Indications for morcellation in gynecologic surgery

William H. Parker

Purpose of review
Minimally invasive gynecologic procedures, in particular laparoscopic hysterectomy and myomectomy, often require tissue morcellation.

Recent findings
Whether morcellated or not, myometrial cells can be found in the abdomen and pelvis after either laparoscopic or open myomectomy. Following morcellation, careful inspection for and removal of tissue fragments and copious irrigation and suctioning of fluid can remove residual tissue and cells without the use of containment bags. The dogma of not 'cutting-through' cancer is not correct for many surgical specialties and irrelevant with regards to leiomyosarcoma (LMS) and minimally invasive gynecologic surgery. Eliminating residual disease in the pelvis and abdomen should be the goal of myomectomy or hysterectomy.

Summary
Morcellation of excised tissue is necessary for many women with symptomatic fibroids who choose to undergo laparoscopic myomectomy or hysterectomy. LMS is an uncommon disease, with a poor prognosis due to early hematogenous metastasis to lung, bone and liver. Preoperatively, it is often difficult to differentiate from benign fibroids. LMS has a high propensity for local recurrence despite performance of total hysterectomy. Efforts to remove all tissue and cells from the pelvis and abdomen should be the goal of minimally invasive surgery with morcellation.

Keywords
cancer cut-through, fibroids, morcellation, uterine leiomyosarcoma

INTRODUCTION

Tissue morcellation is necessary for many minimally invasive myomectomies or hysterectomies when fibroids are the indication for surgery. Occult leiomyosarcoma (LMS) is extremely rare among women having surgery for presumed fibroids, with a prevalence of about one in 2000 women. We discuss here the issues of 'cut-through' tumor and residual disease, as they relate to LMS and suggest techniques to reduce the risk of leaving tissue in the pelvis following morcellation.

Morcellation describes a surgical method of dividing tissue into small sections to allow the tissue to be removed from the abdomen through small abdominal or vaginal incisions. For a woman with a fibroid larger than 4 cm or a uterine size greater than 11.5 weeks, reducing the size of the tissue is usually necessary to remove tissue either through the vagina or a minilap incision [1]. Used during laparoscopic hysterectomy and myomectomy, morcellation allows many women the benefits of minimally invasive surgery. When compared with open abdominal surgery, these benefits include lower mortality rates, fewer intraoperative and postoperative complications, less postoperative pain with less need for narcotic pain medication, shorter hospital stays and faster return to work and family [2].

Morcellation performed with a scalpel at the time of vaginal and minilaparotomy hysterectomies and myomectomies has been utilized for many years. The first mechanical morcellators were hand-operated via repeated squeezing of the instrument handle, which activated a small cutting mechanism at the working end of the instrument. Very small (<1 cm) pieces of tissue could be sequentially removed, but hand morcellators were inefficient and limited the size of uteri and fibroids that could be removed [3]. In addition, the repetitive motion needed to operate

Department of Reproductive Medicine, UC San Diego School of Medicine, San Diego, California, USA

Correspondence to William H. Parker, Health Science Clinical Professor, Department of Reproductive Medicine, UC San Diego School of Medicine, San Diego, California, USA. Tel: +1 858 280 8023; e-mail: w1parker@ucsd.edu

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KEY POINTS

- LMS is an aggressive cancer, with a propensity for early distant metastasis and frequent occurrence of local recurrence, even when total hysterectomy has been performed without morcellation.
- Eliminating residual disease in the pelvis and abdomen should be the goal of myomectomy or hysterectomy.
- If LMS is inadvertently found, it is likely that the longer the delay until reoperation, the more likely that LMS tissue could implant, grow, invade blood vessels and spread to distant sites.
- When morcellation is complete, we advise looking carefully for and removing tissue fragments from the pelvis and abdomen, followed by irrigation of the peritoneal cavity with 3 l of normal saline with the patient in Trendelenburg and reverse Trendelenburg.

