Laparoscopic Myomectomy Using Ultrasonic Dissection

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Laparoscopic myomectomy is gaining in popularity as a means of treating leiomyoma uteri, avoiding hysterectomy, and thereby preserving or restoring fertility, when compared with traditional laparotomic surgery. While technically demanding, a laparoscopic procedure has advantages beneficial to the patient; these include decreased postoperative pain and discomfort, decreased length of stay and cost, and more rapid return to full activity. The disadvantages of laparoscopic myomectomy include increased operative time, inability to palpate the uterus at myomectomy, and the requirement of advanced technical skills. We report on our experience with laparoscopic myomectomy for treatment of infertility, habitual abortion, or to treat symptomatic myomata while preserving fertility.

Optimal technique and proper patient selection criteria are both key to good outcome in this procedure. With the use of gonadotropin-releasing hormone (GnRH) agonists, the use of multilayer uterine closure, and adoption of the ultrasonic scalpel for dissecting out the myoma and subsequently morcellating the mass, we have experienced a decrease in our rate of conversion to open procedure. Postoperative recovery rate has been rapid, and length of stay and estimated intraoperative blood loss have been minimized.

INCIDENCE AND INDICATIONS

Uterine fibroids are the most frequent benign diagnosis requiring a hysterectomy, accounting for 30% of all procedures.[1] Leiomyomas are responsible for a range of symptoms, including pelvic pain, pressure, menorrhagia, occasional ascites or impingement, and infertility. Incidence is high, being found in 30% of women seen between the ages of 30 and 50 years.[1,2] Many patients in this age group seeking treatment for their chronic pain and periodic menorrhagia would logically prefer a myomectomy procedure to hysterectomy, if given the option. Abdominal myomectomy is performed currently with an "acceptable" morbidity rate, comparable to that of hysterectomy.[3] Consequently, the number of myomectomies performed has risen, including a twofold increase in the number performed laparoscopically and an even more dramatic increase in those performed hysteroscopically over the past few years.[4,5] As our skills as surgeons improve, and technologies to facilitate performance of myomectomies safely are developed, the complications associated with hysterectomy may be avoided by electing laparoscopic myomectomy in selected patients.[1]

In patients presenting with infertility, presence of leiomyomata is one factor among many to be considered. The mechanisms by which myomas interfere with fertility are not clear, but may include mechanical factors, such as distortion of the uterine cavity, possible tubal ostia occlusion, vascular and inflammatory or ulcerative changes in endometrium and underlying stroma preventing implantation, or possible biochemical alterations interfering with sperm transport, or endometrial hyperplasia or atrophy.[6-10] Some of the mechanical factors are reversible following myomectomy, and the uterus can regain its normal shape and volume.[9] In a fertility clinic, absolute indications for myomectomy include impingement on the uterine canal. Relative indications include anticipated impingement on the canal with pregnancy. Another potential indication for myomectomy may be in the patient who presents with a large myoma: if the myoma increases in size, outgrows its blood supply, and begins to break down during the initial months of pregnancy, the result for the patient will be intractable pain.

Figure 1. Myoma bed following infiltration of Pitressin.

We have performed 140 laparoscopic myomectomies over the past three years, including a series of 40 patients who underwent laparoscopic myomectomy as part of their treatment of primary or secondary infertility, or habitual abortion.[11] Of these 40 patients, we reported a pregnancy rate (PR) of 75% (n=30) and viable term delivery rate of 70% (n=28). These rates compare very favorably to pregnancy and viable term delivery rates reported in the literature. We report here on the technique which we have developed, and results to date regarding patient outcome.

PATIENT SELECTION AND PRETREATMENT

The criteria used to select patients for the laparoscopic procedure include patients with myomas 4 cm or greater that are entering, distorting, or impinging on the endometrial canal, or myomas 6 cm or greater near the endometrial canal. We have not included patients in whom there were more than five myomas greater than 4 cm, patients with any myoma greater than 10 cm, or patients who had more than seven myomas in total.

