Sonographically Guided Hysteroscopic Myomectomy (SGHM): Minimizing the Risks and Maximizing Efficiency

MORRIS WORTMAN, MD, FACOG
DIRECTOR
CENTER FOR MENSTRUAL DISORDERS AND REPRODUCTIVE CHOICE
ROCHESTER, NEW YORK

ABSTRACT

Hysteroscopic myomectomy (HM), first described by Neuwirth and Amin in 1976, is an important technique in the management of selected women presenting with infertility, abnormal uterine bleeding (AUB), or both. The complications of HM include excessive bleeding, uterine perforation, prolonged operative times, and excessive intravasation of distention media.

The author describes his technique of sonographically guided hysteroscopic myomectomy (SGHM). SGHM allows one to continuously monitor the progress of resectoscopic surgery while minimizing the risk of uterine perforation and permitting one to incorporate non-resectoscopic morcellation. The combination of both resectoscopic and non-resectoscopic techniques enable one to safely and efficiently remove submucous leiomyomas without the risk of excessive fluid absorption.
INTRODUCTION

Submucous leiomyomas are often discovered in the course of evaluating women with menorrhagia, subfertility, and recurrent pregnancy loss. The hysteroscopic removal of these myomas — first described by Neuwirth and Amin in 1976 — obviates the need for abdominal surgery and can even be performed in an office-based setting in carefully selected patients.  

The major risks of hysteroscopic myomectomy (HM) are well known and include excess fluid intravasation, uterine perforation, and collateral injury to adjacent pelvic viscera. Although “laparoscopic control” has been advocated to minimize the risk of uterine perforation, laparoscopy is itself associated with a small incidence of visceral injury and is inadequate for monitoring surgical progress. In contrast, sonographic guidance (SG) — independently described by Shalev et al. and Lin et al. — is non-invasive, allows one to maintain orientation in the presence of poor hysteroscopic visualization, and alerts the surgeon to regions of decreasing myometrial thickness that pose a risk for rupture or perforation. In summary, SG alerts the surgeon that a potential injury may happen while laparoscopy simply advises the surgeon that the injury has already occurred. Finally, SG provides assistance when the hysteroscopic view is impeded by blood and other debris permitting the surgeon to introduce a variety of grasping forceps for removing large fragments of myomas efficiently without the use of a resectoscope.

The author describes his 22-year experience with nearly a thousand sonographically guided hysteroscopic myomectomies (SGHMs). SGHM, which includes both resectoscopic and non-resectoscopic morcellation techniques, allows the author to remove submucous leiomyomas as large as 8 centimeters (130 grams) while minimizing operative time, fluid absorption, and the risk of uterine perforation. SGHM even permits the removal of selected intramural leiomyomas. The author reviews the issues of patient screening and selection, preoperative preparation, personnel, and equipment as well as some more salient points for accomplishing SGHM.

CLINICAL PRESENTATION

The symptoms associated with submucous leiomyomas may be quite variable (Table I) and include abnormal menses, recurrent pregnancy loss, and infertility.

### Table I

**Symptoms Associated with Submucous Leiomyomas**

<table>
<thead>
<tr>
<th>Abnormal Menstruation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclic menses</td>
</tr>
<tr>
<td>Hypermennorhea (menses lasting longer than 7 days)</td>
</tr>
<tr>
<td>Menorrhagia (the requirement for pad and/or tampon changes more frequently than every 2 hours)</td>
</tr>
<tr>
<td>Dysmenorrhea</td>
</tr>
<tr>
<td>May be absent</td>
</tr>
<tr>
<td>May worsen in the presence of clotting</td>
</tr>
<tr>
<td>Anemia</td>
</tr>
<tr>
<td>May be absent</td>
</tr>
<tr>
<td>May worsen and even require a blood transfusion</td>
</tr>
<tr>
<td>Prolonged continuous vaginal bleeding</td>
</tr>
<tr>
<td>Infertility</td>
</tr>
<tr>
<td>Recurrent Pregnancy Loss</td>
</tr>
</tbody>
</table>

Patient Screening and Selection

One must distinguish between patient screening and selection. Screening tools for SGHM assist in clarifying anatomic issues that are generally noted on initial ultrasound examinations performed for the symptoms listed in Table I. These methods assist in determining the size, grade, number, and location of leiomyomas along with any other pathology that may be present. However, additional information is required before a patient is selected for a particular treatment plan.