the instrument caused hand-fatigue and, on occasion, carpal tunnel syndrome for the surgeon. The first electromechanical (power) morcellator employed a rotating sharp hollow blade through which the pieces of tissue could easily be divided and removed. This instrument (and others) greatly improved the surgeon's ability to remove large volumes of tissue from the abdomen and allowed minimally invasive surgical procedures to be available to many women with larger uteri and fibroids. The rotational forces of the morcellator blade can, however, scatter tissue fragments inside the abdomen. In cases of benign fibroids, if tissue fragments are not all removed, they can, on rare occasion, attach to viable tissue, grow and cause symptoms requiring subsequent surgery. For women with undiagnosed LMS, retained tissue may lead to implantation and local growth of the cancer.

Morcellation should not be performed in the presence of known or suspected uterine or cervical malignancy. Ultrasound or MRI findings of a large irregular vascular mass, often with irregular anechoic (cystic) areas reflecting necrosis or enhancement of uterine masses on MRI with gadolinium imaged in the arterial phase, should be viewed with caution. The risk of LMS is higher in older postmenopausal women, and greater caution should be exercised prior to recommending morcellation procedures for menopausal women with new symptoms or with documented enlargement of the uterus after menopause, in the absence of menopausal hormone therapy. Uterine bleeding after menopause in a woman with an enlarged uterus should be evaluated with endometrial biopsy, which occasionally may detect LMS prior to surgery.

THE CONTROVERSY

Although uterine fibroids are extremely common, affecting almost 80% of all women by age 50 years, the uterine muscle wall cancer, LMS, is very uncommon, diagnosed in about 1600 women in the United States each year. Fibroids may cause symptoms that lead to surgery, but they are benign. LMS is an aggressive cancer and has a poor prognosis due to early hematogenous spread, even in early-stage disease. The 5-year survival for stage I LMS is 61% and for stages III and IV, is about 30% [4]. On the contrary, at the present time, a reliable method of preoperative diagnosis of LMS is not available, and it is difficult to differentiate this disease from benign fibroids.

LMS is a rare disease, even in women having symptoms from presumed fibroids that warrant surgery. Pritts *et al.* [5] recently published a rigorous meta-analysis of 133 studies of women having surgery for presumed fibroids and determined that the prevalence of LMS was one in 1960, or 0.051%. Recently updated by the Agency for Health Research and Quality (AHRQ) of the US Department of Health and Human Services with an additional 14 studies including 91 294 more surgeries published after the Pritts report, AHRQ calculated a prevalence of LMS of one in 1429 (0.07%) cases of surgery for presumed fibroids.

The currently accepted treatment for uterine sarcoma is removal of the entire uterus with the tumor intact, that is total abdominal hysterectomy. However, patients usually succumb to metastatic disease rather than intraperitoneal tumor growth. In a retrospective analysis of 113 women with metastatic LMS, 48% had Federation of International Gynecology and Obstetrics stage I and 15% had stage II, and 33% had stage III or IV tumors at the time of diagnosis [6]. Of the 113 patients, 111 patients underwent hysterectomy and two were treated with chemotherapy. Despite the en-bloc removal of the primary tumor, the median time from diagnosis to metastases was 7 months. Lung was the most common site of metastases (74%) followed by the peritoneum (41%), bones (33%) and liver (27%). Despite en-bloc resection of the tumor, local tumor recurrence developed in 50% of these women. These data are consistent with the aggressive nature of LMS, with a propensity for early metastasis and frequent occurrence of local recurrence, even when hysterectomy has been performed. Due to the early metastatic nature of the disease, it is not definitively known whether tissue spread and retention of tumor fragments that can result from unintended tumor morcellation changes the prognosis of women with LMS.