Parker and others have developed and advocated careful patient selection

Figure 2. LaparoSonic® Coagulating Shears, or LCS™.

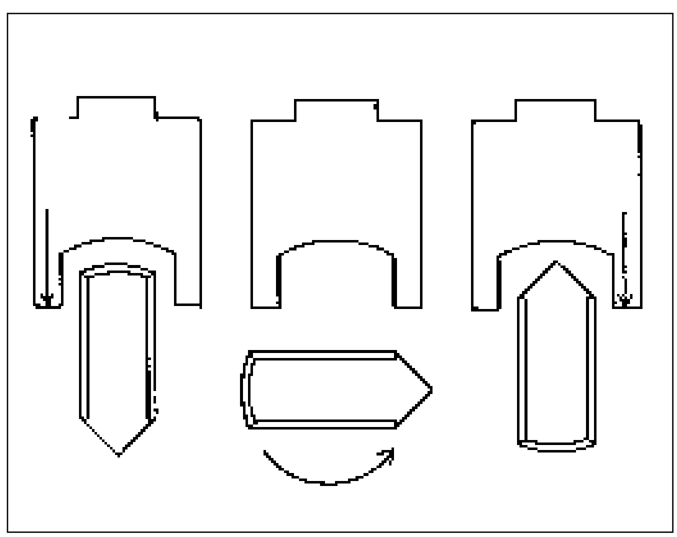

Figure 3. View of the LCS Blade shape in blunt (coagulate), flat coaptive, and shear (cut) modes.

through criteria developed for laparoscopic myomectomy similar to ours.[12] In a procedure which made use of the potassium-titanyl-phosphorous (KTP) laser, criteria included the following: uterine size less than or equal to 14 weeks after 12 weeks of GnRH-a therapy; no myoma larger than 7 cm; no leiomyoma near the uterine artery or tubal cornea; and at least 50% of the leiomyoma subserosal.

Gonadotropin-releasing hormone (GnRH) agonist, depot leuprolide acetate (Lupron, TAP Pharmaceuticals, North Chicago, Ill.), is used to pretreat patients for three to six months, when necessary to shrink larger fibroids prior to the surgical procedure. Myoma size in treated patients is monitored monthly by ultrasound, and if myomas continue to decrease in size, GnRH agonists are employed out to six months. Additionally pretreatment with GnRH agonists renders the myoma tissue softer, facilitating morcellation and removal. Finally, as the effects of GnRH agonists cause amenorrhea, anemia will be corrected in the patient with menorrhagia.

