Hysteroscopy

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Hysteroscopy

Linda D. Bradley, MD, and Sandra D. Dayaratna, MD

PROCEDURE AND HYSTEROSCOPIC EQUIPMENT

Hysteroscopy is a minimally invasive procedure that can diagnose and treat many endocervical and intrauterine abnormalities (Table 1). Hysteroscopy has changed the practice of gynecology by improving the physician’s ability to manage conditions of the endocervix, endometrium, and tubal ostia, but knowledge and skills are necessary to optimize the yield and safety of this procedure. Contraindications to hysteroscopy are shown in Table 2.

This manual provides an overview of hysteroscopic equipment and describes the major diagnostic and operative procedures performed using this technology, including perioperative care and potential complications and their prevention.

OVERVIEW OF PROCEDURE

Prior to hysteroscopy, inspection of the vulva and bimanual examination are necessary to determine uterine position and to exclude adnexal or pelvic tenderness. Knowledge of uterine position helps to orient placement of the hysteroscope and decrease the risk of uterine perforation.

The traditional technique of hysteroscope insertion involves a speculum and, if necessary, a tenaculum. After the speculum is inserted into the vagina, the cervix is cleansed with an antiseptic solution. The distal end of the hysteroscope is then inserted into the cervix, followed by panoramic inspection of the endocervix. The hysteroscope should be advanced into the uterine cavity under direct visualization with distending medium and without undue force. Once the hysteroscope is inside the uterine cavity, the topography of the endometrial cavity and tubal ostia is assessed. If abnormalities are noted, an operative hysteroscope equipped with specialized instruments may be used to obtain targeted biopsies or to remove intracavitary lesions.

Flexible Hysteroscopes

Flexible (fiberoptic) hysteroscopes range in diameter from 3 mm to 5 mm, generally do not require cervical dilation, and have a longer working length than rigid hysteroscopes. They also have a bidirectional and wide angle of view spanning 120 to 180 degrees. The smaller outer diameter (OD) compared to a rigid hysteroscope is advantageous in patients with nulliparity or prior cervical conization, and the longer working length is helpful in morbidly obese patients. The distal tip of the flexible hysteroscope can easily navigate around intracavitary masses.

Although flexible hysteroscopes do not have sheaths, some larger-diameter scopes have ancillary ports that accommodate flexible operative instruments, permitting directed biopsy, retrieval of foreign bodies, or lysis of filmy adhesions. Thus, flexible hysteroscopes may have a role in the ambulatory surgical center or operating room, particularly in cases in which dilation is difficult due to marked cervical stenosis. Once the endocervix is visualized, the surgeon can visually determine the correct path of dilation with the flexible hysteroscope, rather than blindly placing a dilator.

Rigid Hysteroscopes

Rigid hysteroscopes range from 2.7 mm to 10 mm
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in diameter and consist of an optical telescope placed within a sheath. Rigid scopes with an OD of 2.7 mm are often used in the office for diagnostic purposes, whereas larger-diameter scopes are used for operative procedures. Both diagnostic and operative sheaths contain ports for instillation of distending medium. Some operative sheaths have an OD of 7 mm to 10 mm and include both inflow and outflow ports. Rigid hysteroscopes with ancillary ports that allow introduction of rigid or semirigid instruments (eg, forceps, scissors) permit targeted biopsies.

The angle of view with most rigid hysteroscopes ranges from 0 to 70 degrees. Larger angles of deflection may be helpful when performing hysteroscopic sterilization or tubal cannulation. The choice of type of lens is operator dependent.

Resectoscopes

The hysteroscopic resectoscope is an adaptation of the urologic resectoscope, with the added ability to provide continuous circulation of fluid. The continuous flow mechanism clears debris and mucus, allowing excellent visualization throughout the surgical procedure. Resectoscope permits removal of endometrial polyps and submucosal fibroids, directed endometrial biopsy, division of a uterine septum, and endometrial ablation. Monopolar and bipolar operative hysteroscopes are currently available. When a monopolar operative hysteroscope is used, a dispersive pad must be placed on the patient and a nonelectrolyte, nonconducting distending medium must be used; with a bipolar device, saline or lactated Ringer’s solution is used and the patient does not need a dispersive pad.

Ancillary Operative Equipment

A variety of specialized instruments are available for use during operative hysteroscopy, including surgical instruments (eg, scissors, grasping forceps, biopsy forceps) and electrosurgical and laser devices. Surgical instruments may be flexible, semirigid, or rigid. Smaller flexible and semirigid instruments can be used for minor surgical procedures such as retrieval of an intrauterine device (IUD), lysis of thin adhesions, or excision of small polyps. However, due to their fragile nature, these instruments cannot be used to remove fibroids or large polyps. Flexible and semirigid instruments are usually introduced via specially adapted catheters and accessory ports. Rigid instruments either attach permanently to the distal tip of an operative sheath or are inserted through an offset sheath. These instruments are fragile and must be handled carefully to prevent breakage.

