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Hysteroscopic myomectomy: Pearls and pitfalls from 24 years of practice

Hysteroscopic myomectomy continues to evolve with the introduction of new technologies and instrumentation. The author discusses his practices and preferences regarding ultrasound guidance, cervical dilation, fluid monitoring, instrumentation, and patient selection based on long experience performing this procedure.

Submucous leiomyomas measuring less than 4 cm, which are generally small enough to permit hysteroscopic removal, often announce themselves by producing menorrhagia, infertility, and pregnancy wastage. Although the basic technique of hysteroscopic myomectomy, introduced by Neuwirth in 1976, has remained largely unchanged, the integration of ultrasound (U/S) guidance, strict fluid monitoring, careful cervical preparation, and mechanical grasping devices can enhance safety and efficacy while reducing the need for subsequent surgery. This article reviews both "pearls" and "pitfalls" garnered during my 24 years of experience performing more than 600 hysteroscopic myomectomies.

PEARLS
Perform diagnostic hysteroscopy in combination with U/S guidance

There is still controversy regarding the best screening tool for menstrual disorders, infertility, and pregnancy wastage. Some physicians advocate sonohysterography, whereas others favor diagnostic hysteroscopy. Both tests have limitations, but together they can provide abundant information.

Hysteroscopy is not only an important diagnostic tool, but it also provides information about the cervix, such as the presence of stenosis or its failure to descend well into the vagina. These are vital preoperative considerations in assessing a patient's candidacy for hysteroscopic myomectomy. However, hysteroscopy provides limited information regarding myoma size, degree of myometrial penetration, or the location and breadth of its attachment point. A simultaneous abdominal U/S examination allows both a panoramic view of the uterine cavity and a sonohysterogram; the latter provides precise information regarding the size, grade, and location of the myoma and the nature of its attachment point (Figure 1).

Technically, this combined examination is achieved by first obtaining a clear hysteroscopic view of the cavity while holding the distal lens at the internal os. As an assistant holds the tenaculum, the surgeon places the abdominal transducer in both the sagittal and transverse planes, as necessary, to obtain critical U/S measurements. The assistant's other hand allows her to freeze, measure, and store the images while the surgeon positions the hysteroscope and probe for optimum views.

This combined procedure not only simulates what the surgeon may encounter during a subsequent operation, but also enhances the preoperative assessment. The physician can thereby provide realistic expectations for the patient and plan carefully for instrumentation (Table) and the use of adjuvants, including gonadotropin-releasing hormone (GnRH) analogues and laminaria.

Use U/S guidance for hysteroscopic surgery

U/S-guided hysteroscopic surgery was reported independently by Shalev and Zuckerman and Lin et al.
As a noninvasive adjuvant to resectoscopic surgery, U/S provides the operator a 3-dimensional understanding of the intrauterine pathology, taking advantage of the different echogenic characteristics of the distended bladder, myometrium, leiomyomas, and intrauterine distention fluid.

U/S guidance allows for the safe removal of most grade 2 leiomyomas measuring less than 4 cm; it also allows for the resection of cavity-filling myomas by the myoma "coring" technique (Figure 2), and the safe use of mechanical forceps to enhance myoma extraction, a technique first described by Goldrath.\textsuperscript{2} Goldrath's method can be used to supplement the standard resectoscopic technique, expediting removal of large quantities of tissue without exposing the patient to the risks of fluid intravasation.

Mastering U/S-guided hysteroscopic surgery is facilitated by working with the same sonographer over time, beginning with simple cases involving grade 0 submucous myomas and progressing to more complex cases.

Establish the MAFA limit
Hysteroscopic myomectomy has often been associated with excess fluid absorption,\textsuperscript{8} the results of which can be tragic. The American Association of Gynecologic Laparoscopists (AAGL) has established fluid monitoring guidelines\textsuperscript{9} that should be followed carefully. I favor a more stringent protocol that accounts for the patient's body mass using the formula: $\text{MAFA}_{\text{limit}} = 17.6 \text{ mL/kg}$.\textsuperscript{10} Both sets of guidelines establish an absolute limit of 1500 mL of low-viscosity anionic distention fluid (LVADF).\textsuperscript{11}