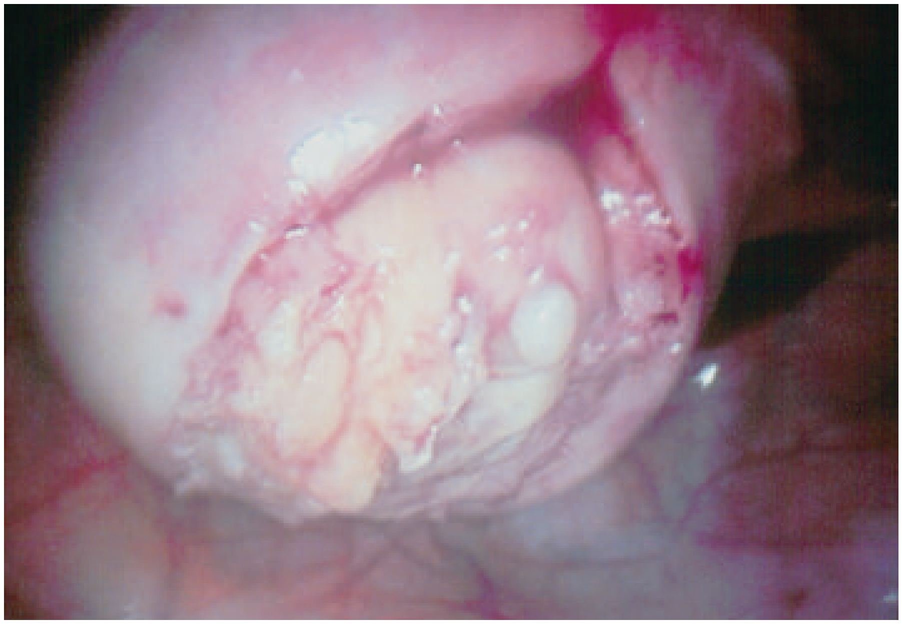

Figure 4. The LCS has been used to transect serosa and myometrium to the level of the myoma.

PROCEDURAL TECHNIQUE

In performing a myomectomy, there are two essential considerations: adequate hemostasis with minimization of blood loss, and prevention of postoperative adhesions.[2,6,7,13-15] Our technique has been developed based on the surgical tenets of careful approximation of tissue planes, meticulous hemostasis, prevention of desiccation, and the minimization of manipulation and trauma to the tissue.

To excise sessile subserosal or intramural myomata, dilute vasopressin (Pitressin, Parke-Davis, Morris Plains, N.J.) (30 units in 100 mL of saline) is injected into the myoma bed for the purpose of vasoconstriction (Fig. 1). Most recently, the ultrasonically activated LaparoSonic® Coagulating Shears (LCS™, UltraCision, Inc., Smithfield, R.I.) are used as a cutting, coagulating, grasping, and blunt dissection device during the procedure (Figs. 2, 3). Using the sharp side of the LCS blade, the uterine serosa is incised to the level of the myoma (Fig. 4). The myoma is stabilized with a myoma screw or laparoscopic single-toothed tenaculum. The LCS is then used as a blunt dissector to mobilize the myoma off the myoma bed, using the same technique as that used in the open procedure (Fig. 5). In a vascular area, hemostasis is maintained throughout the procedure by coapting vessels between the blunt side of the LCS blade and the serrated tissue pad, activating the blade to coagulate as necessary. Coagulation is achieved with the LCS at lower power levels for larger vessels, before continuing with higher power levels for cutting or morcellation of the myoma. The sharp edge of the LCS is used as a knife to morcellate the myoma for subsequent extirpation. Using this technique, morcellation is completed rapidly with proper traction. The technique is repeated for the rest of the myomas. Vascular pedicles of myomas are transected across the base using the clamp (blunt edge) coagulator mode, or with

Figure 5. Myoma bed after myoma has been extracted. Note: meticulous hemostasis without excess char or coagulum.

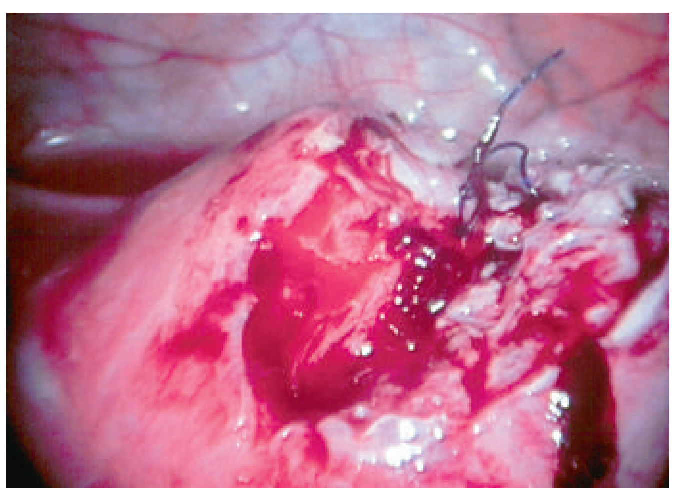

Figure 6. First layer of repair with 3-0 PDS.