Specially adapted wire loop, rollerball, and vaporizing electrodes can be used to resect, ablate, or desiccate endometrial tissue. For monopolar electrodes, a cutting current of 60 to 100 watts is used. When bipolar electrical energy is used, the default settings are applied. Generally speaking, loop electrodes are used for resection of submucous fibroids (myomectomy), and rollerballs are used for endometrial ablation. Fiberoptic lasers (ie, Nd:YAG, argon, and potassium-titanyl-phosphate [KTP]) can be used for endometrial ablation, adhesiolysis, and desiccation of intracavitary lesions.

Recently, a hysteroscopic morcellator device has become available that permits rapid resection of intra- cavitary lesions without electrical energy. Added benefits of this technique include the use of saline as the distending medium and easy removal of resected tissue via suction through the hysteroscopic sheath.

Table 1. Indications for Diagnostic and Operative Hysteroscopy

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Treatment</th>
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<tbody>
<tr>
<td>Evaluation of abnormal uterine bleeding</td>
<td>Myomectomy (intracavitary fibroids and some intramural fibroids)</td>
</tr>
<tr>
<td>Infertility workup (combined with laparoscopy or 3-dimensional ultrasonography)</td>
<td>Endometrial polypectomy</td>
</tr>
<tr>
<td>Follow-up evaluation of abnormal or inconclusive findings on uterine ultrasonography/imaging</td>
<td>Removal of endocervical lesions</td>
</tr>
<tr>
<td>Follow-up evaluation of inconclusive results of endometrial biopsy</td>
<td>Retrieval of foreign bodies (eg, laminaria, displaced intrauterine systems, retained products of conception)</td>
</tr>
<tr>
<td>Targeted endometrial biopsy</td>
<td>Excision of intrauterine adhesions</td>
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<tr>
<td></td>
<td>Repair of uterine septum</td>
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<tr>
<td></td>
<td>Ablation/resection of the endometrium</td>
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<td></td>
<td>Hysteroscopic sterilization</td>
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<td>Tuboplasty or cannulation</td>
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Table 2. Contraindications to Hysteroscopy

<table>
<thead>
<tr>
<th>Contraindications to Hysteroscopy</th>
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<tr>
<td>Viable intrauterine pregnancy</td>
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<tr>
<td>Pelvic inflammatory disease</td>
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<tr>
<td>Mucopurulent cervicitis</td>
</tr>
<tr>
<td>Active or prodromal herpes infection</td>
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<tr>
<td>Cervical cancer</td>
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DISTENDING MEDIA

The endometrial cavity is a potential space; it must be distended for adequate visualization. Operative hysteroscopy is generally performed with fluid distending media, whereas diagnostic hysteroscopy may be performed with fluid or carbon dioxide (CO₂).²,¹⁰

Carbon Dioxide

CO₂ is a preferred distending medium for diagnostic hysteroscopy because it is not messy, is rapidly absorbed, and has an excellent refractive index.¹¹ A hysteroscopic insufflator must be used, which regulates flow and limits intrauterine pressure to a maximum set point of 100 mm Hg. Higher pressures could result in a CO₂ embolus. For this reason, a laparoscopic insufflator, which delivers upward of 1 to 15 L/min, should never be used. CO₂ passes through the fallopian tubes and may cause shoulder pain due to diaphragmatic irritation. Symptoms usually subside within 5 to 15 minutes. If visualization with CO₂ is poor, CO₂ can be replaced immediately with a liquid distending medium infused via intravenous (IV) tubing.

Fluid Media

The type of electrical energy used determines the selection of fluid distending medium. Monopolar energy sources require hypotonic (electrolyte-free) solutions such as 5% dextrose, 1.5% glycine, 3% sorbitol, or 5% mannitol. Glycine, a low-viscosity fluid, is used with monopolar electrocautery because it is a poor electrical conductor; minimizes hemolysis during irrigation, and provides excellent optical images. If electrolytic solutions are inadvertently used during monopolar resectoscopy, the power diffuses and, without directed energy, the wire loop will not cut. Bipolar energy sources require isotonic solutions such as normal saline or lactated Ringer’s. These distending media conduct current and can be used with diagnostic, laser, or mechanical hysteroscopic procedures.

Hyskon® (dextran 70 in 10% dextrose) is a high-viscosity, electrolyte-free, nonconductive distending medium that can be used with Nd:YAG lasers and monopolar energy sources as well as in diagnostic and operative hysteroscopy. Hyskon is immiscible with blood and thereby provides excellent optical clarity. However, there are several disadvantages to its use. It is a plasma expander and can attract large volumes of water when intravasated, leading to electrolyte and fluid overload. Other adverse effects include anaphylaxis and coagulopathy. In addition, there are no automated fluid pumps to accurately measure inflow and outflow, and fluid leaking around the cervix is difficult to retrieve and measure. Finally, the viscous nature of this distending medium makes it difficult to inject with a syringe or pump and requires that all instruments be cleaned in hot water immediately after use.