Some authors advocate office hysteroscopy as a primary screening tool while others favor saline infusion sonography (SIS). Diagnostic hysteroscopy provides significant qualitative information regarding both the intruterine contents and the dilatability of the cervix; additionally, it is superior to SIS in determining the number and location of submucous leiomyomas. SIS provides accurate data regarding the size and grade of submucous leiomyomas as well as precise information regarding the location and size of its attachment point. The simultaneous use of these modalities — sonographically guided diagnostic hysteroscopy (SGDH) — provides a wealth of clinically important information that assists in patient selection.

Both Wamsteker et al. and Lasmar et al. have published classification systems that aid the patient selection process. Wamsteker distinguishes various degrees of penetration into the myometrium while Lasmar also considers the myoma size, topography of the uterine cavity, and distance from the base of the myoma to the serosal surface. Whether using the Wamsteker or Lasmar classification system intrauterine pressure should be kept to the minimum possible that still allows for intrauterine visualization. At a high relative intrauterine pressure a grade 2 myoma may “disappear” into the myometrium creating a false “normal-appearing” uterine cavity. Finally, although these classification systems are helpful they both omit some very important patient selection criteria summarized in Table II.

**Age:** When considering hysteroscopic surgery for AUB one must be aware that with all other factors being equal women over the age of 45 have a better prognosis for avoiding hysterectomy than women under 35.
Body weight: The maximum allowable fluid absorption limit \((MAF_{\text{max}})\) for a given patient varies with her body weight.\(^{15}\) It follows that women with a low body mass and large myomas are at an increased risk for excess fluid intravasation and for an incomplete procedure.

Comorbid conditions: Frequently, the results offered by hysterectomy for the management of AUB resulting from multiple submucous leiomyomas is superior to what can be achieved with hysteroscopic surgery. However, in the presence of comorbidities — marked obesity, severe pelvic adhesive disease, cardiac and pulmonary disease — the author will offer SGHM provided it can be done quickly, safely, and with the reasonable expectation of satisfactory results.

Ultrasound image quality at the time of sono graphically guided diagnostic hysteroscopy: SGDH provides an excellent "dress-rehearsal" for SGHM. Occasionally, ultrasound image quality is poor and when combined with challenging uterine anatomy the gynecologist may be wiser in considering other options in managing a particular clinical scenario.

Cervical factors: SGHM requires repeated "cycles" each consisting of the introduction of a resectoscope or grasping instrument, electrosurgical (or mechanical) morcellation, and retrieval of both a tissue fragment along with the (resectoscope or mechanical grasping) instrument. In order to safely accomplish numerous cycles the cervix must be both readily accessible and dilatable. Deformities and congenital anomalies of the cervix, displacement following multiple cesarean sections, significant stenosis, or an unusually long cervix (greater than 4 cms) all adversely affect the progress of SGHM. Electronic morcel lators, such as MyoSure (Hologic Inc., Bedford, MA) or Truclure (Smith and Nephew Inc., Andover, MA), obviate the need for repetitive insertion and extraction cycles. However, this technology is limited by its comparative inefficiency.

Patient expectation and motivation: An unbiased understanding of a patient’s expectations is essential to her satisfaction with a treatment plan. If a woman is unwilling to accept that hysteroscopic myomectomy cannot offer the predictable amenorrhea that accompanies hysterectomy, one should not persuade her of its value. Most women understand the wisdom of seeking symptomatic relief from the minimally invasive technique of SGHM even if it occasionally requires a two-stage procedure.