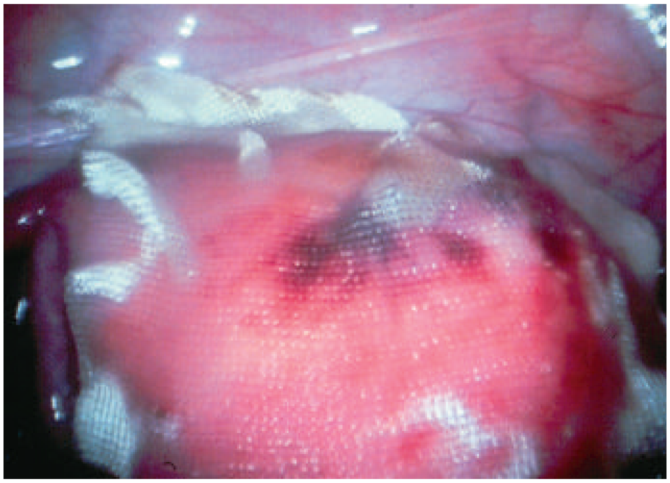

Figure 7. Second layer of repair with 4-0 PDS.

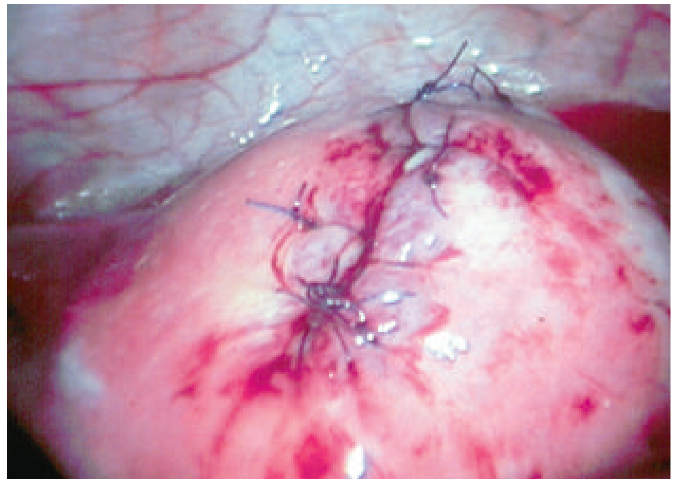

Figure 8. Uterus with repair completed.

the broad, flat surface of the LCS.

Uterine defects are always closed in multiple layers. To repair the uterus, interrupted sutures are used, placed via secondary instrumentation with ski needles. If the endometrial cavity is entered, the first layer is repaired with multiple simple sutures of interrupted 3-0 PDS-2 (polydioxanone, Ethicon, Inc., Somerville, N.J.) which are placed approximately 1.5 to 2.0 mm apart, directly above the endometrium (Fig. 6). The myometrium is then repaired with interrupted simple or mattress sutures of 3-0 PDS-2 (Fig. 7). The serosal layer is closed using 4-0 PDS-2 in a simple interrupted mattress style, or running technique (Fig. 8). Once meticulous hemostasis is achieved, Interceed (TC7, Ethicon, Inc., Somerville, N.J.) is applied over the uterine incision site. The recently introduced EndoStitch (United States Surgical Corp., Norwalk, Conn.) has the potential to facilitate suturing of uterine defects, as long as the myometrium is still repaired in layers, and tissue can be grasped adequately to ensure complete closure of the wound without undue trauma to the tissue.

RESULTS

We have performed 140 laparoscopic myomectomies. Average length of stay averages less than 23 hours. Estimated blood loss, including the initial cases when we first began to work with this modality, has been less than 200 cc and averages less than 100 cc. There have been no intraoperative complications in this series. With use of GnRH agonists to pretreat patients, and adoption of the LCS for dissection and morcellation, we have had to convert only once to an open procedure. Patients return to full activity within one to two weeks.

In a series of 40 patients who underwent laparoscopic myomectomy as part of their treatment of primary or secondary infertility, or habitual abortion, we reported a pregnancy rate (PR) of 75% (n=30) and viable term delivery rate of 70% (n=28), each comparing quite favorably with respective rates following myomectomy published in the literature.