FLUID MANAGEMENT SYSTEMS

Because fluid can be rapidly and unpredictably absorbed, continuous monitoring is essential. Modern gynecologic suites employ fluid management systems (automated fluid pumps) that continuously measure fluid input and output, with audible or visual alarms that signal a predetermined fluid deficit. The physician can preset the allowable fluid deficit based on the patient’s risk factors (eg, age, cardiovascular reserve, renal function). The alarm indicates the need to halt the procedure and quickly evaluate the patient. An additional advantage to fluid pumps is the ability to determine intrauterine pressure and to easily adjust fluid pressures to control bleeding and to decrease “false-negative” views of the endometrial cavity that may occur with higher or constant endometrial pressure. Alternating the intrauterine fluid pressure may also help facilitate full resection of uterine fibroids by causing myometrial contraction, which helps enucleate the fibroid.

Fluid management systems play a vital role in the safety of operative hysteroscopy. Many systems are available, and their use increases patient safety when guidelines for managing fluid absorption are followed.¹² If an automated fluid management system is not available, physicians must rely on the old-fashioned method of tallying fluid input and fluid output.

ANESTHESIA

The choice of anesthesia (ie, local, regional, or general) depends on many factors, including physician preference, patient medical status, type and complexity of the procedure, facility capabilities, and patient preference.¹³ Diagnostic hysteroscopy can be performed in an office setting without anesthesia. More complex hysteroscopic procedures are usually performed as outpatient surgery.

For diagnostic hysteroscopy, nonsteroidal anti-inflammatory drugs (NSAIDs) may be taken 1 to 2 hours before the procedure. For patients who request anesthesia, IV midazolam (anxiolytic) and fentanyl (analgesic) offer excellent onset of action and low risk of oversedation, airway obstruction, or cardiopulmonary compromise. For more complex cases, moderate sedation or general anesthesia can be used. Physicians administering anesthesia must be cognizant of medication side effects and prepared to appropriately manage the patient’s airway.
DIAGNOSTIC HYSTEROscopy

Over the last decade, diagnostic hysteroscopy with directed biopsy has become the gold standard for evaluation of endometrial abnormalities. All other methods currently available for examining the uterine cavity (ie, dilation and curettage, endometrial biopsy, hysterosalpingography [HSG], pelvic ultrasonography, and saline infusion sonohysterography [SIS]) are performed without the benefit of direct visualization. Hysteroscopy offers the advantages of being able to directly visualize any pathology as well as perform targeted biopsy or excision of any lesions identified during the procedure.

Because hysteroscopy permits evaluation of the endometrium, endocervix, and tubal ostia, it can be a valuable tool in the workup of several common gynecologic complaints. Specifically, diagnostic hysteroscopy is indicated in the evaluation of (1) abnormal pre- or postmenopausal uterine bleeding, (2) infertility (along with laparoscopy), (3) abnormal findings on ultrasonography or other imaging of the uterus, and (4) inconclusive results of office-based endometrial biopsy. Diagnostic hysteroscopy can also be used to evaluate the feasibility of operative hysteroscopic procedures (eg, myomectomy, repair of a uterine septum) or to evaluate the success of prior procedures (eg, resection of intrauterine adhesions in a patient with persistent infertility).

EVALUATION OF ABNORMAL UTERINE BLEEDING

Due to its invasiveness and need for a skilled practitioner, hysteroscopy is not always the initial diagnostic step in the evaluation of abnormal uterine bleeding. Typically, the first step is ultrasonography and/or endometrial biopsy, and if ultrasonography reveals a thickened endometrial stripe, either SIS or diagnostic hysteroscopy is performed.

Although endometrial biopsy can detect global endometrial disease such as hyperplasia or cancer, it has been shown to have a low sensitivity in detecting focal disease, including polyps, submucous fibroids, and focal hyperplasia or malignancy. Nondirected endometrial biopsy alone can have as high as an 88% to 98% false-negative rate for detecting focal endometrial lesions. Furthermore, approximately 15% of intracavitary lesions may be missed even when the endometrial echo is of normal thickness. As a result of these concerns, some gynecologists are now using diagnostic hysteroscopy as part of the initial evaluation of abnormal uterine bleeding or suspected uterine pathology, particularly when office hysteroscopy is available. Targeted endometrial biopsy is indicated when focal lesions are noted on diagnostic hysteroscopy or SIS. The endometrial surface may have focal irregularities, polypoid projections, or discrete lesions. Using the wire loop, lesions can be removed in their entirety and sent for histologic analysis.

Hysteroscopy is also helpful for confirming a diagnosis when endometrial biopsy does not yield a sufficient specimen for pathologic diagnosis or when symptoms continue despite a negative endometrial biopsy. In addition, when cervical stenosis precludes endometrial biopsy or SIS, hysteroscopy can be done with cervical ripening or, if dilation is necessary, under anesthesia.

INFERTILITY EVALUATION

Diagnostic hysteroscopy (along with laparoscopy or 3-dimensional ultrasonography) can be used to diagnose causes of infertility and recurrent pregnancy loss. A recent systematic review of studies looking at the relationship between fibroids and pregnancy outcomes found that submucous fibroids appear to decrease implantation rates from 11.5% to 3% and ongoing pregnancy rates from 30% to 14%.