Physician and team experience: Patients do not present themselves in order of increasing complexity. Despite the commitment of a physician and his or her operating room staff, a particular patient’s anatomic challenges may well lie beyond the current abilities of a given surgeon and operating room team. A disciplined physician will inform the patient that the limitations of her or his experience along with that of the O.R. staff support another operative choice.

Preoperative Preparation

A number of preoperative preparations can optimize the operative results.

Decreasing myoma volume: Several authors have demonstrated both a reduction in myoma volume and operative time by the preoperative administration of a GnRH agonist.\(^{16,17}\) One should consider the merits of a GnRH agonist whenever a myoma exceeds 4 cms in greatest dimension or with the anticipation of removing multiple submucous leiomyomas greater than 2 cms in diameter.

Dilate the cervix: The importance of a well-dilated cervix during SGHM cannot be overstated, especially when considering the introduction of operative forceps (Fig. 1). Dilation can be accom-

---

**Table II**

<table>
<thead>
<tr>
<th>Additional Patient Selection Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
</tr>
<tr>
<td><strong>Body weight and maximum allowable fluid absorption limit ((MAF_{\text{max}}))</strong></td>
</tr>
<tr>
<td><strong>Comorbid conditions</strong></td>
</tr>
<tr>
<td><strong>Image quality at the time of U/S guided hysteroscopy</strong></td>
</tr>
<tr>
<td><strong>Cervical factors</strong></td>
</tr>
<tr>
<td><strong>Cervical stenosis</strong></td>
</tr>
<tr>
<td><strong>Cervical length</strong></td>
</tr>
<tr>
<td><strong>Cervical accessibility</strong></td>
</tr>
<tr>
<td><strong>Patient expectation and motivation</strong></td>
</tr>
<tr>
<td><strong>Physician and team experience</strong></td>
</tr>
</tbody>
</table>

---

*Figure 1. Operative forceps used for sonographically guided myoma morcellation.*
Table III
Suggested Instrumentation for Ultrasound-Guided Hysteroscopic Myomectomy

Instrument Table

**Continuous Flow Resectoscopes (CFR)**
- 28 Fr CFR with 27 Fr loops (monopolar)
- 26 Fr CFR with 24 Fr loops (monopolar)
- 22 Fr CFR with 19 Fr loops (monopolar)
- 26 Fr CFR with 24 Fr loops (bipolar)
- Operating bridge for vasopressin injection needle

**Vasopressin injection needle**
- 40 cm x 21 gauge (Vita Needle Company, Needham, MA)

**Cervical Dilators**
- Hegar
- Pratt
- Denniston
- Os-finders (Cooper Surgical)

**Forceps**
- Ovum Forceps (7, 10, and 12 mm)
- Sopher forceps (10, 12, and 14 mm)

**Multiple single-toothed tenacuiae**

**Electrosurgery**
- Electrosurgical generator (bipolar and unipolar)
- Grounding pads with return electrode monitoring
- Various cutting loops (0, 165, 90 degree)
- Ball-end electrode

**Fluid Management System**
- Ultrasound Scanner
- Video-Cart

- Most of our cases are performed in an office setting and require 4 assistants: a first assistant, a sonographer, a fluid management technician, and an appropriately trained and credentialed nurse who administers analgesics and sedatives while monitoring the patient’s vital signs and level of consciousness. Our fluid management technician reports both the net fluid absorption and the rate of fluid absorption.

- The author’s equipment list for SGHM (Table III) is nearly identical to what he reported for sonographically guided hysteroscopic endomyometrial resection, with the addition of larger diameter cervical dilators, a myoma injection needle, and an array of forceps to accomplish morcellation under ultrasound guidance. Our OR is also equipped with an Autocon II 400 (Karl Storz Endoscopy, Culver City, CA) providing us with the capacity to perform surgery in both unipolar and bipolar modes. Sonographic guidance is provided with a Siemens Acuson X150 (Siemens USA, Inc., Washington, DC) equipped with a variable frequency abdominal transducer. Two side-by-side monitors facilitate SGHM by providing real-time displays of hysteroscopy and ultrasound images. We digitally record all of our procedures using a MediCapture USB 200 (MediCapture, Inc., Philadelphia, PA).