DISCUSSION

As noted in the literature, myomectomy has been shown to reduce fetal wastage in fertility patients, reducing the rate of spontaneous abortion from 41% premyomectomy to 20% postmyomectomy.[16] In a study by Hasson et al., the pregnancy rate for laparoscopic myomectomy patients desiring fertility was 71%, demonstrating improved outcome over the rates reported in the literature for open myomectomy.[17] Although the fibroids were removed via a posterior culpotomy incision and therefore not purely through a laparoscopic procedure, this was the first indication in the literature that there might be benefits to the laparoscopic procedure in patients concerned with preserving or restoring fertility. This led us to consider the laparoscopic approach for patients whose presentation suggested they might benefit from this procedure. In our own limited pilot study, 15 laparoscopic myomectomy patients were evaluated at time of Caesarean section. In these patients, minimal adhesion formation, minimal scarring, and no indications of compromise to uterine integrity were noted. These observations led us to continue the laparoscopic approach in selected patients.

The procedure must be performed as atraumatically as possible. The propensity for blood loss if adequate hemostasis is not achieved, with attendant risks of transfusion or postoperative intestinal obstruction or distortion associated with adhesion formation, has been reported by others as troublesome complications.[16,18] In one recent retrospective study conducted at Brigham and Women's Hospital comparing the morbidity associated with hysterectomy versus myomectomy, the authors reported transfusion rates of 26% for abdominal hysterectomy, and 34% for open myomectomy patients.[18] In our experience, comparing our first 70 LAVH versus the last 70 LAVH procedures, we have observed a decline in complication rate from an initial 10% to essentially 0%, including no requirement for transfusion for any of the last 70 patients.

Operative time depends in large part on the amount of bleeding encountered as well as the size of the lesion to be removed. Selection of the appropriate instrumentation and energy source for safe dissection, maintaining hemostasis, and maximizing efficiency by decreasing exchange of instruments are key to minimizing operative time. GnRH agonists are also helpful: their ability to decrease the size of leiomyomata as well as the uterus, resulting in decreased blood loss during surgical procedures particularly in the case of large uteri, has been well documented.[19-20] We have found that another benefit to the use of GnRH agonists in advance of the procedure has been that they have softened the tissue, rendering it easier to morcellate and evacuate the fibroid via a complete laparoscopic approach. In addition, decreasing fibroids in size from 30% to 40%, facilitates myometrial closure. Although GnRH agonists could also cause the fibroid to become tenacious, that has not been a problem when utilizing the LCS, since ultrasonic energy allows easy transection of the myoma capsule. The cavitational effect of the instrument helps to separate tissue planes, rendering dissection of the myoma out of the uterus easier.

It has been our experience that large defects in the uterus must be closed in layers, just as in open myomectomy. It cannot be overemphasized that performing this procedure requires that the surgeon be comfortable with intracorporeal suturing, or at least extracorporeal knot tying. A 3-0 PDS-2 suture should be used because it is less traumatic to tissue than a braided suture such as Vicryl, Maxon, or Polysorb. A ski needle is preferred laparoscopically for ease in entering through laparoscopic ports, and to facilitate skimming across the myometrium, further avoiding unnecessarily deep trauma to tissue. We have noted no difference in postoperative adhesions using either a running baseball-style, simple interrupted, or mattress-style suturing technique for closing the serosa with 4-0 PDS sutures.

Dissection performed using ultrasonic energy results in decreased thermal damage. This may be of benefit in promoting improved healing and maintenance of uterine integrity by avoiding the extent of blanching and lateral char experienced with thermal modalities, and subsequent potential for tissue necrosis and postoperative adhesion formation. Proper use of energy to excise the myoma and provide hemostasis and the subsequent repair of the uterus in multiple layers are important. We are aware of only one report in the literature of myomectomy wound dehiscence.[21] Optimal healing must be the goal not only to restore normal architecture but also to close the dead space in order to decrease the potential for bleeding into the myometrium, and thereby decrease risk of subsequent breakdown and compromise of uterine integrity. We do not perform a posterior colpotomy incision in our patients interested in subsequent reproduction because of the concern of having a repair plane adjacent to another repair plane, and the subsequent risk of scar formation and potential adhesion formation in the cul-de-sac and posterior of the uterus. Rather, the fibroids are morcellated and removed via a secondary 12-mm port, a procedure facilitated by the use of the LCS, or other morcellating instruments being designed currently.