Currently, there is no evidence that the type of morcellation, electromechanical or scalpel, alters survival for women with LMS. AHRQ analyzed 16 studies that included 196 women with sarcomas and reported no significant difference in 5-year survival rates between women having electromechanical morcellation, scalpel morcellation or no tissue morcellation [7]. Importantly, laparoscopic-aided morcellation allows the surgeon to inspect the pelvic and abdominal cavities, remove tissue fragments and copiously irrigate and suction under visual control. In contrast, the possibility of retained tissue fragments is greater with vaginal or minilaparotomy morcellation procedures, as the surgeon cannot visually inspect the peritoneal cavity. In fact, the vast majority of women analyzed in the available LMS survival data had vaginal or minilap morcellation with a scalpel, and not electromechanical morcellation [8–12].

BIOLOGY OF THE TUMOR

Cancer has different behavior based on the differentiation of the cells and the specific biology of the tumor. For instance, melanoma has a great propensity for early metastasis through lymphatics and blood vessels and lung cancer and LMSs are highly aggressive cell types that often metastasize early. In contrast, prostate cancer is often indolent and slow to grow or metastasize. We know little about the biology of LMSs: we do not know how quickly a primary tumor will invade into vessels, and we do not know how long it takes retained tissue fragments to attach to viable tissue, invade through the tissue and into blood vessels.

A study of the disease of uterine sarcomas found that less aggressive sarcomas, such as low-grade endometrial stromal sarcomas, rarely invaded through the wall of blood vessels and into the lumen in which they are able to delaminate and spread [13]. Microscopy showed tumor cells coated by a fibrous band of tissue derived from the vessel endothelium. However, high-grade endometrial stromal sarcoma usually had tumor cells invading completely through the endothelium and directly exposed to the circulation. Likewise, 100% (12 of 12) of stage I or II uterine LMSs already had tumor cells invading through the endothelium and exposed to circulating blood. The authors hypothesized that even simple manipulation of the uterus during surgery might increase delamination of these cells and increase the risk of metastasis. If LMS is inadvertently found, time to reoperation may be important. It is likely that the longer the delay until reoperation, the more likely that LMS tissue would implant, grow, invade blood vessels and spread to distant sites. Many of the cited studies examining survival following diagnosis of occult LMS report many months-long intervals to reoperation, with one study reporting a *mean* interval of 20 months.

THE FALLACY OF CUT-THROUGH CANCER

Tissue morcellation has been criticized by some, as in the rare instances of morcellation of occult LMS, cutting through cancer would be a recognized breach of the standard of care in all surgical fields. However, the surgical dogma of requiring en-bloc resection without cutting through cancer has been challenged in many surgical fields. Piecemeal removal of sinonasal, laryngeal, oropharyngeal and hypopharyngeal cancers is currently performed. Analysis of treatment outcomes for these head and neck cancers shows that piecemeal removal does not compromise tumor control [14▪]. The authors concluded, 'it is time to acknowledge that this time-honored dictum of avoiding tumor violation is no longer valid in selected situations'. In gynecology, stages II–IV ovarian cancer is routinely treated by surgical tumor debulking. Although the surgical goal may be minimal or no residual disease, surgery usually involves multiple instances of cutting through tumor to remove disease.

For melanoma, perhaps one of the most malignant cancers and with a known propensity to metastasize early, the standard of care has been wide local excision (WLE). However, melanoma *in situ* is now often treated by Mohs micrographic surgery (MMS). Sequential thin cuts are made through the tumor until the margins of excised tissue are free of tumor cells. Often, two to four 'cut-throughs' of melanoma are performed to achieve clear margins. A study of 277 patients treated with MMS and 385 treated with WLE found the overall recurrence rate was 1.8% in the MMS group and 5.7% in the WLE group ($P = 0.07$). Five-year overall survival was equivalent when MMS with multiple cut-throughs (92%) was compared with WLE (94%) [15].