Women with müllerian duct anomalies (eg, septate, arcuate, or bicornuate uterus) also have been shown to have worse outcomes, including a higher incidence of spontaneous abortions and preterm delivery. Hysteroscopy is helpful in diagnosing and treating some of these conditions.

EVALUATION OF AMENORRHEA

In cases of oligomenorrhea or amenorrhea unresponsive to oral contraception, hysteroscopy can be helpful in diagnosing and treating an underlying Asherman syndrome (intrauterine adhesions). Although HSG would be equally effective for diagnosing this condition, it would not allow concurrent treatment.

OPERATIVE HYSTEROscopy

PROCEDURES

Indications for operative hysteroscopy include polypectomy, myomectomy, endometrial ablation, repair of a uterine septum (metroplasty), resection of intrauterine adhesions, and sterilization.

Myomectomy and Polypectomy

Hysteroscopic myomectomy and polypectomy are minimally invasive surgical procedures that safely and effectively remove intracavitary lesions. Although the following discussion focuses on myomectomy, the
Hysteroscopy

Techniques used for both procedures are similar and include loop resection and the use of hysteroscopic scissors, lasers, or bulk vaporizing electrodes. Additional intraoperative procedures to facilitate removal of fibroids include pharmacologic agents that cause uterine contractions, uterine massage and decompression, sonographic guidance, and simple mechanical dissection.

**Preoperative evaluation.** Preoperative evaluation of the uterine cavity is important to determine the number of fibroids as well as the size, location, and depth of myometrial penetration. These factors help determine whether a hysteroscopic approach is indicated and, if so, the surgical expertise necessary and whether the procedure can be successfully completed in one operation. Currently, there is no uniformly accepted hysteroscopic classification system for fibroids, although several experts agree that depth of myometrial involvement determines the degree of difficulty, surgical expertise, and risk of fluid overload. One system, developed by the European Society of Gynaecological Endoscopy (ESGE), considers only depth of myometrial penetration and defines type 0 fibroids as being completely within the endometrial cavity, type 1 as extending less than 50% into the myometrium, and type 2 as having more than 50% of their volume within the myometrium. Because this system is derived hysteroscopically, depth of involvement is subjectively determined and may be influenced by intracavitary distending medium and pressure. The ESGE classification system recommends that hysteroscopic myomectomy be limited to type 0 and type 1 fibroids, unless a physician has expert skills in hysteroscopy.

**Technique.** Hysteroscopic myomectomy is commonly performed using a resectoscope and wire loop. Once inside the endocervix, the exact location of the lesion(s) should be determined, the uterotubal ostia visualized, and size of the lesion(s) confirmed. These maneuvers help to map out the surgical procedure to provide the safest operative strategy for hysteroscopic removal. When multiple lesions are encountered, removal of the lesions nearest the cervix and posterior wall is advised, followed by resection of more fundal and lateral lesions.

The basic resection technique involves serial slicing or shaving of a lesion until it is flush with the endometrium. The wire loop (monopolar or bipolar) is placed behind the lesion and drawn toward the physician when the electrode is activated. Cutting begins at the surface, with the trajectory always directed toward the operator, keeping the loop visible at all times. With each passage of the wire loop, crescent-shaped pieces of tissue will float into the uterine cavity. When visualization is obscured, the accumulated fibroid pieces should be removed with the wire loop or polyp forceps. Although fibroids chips may pass spontaneously, leaving them within the uterus may result in colicky pain, persistent leukorrhea, adhesions, or intrauterine infection. Furthermore, pathologic examination of the tissue is essential.

Fibroids may have a myometrial attachment. Full enucleation requires expert hysteroscopic skills and identification of the surgical planes. To facilitate removal, intermittent uterine decompression, manual massage, injection of prostaglandin F2\(\alpha\), and wire loop mechanical resection techniques have been described.

**Endometrial Ablation**

Endometrial ablation refers to destruction or resection of the endometrium to approximately 4 mm to 6 mm beneath the basalis layer. Endometrial ablation is a minimally invasive alternative to hysterectomy for treatment of dysfunctional uterine bleeding in women who are intolerant of or have failed medical therapy, do not desire childbearing, and have a negative workup for abnormal bleeding (ie, exclusion of underlying systemic disease, bleeding disorders, and intracavitary pathology). Contraindications include current pregnancy or a desire for future pregnancy, active infection (cervicitis, endometritis, salpingitis, or vaginitis), endometrial hyperplasia (with or without atypia), müllerian anomalies, IUD in situ, postmenopausal bleeding, and cervical cancer. Endometrial ablation is meant to decrease uterine bleeding with a return to normal menstrual flow. Although some women will achieve hypomenorrhea or amenorrhea, patients should be informed not to expect amenorrhea as the outcome. Women who will be satisfied only with amenorrhea should be offered hysterectomy. Approximately 25% of women undergoing endometrial ablation will require additional surgical procedures or hysterectomy in the future. Nevertheless, many studies have shown a higher success rate with ablation than with medical management for control of abnormal bleeding.