- After removing the previously placed laminaria, the cervix and vagina are prepped with a bactericidal solution. The cervix is grasped at 12 o’clock with a tenaculum after which a vasopressin solution containing 2.5 units in 20 mL saline is injected deep into its stroma (3 and 9 o’clock) using a 21-gauge x 1½-inch needle. Under sonographic guidance the cervix is dilated as necessary to accommodate a 22, 26, or 28 Fr CFR.

- The author quickly establishes a clear panoramic view by delivering Glycine 1.5% or Saline 0.9% at 120–180 mm Hg and identifies any opportunities that might benefit from the injection of an additional dilute vasopressin, such as the attachment point of a myoma or an obvious array of superficial vessels. No
Table IV
General Priorities in Establishing a Sequence for Removal of Leiomyomas

| Priorities in the presence of concomitant endometrial ablation or resection procedures |
| For global endometrial ablation (GEA) procedures remove grade 0, 1, and 2 myomas first. |
| For endometrial resection (EMR) procedures remove grade 0, 1 myomas first. |
| For EMR procedures consider removing grade 2 myomas last. |

| Priorities by grade of myoma |
| Grade 0 leiomyomas should be removed prior to Grade 1 lesions. |
| Grade 1 leiomyomas should be removed prior to Grade 2 lesions. |

| Priorities based on topography of myomas |
| Myomas in the lower segment take priority over myomas in the upper segment. |
| Anterior and posterior wall leiomyomas take priority over lateral wall leiomyomas. |

| Priorities based on methods that do not require the use of distention media |
| Utilize sonographically guided mechanical morcellation (SGMM) whenever it can be safely performed. |

more than 5 units or 40 mL of our vasopressin solution are delivered within 40 minutes.

Begin by Establishing a Proper Sequence of Goals
Table IV provides some general guidelines for establishing an intraoperative sequence. In general, one should begin by removing a myoma if it represents a physical impediment to the removal of another structure such as myomas, polyps, and endometrium. Another helpful guideline is to prioritize the removal of structures that are associated with less bleeding and fluid absorption.

Consider the Use of Both Bipolar Electroosurgery (BPES) and Unipolar Electroosurgery (UPES)
There are 4 advantages in utilizing UPES. First, UPES offers superior coagulation performance compared with BPES, an important feature in reducing intraoperative bleeding. Second, unipolar electrodes tend to be sturdier and less prone to fracturing during the resection of large and dense myomas. Third, most manufacturers offer unipolar electrodes in larger sizes that are more efficient in removing tissue compared with their bipolar counterpart. Fourth, unipolar electrodes come in many more configurations than their bipolar counterparts, which is an important consideration for the techniques such as myoma "coring" and "sweeping" described later in this article. The singular advantage of BPES, however, is that it allows saline — with its less restrictive MAFA to be used once the MAFA of glycine has been exhausted.

Resectoscopic (Electrosurgical) Techniques
There are 3 basic resectoscopic techniques.
1. Myoma-shaving technique (Fig. 2): This technique has the greatest utility of the three and is the only one that does not require SG. It is appropriate to practice or self-teach SG with the shaving technique while gradually incorporating ultrasound guidance into one's armamentarium. Myoma shaving can be performed with either UPES or BPES.

Myoma shaving technique

![Myoma shaving technique](image)

**Figure 2.** Myoma shaving technique.
and is appropriate for most grade 0, 1, and 2 leiomyomas less than 3 cm in diameter.