Moreover, studies of prostate cancer, renal cell carcinoma and head and neck cancers show that positive surgical margins are not the main determinant of prognosis; tumor grade, patient age and serum tumor marker levels were the best predictors of survival [16]. Port-site metastasis following laparoscopic surgery for renal cell carcinoma has been found in patients without specimen morcellation or tumor rupture. Again, the best predictors of port-site metastasis were biologic factors, such as high tumor grade [17].

Importantly, in the instances of sequential resection of cancer or positive surgical margins, cancer is cut through while the tissue is still attached

to blood vessels and lymphatics, allowing the possibility of cells being dispersed through these channels with the possibility of distant metastasis. During minimally invasive gynecologic surgery, including hysterectomy and myomectomy, morcellation is accomplished after the specimen has been surgically separated from adjacent tissue, blood vessels and lymphatics. Therefore, the probability of morcellation causing hematogenous or lymphatic spread during the morcellation procedure is nil.

RESIDUAL DISEASE IS THE KEY

Residual disease at the end of surgery is a predictor for survival and prognosis in many cancers, notably ovarian cancer, head and neck cancers, gastro-intestinal cancers and lung cancer. The goal of most cancer surgery is to minimize residual disease. A study of abdominal myomectomy, performed on exteriorized uteri, showed that myoma cells can be identified in fluid aspirated after hysterotomy, myoma enucleation and closure of the hysterotomy [18▪]. During the performance of a laparoscopic myomectomy, consider that the uterus is incised to gain access to the fibroid which is grasped with a tenaculum, separated away from the myometrium with sharp dissection and teased away from the overlying pseudocapsule. The fibroid is placed in the pelvis or abdomen while the hysterotomy incision is sutured closed. The myoma is then retrieved for morcellation. If the fibroid is placed in a containment bag, smooth muscle cells and tissue fragments are already present in the pelvis and abdomen [19▪]. Some surgeons are concerned that containment bags may make morcellation more cumbersome and less safe by obscuring nearby bowel or blood vessels and may increase the risk of inadvertent injury to these structures. In addition, use of a containment bag adds approximately 26 min to the surgical time, time that could be used for more thorough inspection for tissue fragments and copious irrigation [20].

A number of techniques can be utilized to limit tissue dispersal during morcellation and to remove fragments and cells from the peritoneal cavity. During morcellation of smaller tissue fragments, we 'pulse' the morcellator blade on and off every second to limit rotational forces that can scatter and disperse tissue inside the peritoneal cavity [21]. When morcellation is complete, we look carefully for and remove tissue fragments from the pelvis and abdomen. We irrigate the peritoneal cavity and diaphragms with saline with the patient in Trendelenburg, shift the patient into reverse Trendelenburg and allow the fluid to flow down into the pelvis, carrying small tissue fragments and cells with it. This procedure is performed multiple times, using 3 l of saline. When no further tissue fragments are seen and when the effluent is clear, we end the procedure. A recent study of laparoscopic myomectomy patients showed that, following hysterotomy, dissection and removal of the fibroid and suturing of the myometrial defect (but before morcellation), myometrial cells could be found in aspirates of irrigation fluid. Following morcellation and careful removal of tissue fragments and irrigation with 3 l of sterile saline or water, as described above, no myometrial cells were found [22]. It seems highly prudent, whether a containment bag has been used or not, to meticulously search for tissue fragments and copiously irrigate and suction the pelvis and abdomen.

MORCELLATION AND PATIENT INJURY

A 2014 review of the Medical Device Reporting and the Manufacturer and User Facility Device Experience databases, both voluntarily reported, and a medical literature search for adverse events related to the use of power morcellators found 55 morcellator-related complications over 20 years (1992–2012) [23]. Injuries included the following: intestine ($n = 31$), vascular system ($n = 27$), kidney ($n = 3$), ureter ($n = 3$), bladder ($n = 1$) and diaphragm ($n = 1$). There were also 15 reports of retained tissue including dissemination of benign fibroids, endometriosis and adenomyosis. Surgeon inexperience was thought to be a key factor contributing to injury.