Contraception is still necessary after endometrial ablation. Pregnancies following endometrial ablation have been associated with increased rates of miscarriage, premature delivery, intrauterine growth restriction, premature rupture of membranes, postpartum hemorrhage due to abnormalities in placentation, and maternal death. Current methods for endometrial ablation include first-generation (nonglobal) and more recently developed second-generation (global) techniques. Nonglobal ablative methods (rollerball, laser, vaporizing electrodes, and transcervical resection) are
performed with an operative hysteroscope under direct visualization and require knowledge of fluid management and hysteroscopic expertise. Rollerball and resection procedures can be performed with monopolar or bipolar wire loops, balls, or barrels. Global ablative methods include heated balloon therapy, cryoablation, circulation of 90°C saline, bipolar desiccation, and microwave energy. The microwave device is contraindicated when the myometrial thickness is less than 10 mm (women who have undergone cesarean section are at risk of developing a thin myometrium). In experienced hands, the nonglobal ablative methods can be used in women with larger or irregular endometrial cavities (eg, in the presence of submucosal fibroids), whereas the global ablative methods are limited to use in women with endometrial cavities that meet certain criteria.

Metroplasty

Septate uterus is the most common of all congenital uterine malformations, accounting for 35% of müllerian anomalies. Although a uterine septum does not appear to affect fertility, it is associated with poor reproductive outcomes, including recurrent pregnancy loss and preterm delivery. Hysteroscopic metroplasty leads to successful repair in many cases of septate uterus. When compared with an open procedure, hysteroscopic metroplasty offers the advantages of outpatient surgery, no reduction in uterine cavity size, less postoperative morbidity and quicker recovery, avoidance of an abdominal scar, and no requirement for a cesarean delivery.

Technique. Hysteroscopic metroplasty can be performed with hysteroscopic scissors (microscissor and rigid sheath), a laser, a resectoscope with a wire loop, or vaporizing electrodes. While scissors carry no risk of thermal injury, they cannot be used to control bleeding. The use of laser technology is more expensive. More recently, smaller 5 French bipolar electrodes have been used for hysteroscopic metroplasty.

The goal of metroplasty is to incise the uterine septum until it is retracts and flattens against the uterine fundus. Under hysteroscopic guidance, the incision begins at the apex and, working in a side to side manner, is extended caudally. Once the septum is flush across the fundal portion and the hysteroscope can be moved from one tubal ostium to the other without an intervening septum noted, the procedure is complete. No tissue is actually removed, it is just incised. Care must be taken not to cut deeply into the myometrium, as this can lead to bleeding or perforation. In cases of complete uterine septum, the cervical septum should be sectioned as well.

Adhesiolysis

Intrauterine adhesions most often develop as a result of trauma from curettage (eg, for elective pregnancy termination, missed or incomplete abortion, postpartum hemorrhage, or retained products of conception). The standard treatment is adhesiolysis using an operative hysteroscope under direct visualization. Thick synechiae are lysed with scissors or wire loop cautery. Laparoscopic or sonographic guidance may be used to facilitate surgery, minimize risk of perforation, and maintain orientation, since global visualization is sometimes difficult in the setting of many adhesions. When extensive adhesiolysis is anticipated, the procedure should be performed in the operating room.

Sterilization

Hysteroscopic sterilization by tubal occlusion device was approved in 2002 by the U.S. Food and Drug Administration (FDA). The effectiveness of this permanent contraceptive method is 99%. The procedure involves bilateral placement of microinserts into the fallopian tubes via hysteroscopy. The microinsert is soft and flexible, consisting of an expanding microcoil with a flexible stainless steel inner coil and an outer coil made of nickel-titanium alloy and polyethylene terephthalate fibers. After placement, the device induces a local fibrotic reaction in the proximal tubal ostia within 3 months.

Hysteroscopic sterilization may be performed in an ambulatory surgical center or office with minimal or no anesthesia, using a 7-mm hysteroscope with an operating channel and normal saline for distension. Preoperative oral contraception or pretreatment with depot medroxyprogesterone acetate facilitates placement of the coil, as the in utero environment will be atrophic, facilitating easier visualization of the tubal ostia. The FDA has recommended that HSG be performed 3 months after placement to confirm tubal occlusion. The patient must continue using reliable contraception until tubal occlusion is confirmed.

PERIOPERATIVE CARE

Preoperative Care

Presurgical planning is important to determine the type and extent of the operative hysteroscopic procedure and necessary surgical skills. The risks (including delayed risks), benefits, complications, possibility of not completing the procedure, and expected outcomes should be reviewed with the patient and informed consent documented. Patients should be informed that, in the event of uterine perforation, laparoscopy, laparotomy, and/or blood transfusion may be indicated.
**Patient positioning** is important to prevent neurologic injury. Peroneal nerve injury can be minimized by proper positioning of the legs to avoid undue pressure on the lateral aspect of the leg. Femoral nerve injury can be prevented by minimizing hyperextension and hyperflexion of the leg. Compression stockings are advised to decrease the risk of deep venous thrombosis.