Taking these factors into consideration, the choice of laparoscopic approach versus open myomectomy must depend on the surgeon's skill and experience. The surgeon must be confident in providing adequate hemostasis and must be comfortable with laparoscopic suturing techniques to ensure maintenance of uterine integrity. Although we have performed 140 laparoscopic myomectomies, as well as other advanced procedures, we still consider laparotomy in cases of multiple myomectomies and for myomas larger than 10 cm.

USE OF ULTRASONIC ENERGY

The instrumentation which we have incorporated into our technique for laparoscopic myomectomy, the LaparoSonic® Coagulating Shears, or LCS™, has proven to be a safe, efficient tool for cutting, coagulating, and morcellating myomas. We first evaluated the Harmonic Scalpel hook blade for use in myomectomies. A series of 25 patients with symptomatic fibroids who underwent successful laparoscopic myomectomy performed using the Harmonic Scalpel hook blade for dissection and coagulation has already been reported.[22] The cutting and coagulating mechanism of action is ultrasonic energy, delivered by a blade vibrating at 55,500 Hz/sec.[23-24] Power levels are modulated by a setting at the generator as well as a choice of foot switches. With tissue under traction, the blade's vibration causes a decrease in pressure ahead of the blade edge, creating a cavitational effect facilitating dissection between the planes of tissue. By applying the broad side of the blade to coapt a vessel, activation of the blade causes it to vibrate, resulting in friction with the tissue. This heat from friction in the tissue causes protein to denature, resulting in a coagulum which seals the vessels. The blade is then rotated to transect the tissue.

While the scalpel affords a safe dissection technique, the development of the LCS permits application of the ultrasonically activated system to unsupported tissue. The LCS blade also vibrates 55,500 times per second and allows selection of various power levels, but incorporates both sharp and blunt edges. The LCS also includes a serrated tissue pad which, when closed on the blade, grasps the tissue or vessel to be coagulated or cut. Since no electrical current travels through the blade, there is no risk of stray electrical charge, or capacitive coupling, decreasing the hazard for the patient as well as the OR staff. If contact is made between the Harmonic Scalpel or LCS blades and other metal instruments, such as the myoma screw, the blade vibrating against metal is audible but presents no thermal or conductive hazard to the patient or surgeon. This instrument also allows safe blunt dissection of myomas without requiring additional exchanges of instrumentation. More recently, a significant modification was made when the active portion of the LCS blade was lengthened to 15 mm, allowing better visibility of the instrument tip and more rapid hemostatic dissection using the same, safe levels of ultrasonic energy. Additionally, this newer version permits coaption and coagulation with the broad, flat side of the blade, allowing larger vessels to be safely transected and enhancing the grasping capacity of the instrument.

By using ultrasonic energy, there is little or no generation of smoke, keeping the field of view in laparoscopic procedures clear and decreasing the potential for generation of toxins in the pneumoperitoneum.[25] There is some atomization of fluids with the Harmonic Scalpel or LCS, but the droplets rapidly fall out of view and do not obscure visibility or require evacuation, unlike the smoke from lasers or electrosurgery. Because the LCS uses ultrasonic energy to coagulate and cut tissue, thermal effect is greatly reduced,[26] and little or no char is produced. The decreased thermal damage was associated with improved healing in a preclinical model which compared laser, electrosurgery, ultrasonically activated scalpel, and regular scalpel blade.[27] This ability to provide superficial coagulation without the risk of fistula formation associated with thermal energy forms is essential to performing a safe laparoscopic myomectomy.