The myoma shaving technique requires that the active electrode be brought from behind the uterine leiomyoma and drawn toward the operator (Fig. 3). Careful adherence to this routine virtually eliminates the possibility of uterine perforation. However, this technique is inefficient for removing myomas greater than 3 cm and is not feasible in the presence of a cavity-filling myoma or one that does not allow the passage of an electrosurgical loop behind it. Additionally, the shaving technique cannot be used for the removal of many grade 1 and 2 myomas that originate from the fundus, ones that require the “sweeping” technique described later in this article. The myoma shaving technique is capable of removing as much as 1.5 grams/minute and is well-suited for removing most myomas less than 3 centimeters in diameter depending on their location.

2. Myoma-coring technique (Fig. 4): Submucous leiomyomas that exceed 3 to 4 centimeters in diameter often fill the uterine cavity preventing one from placing an electrosurgical loop behind, eliminating the possible use of the shaving technique. In this scenario the myoma can be initially reduced in volume by removing its “core.” In the myoma-coring technique a tunnel (or core) is removed under careful sono- graphic guidance utilizing a 135- to 180-degree loop electrode. After resection of this tunnel a standard 77- to 90-degree loop can be used to enlarge the tunnel causing the myoma to collapse. By reducing the myoma volume in this manner one may proceed to its lateral surface and perform a standard shaving technique.

3. Myoma-sweeping technique (Fig. 5): The removal of many grade 1 and most grade 2 submucous leiomyomas with a fundal attachment requires special consideration — their removal requires a sweeping motion with an extended 0 degree loop electrode. The removal of the submucous portion of leiomyoma is often followed by the extrusion of the remaining intramural portion into the uterine cavity. Careful sono- graphic guidance is required during this maneuver to prevent an inadvertent uterine perforation with an extended loop.

Non-resectoscopic (Mechanical) Morcellation Technique

Sonographically guided mechanical morcellation (SGMM) is shown in Figure 6. The mechanical morcellation of leiomyomas using grasping forceps was first described by Goldrath, who employed a variety of instruments to blindly remove submucous leiomyomas after hysteroscopic confirmation. SGMM offers the efficacy and safety of sono- graphic guidance, and like Goldrath's technique it requires only inexpensive re-usable instruments — ovum, Sopher and Bierer forceps — and eliminates the need for uterine distention and the risk of excess fluid intravasation. SGMM is extremely efficient and capable of removing 2 to 10 grams of tissue per minute (Figs. 7a, 7b, & 7c) in properly selected patients. Using this technique
the author has removed myomas as large as 8 centimeters (130 grams) without any other concomitant technique.

SGMM requires a well-prepared cervix — generally accomplished by the insertion of a 3-4 laminaria japonica the day prior to surgery. On the day of surgery the cervix is dilated 12 mm to 16 mm depending on the size of the myoma to be removed. It is not always desirable or necessary to remove most myomas intact. Instead the goals are to morcellate and remove them piecemeal, thereby avoiding grasping a myoma too large to be delivered through the cervix. The risks of SGMM include uterine perforation, rupture, and collateral visceral injury. Careful and continuous sonographic monitoring can all but eliminate these risks.

**CURRENT DENSITY**

In general, the author utilizes unmodulated (cutting) current to accomplish smooth electro surgical cutting and reserves coagulation current for the desiccation of small vessels. The determinants of power setting for a particular case include the texture and density of the tissue to be resected, the gauge and diameter of the cutting loop, and the type of resection technique. The myoma coring and sweeping techniques require delicate tissue handling and high current density to prevent any mechanical drag while performing electro surgical cutting. When employing UPES the author typically sets the cutting current at 140 to 240 watts depending on the variables already noted. A high power setting and the resulting current density is safe as long as the surgeon maintains his orientation at all times. The activation of cutting current is often associated with a characteristic sonographic appearance, which assists in tracking one’s progress. When employing BPES with the Autocon II 400, a saline-C-cut, effect 5 is generally employed.