Routine antibiotic prophylaxis is not recommended in patients undergoing hysteroscopic surgery.39,40

**Intraoperative Care**

The operative hysteroscope should always be inserted under direct visualization to decrease the risk of uterine perforation. Concomitant laparoscopy has traditionally been used to guide difficult procedures such as repair of a uterine septum or resection of extensive adhesions. However, intraoperative sonographic guidance has been shown to be effective and safe. Coccia et al34 compared outcomes among 81 patients undergoing hysteroscopy with sonographic guidance for treatment of submucous fibroids or a uterine septum with those of an historical control group of 45 patients who had been similarly treated with laparoscopic monitoring. Hysteroscopy under sonographic guidance was not only effective, but there were no complications due to inadequate visualization and, among those undergoing metroplasty, no need for reoperation (a second operation was needed in 4 patients from the control group). Investigators concluded that a wider resection (10 mm to 15 mm distance from the external surface of the uterus) of fibroids was achieved using sonographic guidance.

During operative hysteroscopy, the lowest intrauterine pressure necessary to maintain a clear operative view should be used. This is most safely accomplished with a continuous flow hystroscope and an automated fluid pump. There is an increased risk of fluid absorption when the intrauterine pressure is greater than the mean arterial pressure. Breaching the myometrial sinuses also increases bleeding and fluid absorption. (Normally, bleeding is minimal during hysteroscopy because the intrauterine pressure compresses myometrial sinuses.) Generally, adequate visualization can be accomplished with infusion pressures of 60 to 75 mm Hg. Briefly increasing the intrauterine pressure with close attention to fluid deficit may be necessary to obtain adequate visualization. When visualization is hampered, it is important to determine if the fluid bags are empty or if a uterine perforation has occurred. Lastly, the tubing should be inspected to determine if it has been disconnected. When a longer surgical procedure is anticipated (eg, in the case of a large intracavitary lesion, extensive intrauterine adhesions, or a uterine septum), the anesthesiologist should also decrease IV fluids.

**Postoperative Care**

Most patients can be discharged within 1 to 2 hours after hysteroscopy. Postoperative pain is minimal, typically requiring a mild narcotic and NSAID for several days. Fever is uncommon. Patients should be instructed to call if they develop a fever or experience increasing pelvic pain. Patients should avoid coitus until bleeding is minimal. Exercise can resume within 1 week after surgery.

**COMPLICATIONS**

Generally, hysteroscopy is safe and complications are uncommon, particularly with diagnostic procedures. In a prospective study of 13,600 hysteroscopies performed at 63 hospitals in the Netherlands, Jansen et al41 reported an overall complication rate of only 0.28% (0.13% for diagnostic procedures; 0.95% for operative procedures). Of note, there were no deaths.

Complications of hysteroscopy generally fall into 3 categories: procedure-related, media-related, and late postoperative. With proper selection of patients, appropriate preprocedure planning and anticipation of complications, and prompt intervention, risks can be minimized.

**PROCEDURE-RELATED COMPLICATIONS**

Procedure-related complications include uterine perforation, intraoperative bleeding, cervical lacerations, injury to adjacent organs, and an inability to complete the planned procedure. In a retrospective study, Propst et al42 found a 2.7% incidence of operative complications in a cohort of more than 900 women who underwent hysteroscopy, with a higher incidence of complications in those who underwent myomectomy or metroplasty versus polypectomy or endometrial ablation. In the study by Jansen et al,41 the risk of complications was greatest with adhesiolysis (4.5%), followed by endometrial ablation and myomectomy (both 0.8%), and polypectomy (0.4%). Nearly half of the complications were related to cervical entry.

Procedure-related complications may be minimized by cervical ripening with misoprostol, a prostaglandin E1 analog. Misoprostol increases intracervical accumulation of free water, softens the cervix, and passively increases the diameter of the cervical os. A randomized controlled trial of 152 patients showed that 200 μg of vaginal misoprostol administered 9 to 10 hours prior to operative
Hysteroscopy

Hysteroscopy reduced the need for cervical dilation, decreased the incidence of cervical tears, and reduced operative time in comparison with controls.\(^4\)\(^3\) Other routes of administration (eg, oral), dosages, and times of administration have also been studied, with similar results.\(^4\) The most common side effects of misoprostol are crampy lower abdominal pain, diarrhea, and mild vaginal bleeding.

Uterine Perforation

The reported incidence of uterine perforation during operative hysteroscopy varies from 0.8% to 3%.\(^4\)\(^1\) Risk factors include nulliparity, cervical stenosis, menopause, prior endometrial ablation, multiple cesarean sections, use of gonadotropin-releasing hormone agonists, prior cone biopsy, markedly retroverted uterus, and use of force during insertion.

It is vital to perform a pelvic examination prior to performing hysteroscopy, as this will determine the direction in which the hysteroscope is inserted. Adequate cervical dilation decreases the force required for insertion. Minimal dilation is needed with diagnostic hysteroscopy, but operative hysteroscopy requires that the internal os be dilated to 8 mm to 10 mm. Extra care and precaution must be taken in women who have had prior cesarean delivery, myomectomy, or uterine perforation as these factors can lead to myometrial weakness and increased risk of perforation. Complete visualization of uterine landmarks is essential during operative hysteroscopy, and the physician should not proceed if visualization is inadequate.