Provide adequate pressure through the fluid management system
Adequate visualization allows one to obtain a panoramic perspective of the uterus while avoiding disorientation, inadvertent uterine perforation, and incomplete removal of intrauterine pathology. These goals are dependent on both adequate intrauterine pressure and sufficient flow. Inexperienced surgeons tend to set fluid pump pressures too low, a problem that is fostered by the AAGL fluid monitoring guidelines, which state that "adequate visualization can generally be obtained with a maximum delivery pressure of 75 to 100 mm Hg."\textsuperscript{9} This setting is not based on randomized controlled trials and, in my opinion, it is often far below what is required for adequate visualization during hysteroscopic myomectomy. The practice of setting the pump pressure below the mean arterial pressure, first suggested by Garry et al.,\textsuperscript{12} makes little practical sense. As Loffer pointed out, the fluid deficit is the factor "that should guide the conduct of any case."\textsuperscript{13}

I prefer to begin a case with the pump pressure at 140 to 180 mm Hg and to decrease it until the infusion pressure is at the minimum level necessary for adequate visualization. One should remember that the actual intrauterine pressure varies depending on the adjustment...
This sonographically guided technique offers a safe approach for removing a cavity-filling myoma by reducing its size, beginning at its core and systematically working toward the periphery.

Myoma coring technique

Understand the critical importance of cervical dilation

Hysteroscopic myomectomy requires a well-dilated cervix to allow the easy introduction, removal, and reintroduction of a resectoscope, an important and often-repeated sequence in hysteroscopic myomectomy. In fact, cervical stenosis may be a relative contraindication to the removal of all but the smallest myomas.

Inadequate cervical preparation may result in forceful dilation and excessive traction on the cervical tenacula. The former increases the risk of uterine perforation and endocervical lacerations, and the latter increases the risk of ectocervical lacerations. Cervical dilation can be enhanced with the use of intravaginally administered misoprostol or the placement of a 3- to 4-mm laminaria japonica the afternoon before surgery. In most instances, these adjuvants permit the easy introduction of a 9-mm resectoscope the following day with minimal dilatory effort. Dilatory forces can be further reduced by intracervical injection of vasopressin. My practice is to inject vasopressin, 2.5 units diluted in 20 mL of saline, to a depth of 2 to 4 cm into the cervical stroma at the 3- or 9-o’clock positions.

In other instances, the cervix may be patulous and overdilated. This results in unwanted egress of distention fluid, resulting in poor uterine distention, inadequate visualization, and disorientation; these conditions in turn increase the risk of accidental perforation and incomplete myoma removal. This condition is easily managed by sequential placement of tenacula at the 3 and 9-o’clock positions until an adequate seal develops between the resectoscope and the cervical os.

Use appropriate instrumentation

The Table summarizes my preferred instruments and their indications. Operative hysteroscopes for myomectomy include both electrosurgical resectoscopes and the newly available mechanical hysteroscopic morcellators. The latter are not well studied and I have little experience with them. Although a 9-mm unipolar resectoscope will suffice for most hysteroscopic myomectomies, cervical stenosis may require the use of a smaller 7-mm resectoscope or a small-diameter hysteroscopic morcellator. Other instruments, such as the hysteroscopic injection needle, mechanical forceps, cervical dilators, and multiple tenacula, are useful to manage an array of clinical scenarios.

Electrosurgical resectoscopes are available as both unipolar and bipolar models. The former are generally offered in a 9- and a 7-mm version. Unipolar systems provide the ability to electrosurgically resect myomas; however, these systems are not widely used. Significantly, 7-mm resectoscopes are not the ideal size for myoma removal.

Bioprosthetic and bioresorbable LVADs have been used for patients with severe refractory heart failure. The LVAD is a pulsatile, blood pump that is placed within the left ventricle as a bridge to transplantation. The LVAD can be used as a left ventricular assist device, a right ventricular assist device, or a total artificial heart. The LVAD is typically implanted via a thoracotomy and connected to the patient’s aorta and pulmonary artery. The LVAD is powered by a computer that regulates the amount of blood pumped and the pressure within the LVAD. The LVAD provides a steady flow of blood, which helps to maintain a normal blood pressure and oxygenation. The LVAD is typically used as a temporary solution until a transplant is available. Patients may require weeks to months of LVAD support, depending on their condition. during resectoscopic surgery.
provide excellent cutting and coagulation with a sturdy electrode that does not easily deform or fracture; however, these require an LVADF and a MAFA that are more restrictive compared with normal saline. Significant cervical stenosis often requires the use of a 7-mm resectoscope, which results in longer operative times because the smaller 19F electrosurgical loop removes less tissue.

