelle®. It is a flexible plastic tube with a side opening at the tip and a smaller tube (internal piston) inside the Pipelle® that is withdrawn to create suction.

Manual Vacuum Aspiration

The following equipment is required in order to perform a MVA:

- Speculum
- Antiseptic (usually iodine; use chlorhexidine gluconate, Hibiclens®, [Mölnlycke Health Care, Norcross, GA], if the patient is allergic to iodine)
- Metal cup or kidney bowl (to collect aspirated material)
- Lidocaine 0.5% with or without epinephrine (provider preference)
- Hypodermic needles (18 G to draw up lidocaine, 23 G to inject)
- 10- or 20-mL syringes
- An MVA system (such as the Ipas MVA Plus™ Aspirator [Ipas, Chapel Hill, NC], which is reusable, or the Ipas Double-valve/DVS Aspirator, which is for single use)
- An Ipas EasyGrip® aspiration cannula in appropriate size (the appropriate size in mm diameter roughly equals the weeks of gestation)
- Lidocaine or benzocaine spray or gel (such as HurriCaine® spray, [Beutlich Pharmaceuticals,

Waukegan, IL], as long as patient is not allergic)

- Tenaculum
- Large cotton swabs
- Possibly silver nitrate sticks (to stop any bleeding from tenaculum sites)
- Possibly dilators

SURGICAL MANAGEMENT

Positioning

- The patient is positioned in the dorsal lithotomy position with the feet in the exam table stirrups.

Approach

- A bimanual pelvic exam should be performed to determine the position of the uterus (ante- versus retroverted).

Endometrial Biopsy

- The speculum is inserted in the vagina and the cervix visualized. If that is difficult, sometimes a different size speculum may be needed. Sometimes it also helps to move the patient a little further down on the table.
- The cervix is disinfected, usually with two to three different swabs. Local anesthetic can be applied to the cervix.
- The endometrial biopsy device is placed through the cervix. The normal uterine length is about 6 to 7 cm, usually more in multiparous patients. Depending on the curve of the cervix, the catheter can be slightly bent for easier passage. In many cases placement of a tenaculum is necessary to straighten out the uterus and advance the device through the cervix. The tenaculum can be placed on the cervix while the patient is asked to cough (to distract the patient and potentially decrease the amount of discomfort). The tenaculum should only be locked in the first ratchet.
- With the tenaculum in place and used for some traction, usually it is easy to advance the Pipelle® until resistance is felt at the fundus. If the Pipelle® meets resistance within the first couple of centimeters, the internal cervical os needs to be dilated with a set of dilators.
- Once the Pipelle® has been advanced to the fundus, 2 to 3 passes from different portions of the uterine cavity should be obtained. The Pipelle® should be turned and used in a "scratching" fashion. After completing the endometrial biopsy, check for the presence of an adequate amount of endometrial tissue. Often women who are menstruating or have endometrial fluid in the uterine cavity can fill the Pipelle® with blood and/or fluid and minimal endometrial tissue is obtained.
- The sample is placed in formalin and sent to the lab.

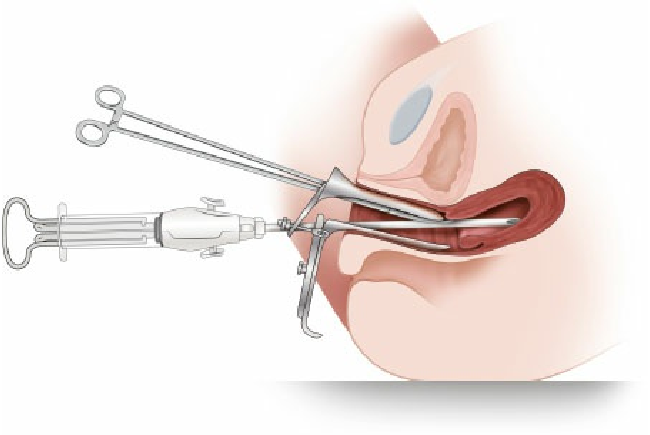
Manual Vacuum Aspiration

- The procedure should be performed per manufacturer's instructions.[6] The aspiration system also needs to be assembled per manufacturer's instructions prior to starting the procedure, including checking the vacuum retention and selecting the correct cannula size.[6]
- The bivalve speculum is placed in the vagina and the cervix cleansed with an antiseptic.
- Paracervical block is performed with a total of 10 to 20 mL of 0.5% lidocaine solution (maximum 4 mg/kg body weight) with or without epinephrine, per practitioner preference. One technique includes 1 to 2 mL of lidocaine injected into the cervix at the presumed tenaculum site, usually at 12 o'clock. The tenaculum is placed and the cervix moved slightly to define the transition of the cervix to the vaginal tissue. Two to 5 mL of lidocaine is then injected at both the 4 and 8 o'clock position at the transition zone to a depth of 1 to 1.5 in. To avoid intravascular injection, one should aspirate prior to injecting the local anesthetic.
- The cervix is dilated as needed.
- The flexible suction cannula is passed through the cervix to the fundus of the uterus, and the assembled syringe for suction is attached.
- The valves on the MVA aspiration syringe are closed (buttons pressed forward and downward). Once the valves are closed, the piston of the MVA aspiration syringe is pulled back, which "charges" the syringe. Valves are released after the syringe is "charged" establishing vacuum to the uterine cavity (**Tech Fig. 10.1**).