The authors' suggestions regarding morcellator safety included

(1) Upon insertion of the morcellator into the abdomen, the blade should be covered and insertion should be under direct vision and away from vital structures.
(2) During morcellation, the specimen should be handed to the morcellator tenaculum to decrease the risk of the tenaculum inadvertently grasping viscera.
(3) The tenaculum and morcellator blade should remain in view at all times and the morcellator blade should remain near the anterior abdominal wall and away from viscera and the great vessels.
(4) During activation of the morcellator blade, the tissue should always be brought to the morcellator – the morcellator should not be advanced toward the specimen.
(5) The pneumoperitoneum should be maintained at all time, and if rapid loss of pneumoperitoneum occurs, the morcellator blade should

be visualized and moved away from vital structures.
(6) Every visible fragment of tissue should be removed, and careful inspection should be made to confirm the absence of retained tissue.

WHAT RESTRICTED MORCELLATION MEANS FOR WOMEN

Restriction of morcellation, including vaginal and minilaparotomy morcellation, limits women with symptomatic fibroids to one option, total abdominal hysterectomy. For women with fibroids larger than a 11.5-week pregnancy size [1], which most often require either scalpel or power-morcellation to remove tissue, restriction of morcellation eliminates the following procedures:

(1) vaginal hysterectomy (scalpel morcellation)
(2) minilaparotomy hysterectomy (scalpel morcellation)
(3) laparoscopic hysterectomy (scalpel morcellation)
(4) laparoscopic supracervical hysterectomy (cervix cut-through)
(5) open supracervical hysterectomy (cervix cut-through)
(6) laparoscopic myomectomy (power morcellation)
(7) minilaparotomy myomectomy (scalpel morcellation)
(8) hysteroscopic myomectomy (intrauterine morcellation)
(9) uterine artery embolization (no specimen and will delay diagnosis)
(10) high-intensity focused ultrasound (no specimen and will delay diagnosis).

A study found that in the 8 months following the federal drug administration (FDA) safety communication, utilization of laparoscopic hysterectomies decreased by 4.1% ($P = 0.005$) and both abdominal and vaginal hysterectomies increased (1.7%, $P = 0.112$ and 2.4%, $P = 0.012$, respectively). Major surgical complications (not including blood transfusions) significantly increased from 2.2 to 2.8% ($P = 0.015$), and the rate of hospital readmission within 30 days also increased from 3.4 to 4.2% ($P = 0.025$) [24▪▪]. These findings merit consideration as women weigh the pros and cons of minimally invasive surgery with morcellation versus open surgery. Women should undertake shared decision-making with their surgeon and consider the risks and benefits of minimally invasive surgery with morcellation and decide for themselves whether the procedure is appropriate for them. Women have a right to this self-determination.

CONCLUSION

Minimally invasive gynecologic surgery has many advantages over open abdominal surgery and benefits many women. For fibroids or uteri larger than 12-week size, morcellation is necessary to remove tissue. Whether contained or uncontained morcellation is performed, the goal should be to entirely remove the morcellated tissue and avoid 'residual disease'. Careful inspection for tissue fragments and copious irrigation and suctioning (3 l of fluid) may avoid residual tissue. However, occult LMS is associated with local and distant metastasis/recurrence, even if total hysterectomy without morcellation is performed.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES AND RECOMMENDED READING

Papers of particular interest, published within the annual period of review, have been highlighted as:
▪ of special interest
▪▪ of outstanding interest