Bipolar resectoscopes are helpful in patients with a low body mass, requiring one to carefully limit the use of LVADF, or with large or multiple myomas, for which long resection times are anticipated. The use of normal saline for distention with bipolar instruments allows greater fluid absorption; this reaches 2,500 mL in most cases. One shortcoming of bipolar systems is that they provide relatively poor tissue coagulation compared with unipolar systems. In a unipolar system, the coagulation current travels through the tissue to a ground plate. That same current also travels through the area of least impedance, along blood vessels that run perpendicular to the surface of the uterus or myoma. In a bipolar system, the current returns to a negative electrode about 1 cm away (located on the resectoscope). In vivo models have demonstrated that the temperatures reached in unipolar systems and the resulting tissue penetration is greater than what can be achieved with bipolar systems. For this reason, I prefer to use a 9-mm unipolar resectoscope for the vast majority of cases.

You may begin a case with unipolar electrosurgery and transition to a bipolar system, provided that you adhere to the fluid management guidelines of both systems. This practice often allows completion of a procedure once the MAFA of LVADF has been reached.

When the pedicle can be clearly visualized, direct injection of vasopressin helps reduce bleeding during the hysteroscopic myomectomy. The same dilution of vasopressin used for intracervical injection is employed. The total amount of vasopressin should not exceed 5 units in 40 minutes. I prefer to use a 40 cm x 21-gauge G injection needle (Vita Needle Company, Needham, MA), which is passed down the operative port of a standard 26-F resectoscope.

In 1990, Goldrath described the technique of "vaginal" myomectomy, which involved the insertion of laminaria tents to accomplish cervical dilation and the blind removal of leiomyomas using various forceps. In his series of 151 patients, the hysterectomy avoidance rate was 92% and there were 2 uterine perforations (1.3%). With the use of US guidance, this technique need no longer be performed blind. Provided the cervix is well dilated, there are 3 clear advantages to this technique. First, it obviates the need for any distention media and thereby precludes the issues associated with excess fluid absorption. Second, the procedure is extremely efficient; well-selected leiomyomas can be removed quickly provided that they are pedunculated grade 0 leiomyomas that have been reduced to less than 3 cm. Third, the procedure eliminates the need for relatively expensive uterine morcellators.

The major risks of this procedure are 2-fold. First, uterine perforation is still possible in inexperienced hands. Second, in some circumstances the combination of the myoma and grasping forceps cannot be delivered through the endocervical canal, precluding removal of the instrument or the fibroid. To prevent this occurrence, one should be able to disarticulate all grasping forceps used for this purpose at their fulcrum. Surprisingly large fibroids can be removed in this fashion (Figure 3).

Small flexible dilators such as Cooper Surgical os finders are often helpful in managing marked or moderate cervical stenosis. Their flexible tip helps avoid inadvertent perforation. Routine dilation to 9 mm is best performed with Hegar dilators, which have a short dilating surface that also helps avoid uterine perforation, a concern with a short, very anteflexed, or retroflexed uterus. When greater dilation is necessary, for example with the use of mechanical forceps, large-diameter Hegar dilators (up to 16 mm) or Denniston dilators (up to 14 mm) should be inserted under sonographic guidance.

As already noted, I often use multiple tenacula to limit unwanted fluid egress between the resectoscope and the cervix. The placement of tenacula is similarly useful after mechanical forceps are used to extract a submucous leiomyoma.

Consider administration of GnRH analogues

Selective use of a GnRH analogue may enhance the feasibility and safety of hysteroscopic myomectomy, particularly for myomas larger than 4 cm. Crosignani et al reported that use of a GnRH analogue before surgery for uterine leiomyomas produced a temporary 40% to 50% reduction in mean uterine volume. Perino et al observed a 35.1% reduction in operative time along with a marked improvement in procedure completion rates with the use of leuprolide acetate depot. I have observed similar advantages using leuprolide depot 3.75 mg (Lupron Depot; Abbott Laboratories, Abbott Park, Illinois) for 2 months before surgery.
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Use appropriate electrosurgical generator settings
Myomas vary considerably in density; therefore, there is no single correct power setting for all myomectomies. If a loop electrode begins to deform because of mechanical drag, increase the current density until true electrosurgical cutting is achieved. Settings between 140 and 240 W work well and should be selected based on their bioeffects.