**MANAGING “CHIPS AND STRIPS”**

Without the ongoing removal of myoma fragments — chips and strips — of tissue it is difficult to monitor one’s progress and maintain orientation. Tissue fragments can be removed individually after each resection cycle by trapping them between the inert electrode and the inner sheath. Another method employs ovum forceps to recover multiple tissue fragments at once. In order to avoid disorientation or the inefficiency of cutting strips that have already been detached from the myoma the author recommends retrieving tissue after 4 to 5 strips have been generated. The simple process of removing the resectoscope and allowing the intrauterine pressure to fall often facilitates extrusion of the intramural component of a myoma.

When cervical stenosis limits the number of “insertion-removal-reinsertion” cycles one may leave the outer sheath in place and remove the assembly consisting of inner sheath and inert loop along with the individual tissue strip.

**PUMP PRESSURE**

Adequate hysteroscopic visualization requires sufficient pressure to enable continuous flow and distention, bearing in mind that inordinate intrauterine pressure may cause excessive fluid intravasation. Garry et al., in an attempt...
to debar this complication, suggested the practice of setting pump pressure below the mean arterial blood pressure. This makes little practical sense, however, given the fact that commercial fluid management systems do not record intraperitoneal pressure, which falls dramatically when distention media is allowed to escape through the outflow port or from a leaking cervix. A more practical approach is to set the pump pressure at the upper limit available from the manufacturer, establish continuous flow, and adjust inflow and outflow as necessary to maintain both distention and visual clarity. Rather than slavish adherence to an arbitrary pump pressure setting the author is attentive to net fluid absorption, which is critically important in avoiding hyponatremia and encephalopathy. In the presence of brisk fluid absorption the author restricts flow through the inflow port of the resectoscope and adjusts the outflow to optimize visual clarity.

**MANAGING THE CERVIX**

A favorable cervix is essential to accomplishing SGHM. In fact, the presence of a small, stenotic, or friable cervix should be considered a relative contraindication to these techniques. Although considerable cervical dilation (12 to 16 mm) is a requirement for these techniques that require the insertion of large forceps (SGMM) the resultant over-dilation permits leakage of distention fluid and poses challenges in performing subsequent resectoscopic surgery. This problem can be corrected by placing several tenaculae at the lateral cervix in order to seal the leak of distention fluid from this point of egress. Once the leaking has been controlled (Fig. 8) uterine distention, continuous flow, and visualization can be restored.

**SPECIAL CASES: REMOVAL OF INTRAMURAL LEIOMYOMAS**

The same principles of SGHM that are effective in removing submucous leiomyomas are also useful in removing selected intramural (IM) myomas. Often IM myomas are excised during the course of an endomyometrial resection at which time they become unroofed and begin to extrude into the uterine cavity; in such instances the preservation of fertility is obviously not a factor.

However, patients occasionally present who have a symptomatic intramural leiomyoma — generally tangential to the endometrial cavity — that requires removal. Such myomas can be removed using an SGHM technique with care to avoid disruption of the endometrial surface. Figure 9 illustrates a 29-year-old woman with recurrent pregnancy loss and menorrhagia. After removing her laminaria, a knife electrode was used to cut the overlying endometrium on the posterior uterine wall until the pseudocapsule of the myoma was entered. After several minutes elapsed during which time no distention fluid was allowed into the cavity the myoma slowly extruded into the uterine cavity. In this fashion it could be safely removed in its entirety.

**CONCLUSION**

Hysteroscopic myomectomy offers the gynecologist the ability to safely perform a truly minimally invasive procedure that obviates the need for hysterectomy in well over 85% of properly selected candidates. Sonographic guidance is an extremely effective and non-invasive method of intraoperative
monitoring that can virtually eliminate uterine perforation. In addition, SG allows the use of efficient morcellation techniques that can be done with inexpensive, readily available, and reusable operative equipment.

The author is a consultant for Hologic Inc. (Bedford, MA).

REFERENCES