Tech Figure 10.1. MVA syringe with the valves in the open "released" position.

- The cannula and aspirator are operated with one hand, while the other hand applies gentle traction to the attached tenaculum. Suction starts when the valves on the MVA aspirator are released. At that point, the aspirator is gently rotated 180 degrees alternatingly in each direction with an in and out motion (**Tech Fig. 10.2**). Depending on the amount of tissue obtained, the syringe may have to be emptied once or more often during the procedure, or instead multiple different syringes can be used in succession.
- The procedure is completed once the uterine contents have been evacuated. Signs for this include: No more tissue can be obtained; the uterus contracts and the cannula cannot be advanced as much any more; a gritty sensation is noted when the cannula is advanced.
- Some providers prefer to perform a transvaginal ultrasound to document an empty uterine cavity.
- All instruments are then removed from the vagina once good hemostasis is noted at the previous tenaculum site on the cervix. Silver nitrate can be used for hemostasis if bleeding

continues despite local pressure with gauze sponges to the prior tenaculum site.



Tech Figure 10.2. Use of the MVA: The aspirator is gently rotated 180 degrees alternatingly in each direction with an in and out motion.

PEARLS FOR PERFORMING AN ENDOMETRIAL BIOPSY	
Sounding of uterine cavity	○ Not recommended because it increases the risk of perforation and does not give any additional valuable information
Discomfort	○ Give NSAIDs such as Ibuprofen 600 mg orally 60 minutes prior to planned procedure
Uterus very ante- or retroverted	○ Perform procedure under visualization through transabdominal ultrasound (and full bladder) to decrease risk for perforation
Cervical stenosis	○ Give misoprostol 400 µg orally 12 hours prior to planned procedure
PITFALLS WHEN PERFORMING AN ENDOMETRIAL BIOPSY	
Blood and/or fluid in endometrial cavity	✖ Inadequate endometrial tissue often obtained when blood and/or fluid fills the Pipelle® or other endometrial suction device.
PEARLS FOR PERFORMING A MANUAL VACUUM ASPIRATION	
Injection of local anesthetic for paracervical block	○ Side effects include buzzing in the ears, dizziness, numbness in lips, and metallic taste. In higher doses, seizures can occur
Reaction to local anesthetic/respiratory distress	○ Obtain intravenous access; give epinephrine 0.4 mg subcutaneously and diazepam 5 mg IV slowly; support ventilation
Patient is Rh (rhesus) negative	○ Need to administer Rh (D) immunoglobulin (Rhogam); standard dose is 300 µg given intramuscularly; a "minidose" of 50 µg is sufficient in the first trimester, but not available everywhere.
Routine cervical priming	○ Not recommended[7] but can be performed in certain cases with misoprostol 400 µg orally 12 hours prior to the procedure
Discomfort during injection of local anesthetic	○ Inject slowly[8]; dilution of lidocaine with sodium bicarbonate (1:10 ratio by volume of bicarbonate to lidocaine) can speed numbing effect and alleviate stinging sensation
PITFALLS WHEN PERFORMING A MANUAL VACUUM ASPIRATION	
Loss of vacuum	✖ Do not withdraw the opening of the cannula beyond cervical os; if vacuum is lost the device needs to be removed and reassembled

POSTOPERATIVE CARE

- After an endometrial biopsy, no specific postoperative care is necessary. The patient can leave the office if she is feeling well and after counseling performed.
- After an MVA, the patient should be monitored for 15 minutes after completion of the procedure. Prior to discharge, the following needs to be discussed with her:
  - pain medication regimen
  - continuation of antibiotics
  - warning symptoms and when to contact provider (such as worsening pain, foul smelling discharge, heavy bleeding, malaise, and fever)
  - resumption of sexual activity (usually not recommended for at least 1 week)
  - possibly contraception

OUTCOMES

- The accuracy of an endometrial biopsy for the detection of endometrial cancer or precursors compared to dilation and curettage is quoted as high, with a detection rate of 99.6% in postmenopausal and 91% in premenopausal women, and an overall sensitivity of 98% and specificity of 99%.[9] The Pipelle® endometrial biopsy device appears to work well in most clinical cases. Any insufficient sample requires further evaluation, and with significant risk factors or persistent symptoms a dilation and curettage should be performed.[10] It is important to remember that even a dilation and curettage can miss cancer in 2% to 6% of cases.[11]
- An MVA successfully ends first trimester pregnancies (up to 12 weeks gestational age) in 99.5% of cases, which is comparable to the conventional suction D&C.[12]
- In a case series of 58 patients with either missed or incomplete abortion, an MVA successfully removed the retained products of conception in all patients.[13]

COMPLICATIONS

- Possible complications are similar for performing an endometrial biopsy or an MVA. Side effects include cramping and spotting. Complications include a vasovagal syncope, a pelvic infection, and uterine perforation with possible damage to adjacent structures. When a paracervical block is performed, local anesthetic toxicity can occur.

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