Terminate the procedure if necessary
It is not always possible to complete a hysteroscopic myomectomy in a single procedure. Foreseeable factors that increase the likelihood of a 2-stage procedure include a low body mass, which results in a lower MAFA limit, and large, complex, or numerous leiomyomas. An unforeseeable risk factor for a 2-stage procedure is the "hyper-absorber," or the occasional woman who absorbs a great deal of distention fluid despite low pump pressures. The reason some women absorb large quantities of distention fluid is neither predictable nor well understood.

As surgeons, we tend to be goal oriented and to forget that unlike many operative procedures, hysteroscopic myomectomy does not need to be completed. Cases should be discontinued in the presence of excessive bleeding, disorientation, or uterine perforation, or if the patient's MAFA limit has been reached. Occasionally it is necessary to have your patient return in 8 to 12 weeks for a second procedure, depending on her clinical response. Postoperative bleeding can be managed by inserting a Foley catheter with a 30-mL balloon and removing it after 2 hours. Prospective surgical candidates must understand the occasional requirement for a 2-stage procedure to avoid the serious consequences associated with excess fluid absorption.

Select patients carefully
Patient selection depends on a variety of factors, including the size, number, grade, and location of myomas. Both Wamsteker et al and Lasmar et al have published classification systems for leiomyomas in an attempt to aid the surgeon in predicting outcomes. Wamsteker et al distinguished various degrees of penetration into the myometrium, whereas Lasmar et al considered parameters such as the distance from the base of the myoma to the serosa, the size of the nodule, and the topography of the uterine cavity. However, other patient-selection factors are omitted if one relies solely on these classification systems.

Because the MAFA limit varies with the patient's weight, women who weigh less than 50 kg and have a single large myoma (3-4 cm) or numerous smaller myomas should be warned of the possible requirement for a 2-stage procedure. Another important factor is the quality of the images obtained during a combined hysteroscopy and sonohysterogram because a poor ultrasound image may limit the surgeon's ability to safely excise some leiomyomas. Other factors that may represent intraoperative challenges include cervical stenosis and excessive cervical length (>4 cm) or uterine length (>10 cm).

Finally, the patient should have a realistic understanding of the possible short- and long-term complications. Short-term complications may include uterine perforation, excessive fluid absorption, and the need to discontinue a case before its completion; long-term sequelae include the effect of myomectomy on a subsequent pregnancy or the possible need for future surgery.

PITFALLS
Surgeons may encounter several possible pitfalls while planning and performing hysteroscopic myomectomy. Many of these are discussed above, including excessive fluid absorption or bleeding, poor visualization of the uterine cavity and myoma(s), risk of inadvertent uterine perforation, risk of incomplete removal of intrauterine pathology, inadequate cervical dilation with possible laceration, leakage of distention fluid, large or multiple myomas, and unfavorable patient characteristics such as low body mass and cervical stenosis. Both short-term and long-term complications can occur after the procedure.
Solutions to these issues are also discussed above. Calculation of the MAFA is critical to help avoid excess fluid absorption. Other strategies include the implementation of U/S guidance; use of adequate intrauterine pressure and flow; selection of an appropriate electrosurgical generator setting; cervical preparation with misoprostol, laminaria, vasopressin, and cervical dilators; proper use of instruments; and consideration of GnRH analogues. When necessary, a procedure should be discontinued and a second procedure scheduled later. Surgeons can also avoid pitfalls through careful patient selection based on myoma characteristics, body weight, quality of U/S images, and other factors such as cervical stenosis, cervical length, and uterine length.

**SUMMARY**

Hysteroscopic myomectomy requires an array of instrumentation to accommodate a variety of intraoperative scenarios. Physicians should avoid scheduling a case unless the required equipment is available, and every operating room should have redundant equipment because instrument failures do occur. Evaluation of each patient must include an assessment of whether the cervix is amenable to hysteroscopic surgery. Surgeons should avoid performing hysteroscopic myomectomy on patients who have unrealistic expectations or taking on surgical challenges that are beyond their current abilities. Likewise, ob/gyns should not be pressured into performing a procedure if they do not believe it can be done safely and should not complete a procedure complicated by poor visualization and excessive fluid absorption; doing so invites both frustration and danger. Because patients do not present themselves in order of increasing complexity, it is best to begin with simple cases so that the surgeon and team can develop skills and confidence. 

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**REFERENCES**