Perforation should be suspected when the uterine sound goes well past the expected size of the uterus; there is difficulty maintaining uterine distension, poor visualization, or increased vaginal bleeding; or an appendiceal epiploica or bowel is seen. Patients who sustain a uterine perforation with subsequent intraperitoneal bleeding often complain of abdominal and shoulder pain and can experience hemodynamic instability. A quick survey of the abdomen with ultrasonography will demonstrate free intraperitoneal fluid. It is rare for large amounts of intraperitoneal fluid to accumulate by transstomal egress during operative hysteroscopy.

If a perforation is suspected, it is advisable to stop the procedure immediately. If the perforation is midline and fundal and there was no use of thermal energy, observation may be adequate. If a lateral uterine or cervical perforation is suspected or the patient is unstable, laparoscopy or laparotomy may be necessary. A survey of the abdomen (laparoscopy or laparotomy) is necessary if thermal energy was used at the time of perforation. In addition, fluid deficit should be quantified and managed accordingly if the perforation occurred during hysteroscopy rather than with dilation.

Bleeding

Excessive intra- and postoperative bleeding is rare. Intraoperative bleeding can be managed with direct application of electrocautery if the area of bleeding is identified inside the uterus. Intracervical injection of dilute vasopressin also has been shown to decrease intraoperative bleeding. Vasopressin induces smooth muscle contractions of the uterine capillaries, small arterioles, and venules.\(^4\)\(^5\)\(^6\) Its use is advocated when prolonged surgery, larger lesions, or deeper myometrial resection is anticipated. If visualization is obscured by blood, a 30 mL Foley catheter balloon inserted into the uterus and inflated and left in situ may stop the bleeding. In cases of active bleeding and poor visualization, the procedure must be terminated.

Injury

Cervical lacerations can be sutured after the hysteroscopic procedure is completed. Any suspected intra-abdominal (bowel, bladder) thermal injury requires evaluation by laparoscopy or laparotomy.

MEDIA-RELATED COMPLICATIONS

Media-related complication and their severity vary based on the type of distending medium used. Key steps to avoiding these complications are appropriate preventive strategies, vigilant monitoring, and immediate response to signs of a problem.

Fluid Overload

The greatest risk of morbidity and mortality in operative hysteroscopy is from excessive intravascular fluid absorption.\(^4\)\(^7\) Fluid absorption is affected by the surface area of the surgical field, duration of surgery, open venous channels, vascularity of the lesion (eg, resection of a fibroid with many feeding blood vessels), intraperitoneal pressure, and type of fluid used. Frequent monitoring of fluid deficit is essential. An automated fluid pump or a dedicated nurse who calculates input and output is imperative for patient safety.

Fluid overload with electrolyte-free solutions. Excessive systemic absorption of electrolyte-free solutions (eg, glycine, sorbitol, mannitol) can lead to hyponatremia. If a fluid deficit is undiagnosed or not managed actively, serious complications can develop. Postoperative signs of hyponatremia include nervous system agitation, nausea, vomiting, headache, blurred vision, and seizures.

Sufficient intravascular absorption of electrolyte-free fluid will result in dilutional hyponatremia and

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hypo-osmolality. In these situations, water molecules move across the blood-brain barrier and cause the intracellular and extracellular osmolality to equalize, which can result in increased intracranial pressure, cerebral edema, and cellular necrosis.\textsuperscript{38,40} Glycine carries the greatest risk of hypo-osmolar hyponatremia. The half-life of intravascular glycine is 90 minutes, after which much of it is absorbed intracellularly. This can result in a surplus of free water, which can further compound the hypo-osmolar hyponatremia.\textsuperscript{40} In addition, glycine is metabolized in the liver and kidney to ammonia and glycic acid. Ammonia toxicity causes central nervous system symptoms such as lethargy, seizures, encephalopathy, and coma. Glycine has an inhibitory effect in the midbrain, spinal cord, and ganglion cells in the retina, and transient blindness may occur.\textsuperscript{50} There is less risk of hypo-osmolality with mannitol, although dilutional hyponatremia can still occur. Mannitol also causes an osmotic diuresis, which can counteract the hazards of excessive amounts of fluid intravasation. However, deposition of sugar crystals on instruments may distort the visual field.\textsuperscript{51}

With electrolyte-free solutions, if a deficit of 750 mL occurs, the fluid deficit should be monitored even more closely and an attempt should be made to bring the procedure to a conclusion. In patients who are elderly or have comorbidities, it may be wise to terminate the procedure at this time. For younger, healthy patients, as long as there is no concern for a uterine perforation, the procedure should be terminated when the deficit reaches 1000 to 1500 mL. An electrolyte panel should be drawn in the recovery room and administration of diuretics contemplated. If severe hyponatremia occurs, consultation should be sought for correction, but typically serum levels should be increased slowly, by 1 to 2 mEq/mL per hour and by no more than 12 mEq/L in the first 24 hours.\textsuperscript{52}

**Fluid overload with electrolyte solutions.** Normal saline and lactated Ringer’s solution are iso-osmolar to intravascular fluid, but excessive fluid intravasation can still lead to volume overload. In addition, it is thought that the action of antidiuretic hormone (ADH) on the kidneys can result in excretion of hypertonic urine and, thus, cause a serum hyponatremia.\textsuperscript{53} Particularly in young women, the release of ADH may be triggered by a combination of stress, pain, and nausea rather than resulting from hyperosmolality or hypovolemia. Pulmonary edema and congestive heart failure and the neurologic complications seen with electrolyte-free solutions can occur but not as commonly and only with larger volume deficits. When using isotonic solutions, the procedure should be terminated when the fluid deficit reaches 2500 mL and volume overload managed in the same way as with electrolyte-free solutions, with an assessment of serum electrolytes and a low threshold to administer a diuretic agent.