WOUND HEALING AND POSTOPERATIVE ADHESION FORMATION

Adhesion formation following open myomectomy is a common complication and compromises the efforts of preserving or restoring fertility. As reported by Hasson et al. in their clinical series, the estimated amount of blood loss and the frequency of adhesion formation associated with laparoscopic myomectomy both appear to be less than those reported with abdominal myomectomy.[17] Our experience supports this observation. Although it has been suggested that lasers in myomectomy may be a means to decrease postoperative adhesion formation, reports are uncontrolled and contradictory.[28] In fact, the presence of blood and char (typical of electrosurgery or lasers) has been associated with formation of postoperative adhesions.[29] The production of smoke by these modalities is also problematic. None of these modalities allows rapid morcellation. Electrosurgery is associated with increased depth of penetration and extended tissue necrosis, potentially leading to a weakened repair. Understandably, based on the experience with these thermal modalities, it was acknowledged that, until better instrumentation for hemostasis and morcellation were available, laparotomy would be safer for large myomas.[30]

When the ultrasonically activated scalpel was compared with electrosurgery, lasers and a regular scalpel, wound strength was also superior to that of lasers and electrosurgery.[27] In the porcine and rat models, the ultrasonically activated scalpel has been shown to be associated with reduced postoperative adhesion formation.[31-33] In our experience, the ultrasonically activated blades provide exceptional cutting effect as well as effective hemostasis, without the thermal damage seen with lasers and electrosurgery. Our ability to evaluate postoperative adhesion formation necessarily depends on the patient returning with an indication to reoperate. In the fertility patients who were seen at time of Caesarean delivery, and in the few second-look laparoscopies that we performed in patients unable to achieve pregnancy post-LCS myomectomy, we have been impressed by the paucity of postoperative adhesions when compared to the standard laparotomy patient. This supports the postulation by Bhatta and others that to deny the presence of char and blood may result in greatly decreased adhesion formation.[29] This is an important factor, since open myomectomy itself has been implicated as a cause of adhesions.[6] Gehlbach et al. reported that the number of myomas resected did not affect PR or myoma recurrence rate, but presence of adhesions significantly reduced the chance of conception.[28] Although we included the use of Interceed barrier over the uterine incision site, it should be noted that this is not effective if adequate hemostasis has not been maintained; use of this material in a bloody field may actually increase the potential for adhesions.[34-35]

We believe the minimal adhesion formation seen in our experience may be due to a number of factors. While the time taken to perform the laparoscopic myomectomy should be considered, the fact that the tissue is not allowed to dry decreases the risk of subsequent adhesion formation. We are using an enabling technology by incorporating a multifunctional instrument such as the LCS in this procedure, facilitating progress in the procedure by decreasing time taken to exchange instruments, as well as avoiding desiccation of tissue by avoiding the thermal-based modalities for cutting and coagulation. Also, we believe manipulation is kept to a minimum in a laparoscopic approach; we do not grasp the tissue in the laparoscopic procedure, as may occur in open procedures. These same techniques may be factors promoting uterine integrity, good healing, as well as decreased postoperative adhesions.

CONCLUSION

As advantages and disadvantages of various tools already at our disposal are scrutinized, we should see improvement in the quality of care afforded our patients. Laparoscopic myomectomy is a relatively new procedure, which compares favorably with the open approach. Our data to date supports the ameliorative effect of laparoscopic submucosal myomectomy. We must be able to offer a procedure with repair equal to that achievable with open myomectomy. As physicians, we must make sure that our skill base improves adequately to adopt this new approach safely and keep pace with patients' expectations for improved outcomes. By incorporating cost-effective and enabling technologies which assist in the safe transition to the laparoscopic procedure, by realistically assessing our capabilities, and by recognizing the need for additional courses in learning a new laparoscopic procedure, this process need not be out of our control, nor weighted with increased complication rates. STI

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