**Air or Gas Embolism**

Air or gas embolism is a rare but catastrophic complication of hysteroscopy. A recent survey of the literature by Groenman et al\textsuperscript{54} revealed 13 reported cases with a 50% mortality. If the patient is conscious, chest pain and dyspnea may occur. Additional signs include a classic “mill-wheel” murmur, decreased oxygen saturation, decreased end tidal CO\textsubscript{2}, and hypotension.

Gas embolism has been reported with diagnostic hysteroscopy using CO\textsubscript{2} for distension; an air embolus (from room air) is more common with operative procedures. In order for an air or gas embolus to occur, there must be open venous channels and a pressure gradient. If such a situation is suspected, the patient should be placed in the left lateral decubitus position with the head tilted down 5 degrees. This may allow the trapped air to be aspirated from the right ventricle via cardiocentesis or a catheter passed down the jugular vein. To decrease the risk of an embolus, it is important to purge air from the tubing before instillation, maintain intrauterine pressure at or below the patient’s mean arterial pressure, maintain flow rate at less than 100 mL/min, and minimize the number of times the operative hysteroscope is removed.

**LATE COMPLICATIONS**

Postoperatively, patients generally have a quick return to activity, minimal need for pain medications, and limited complaints. Although bowel and bladder injury and postoperative endometritis are infrequent, these must be considered and investigated when patients experience persistent pain, fever, foul-smelling discharge, or general malaise. Office evaluation, including thorough abdominal and pelvic examination, laboratory testing (eg, electrolytes, complete blood count), ultrasonography, and other imaging of the abdomen and pelvis may be required depending on the severity of symptoms and length of time since the procedure. Late postoperative bleeding may occur days to weeks afterward due to denuding or sloughing of the endometrium, endometritis, or onset of menses. Some complications of hysteroscopy may not become clinically evident for months or even years.\textsuperscript{55} These include complications of pregnancy, postablation tubal sterilization syndrome, new or worsening dysmenorrhea, hematometra, endometrial cancer, and failure to completely treat symptoms.
Pregnancy-Related Complications

Pregnancy after endometrial ablation is rare, with a reported incidence of 0.6%. From 1966 through 2005, there were 74 cases reported in the literature. Postablation pregnancy is associated with a high incidence of complications, including preterm labor, premature delivery, intrauterine growth retardation, prenat al death, postpartum hemorrhage, and placental abnormalities. Therefore, all reproductive-aged women should be advised that contraception is crucial after endometrial ablation. Some centers now recommend tubal ligation at the time of ablation.

Uterine dehiscence and acculation and extremely thin myometrium have been reported after adhesioly sis, myomectomy, and uterine perforation. A high index of suspicion is vital when a pregnant woman who previously underwent operative hysterectomy presents with pelvic pain, decreased fetal movement, vaginal bleeding, or abnormal uterine masses detected ultrasonographically. Patients should be informed of the risk of uterine rupture so they may consider elective cesarean section. Regardless of the mode of delivery, prompt attention is vital if fetal distress is suspected.

Hematometra

Hematometra is an infrequent late complication of operative hysteroscopy. After endometrial ablation, if cyclic or chronic lower pelvic pain occurs in a menstruating or amenorrheic woman or in a woman taking hormone replacement therapy, scarring or narrowing of the endometrial cavity may be the cause. Any bleeding from persistent endometrium may be obstructed. In most cases, hematometra can be treated successfully with cervical dilation alone. Since the cervical canal contains no endometrial glands, there is no need to treat this area in women undergoing endometrial ablation.

Postablation Tubal Sterilization Syndrome

Postablation tubal sterilization syndrome refers to a rare condition that may develop as a late complication of endometrial ablation in patients with a history of tubal ligation or obstruction. Because of the difficulty reaching the cornual regions of the fallopian tubes during ablation procedures, a small area may not be treated. As a result, there is a build-up of endometrium and blood that cannot efflux through the ligated fallo pian tube or through the ablated uterus, with resultant pelvic cramping. Treatment includes bilateral cornual resection and re-ablation of proximal endometrium or hysterectomy.

CONCLUSION

Hysteroscopy is a safe and effective minimally invasive technique for diagnosing and treating a number of intrauterine pathologies. With adequate knowledge of the equipment, experience using the technology, and anticipation of potential complications, even advanced hysteroscopic procedures can be performed with minimal risk to patients.

REFERENCES