1. Wolfe M, Biest S, Tutlam N, *et al.* Preoperative factors that predict the need to morcellate in total laparoscopic hysterectomy. J Minim Invasive Gynecol 2017. [Epub ahead of print]
2. Nieboer TE, Johnson N, Lethaby A, *et al.* Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev 2009; CD003677.
3. Parker W, Rodi I. Patient selection for laparoscopic myomectomy. J Am Assoc Gynecol Laparosc 1994; 2:37–40.
4. Kosary CL. Cancer of the corpus uteri in SEER survival monograph: cancer survival among adults: U.S. SEER program, 1988–2001, patient and tumor characteristics. In: Ries LAG, Young JL, Keel GE, editors. NIH pub. no. 07-6215. Bethesda, MD: NIH; 2007.
5. Pritts E, Vanness D, Berek J, *et al.* The prevalence of occult leiomyosarcoma at surgery for presumed uterine fibroids: a meta-analysis. Gynecol Surg 2015; 12:165–177.
6. Tirumani S, Deaver P, Shinagare A, *et al.* Metastatic pattern of uterine leiomyosarcoma: retrospective analysis of the predictors and outcome in 113 patients. Gynecol Oncol 2014; 25:306–312.
7. AHRQ. (pending release).
8. Perri T, Korach J, Sadetzki S, *et al.* Uterine leiomyosarcoma: does the primary surgical procedure matter? Int J Gynecol Cancer 2009; 19:257–260.
9. Morice P, Rodriguez A, Rey A, *et al.* Prognostic value of initial surgical procedure for patients with uterine sarcoma: analysis of 123 patients. Eur J Gynaecol Oncol 2003; 24:237–240.
10. George S, Barysauskas C, Serrano C, *et al.* Retrospective cohort study evaluating the impact of intraperitoneal morcellation on outcomes of localized uterine leiomyosarcoma. Cancer 2014; 120:3154–3158.
11. Oduyebo T, Rauh-Hain AJ, Meserve EE, *et al.* The value of re-exploration in patients with inadvertently morcellated uterine sarcoma. Gynecol Oncol 2014; 132:360–365.

12. Pritts EA, Parker WH, Brown J, Olive DL. Outcome of occult uterine leiomyosarcoma after surgery for presumed uterine fibroids: a systematic review. J Minim Invasive Gynecol 2015; 22:26–33.
13. Roma AA, Barbuto DA, Samimi SA, *et al.* Vascular invasion in uterine sarcomas and its significance. A multiinstitutional study. Hum Pathol 2015; 46:1712–1721.
14. ▪ Robbins KT, Bradford CR, Rodrigo JP, *et al.* Removing the taboo on the surgical violation (cut-through) of cancer. JAMA Otolaryngol Head Neck Surg 2016; 142:1010–1013.

A number of surgical fields are rethinking the dogma of 'never cut-through cancer'. Patients with head and neck surgery have no decline in survival if these cancers are removed piecemeal.

15. Nosrati A, Berliner JG, Goel S, *et al.* Outcomes of melanoma in situ treated with Mohs micrographic surgery compared with wide local excision. JAMA Dermatol 2017; 153:436–441.
16. Retèl VP, Bouchardy C, Usel M, *et al.* Determinants and effects of positive surgical margins after prostatectomy on prostate cancer mortality: a population-based study. BMC Urol 2014; 14:86.
17. Song J, Kim E, Mobley J, *et al.* Port site metastasis after surgery for renal cell carcinoma: harbinger of future metastasis. J Urol 2014; 192: 364–368.
18. ▪ Sandberg EM, van den Haak L, Bosse T, Jansen FW. Disseminated leiomyoma cells can be identified following conventional myomectomy. BJOG 2016; 123:2183–2187.
19. ▪ Toubia T, Moulder JK, Schiff LD, *et al.* Peritoneal washings after power morcellation in laparoscopic myomectomy: a pilot study. J Minim Invasive Gynecol 2016; 23:578–581.

The article and the Sandberg *et al.* [18▪] article found myometrial cells in irrigation following abdominal (Sandberg) and laparoscopic (Toubia) myomectomies. It is unlikely that containment bags will obviate the need for copious irrigation for myomectomy patients.

20. Vargas MV, Cohen SL, Fuchs-Weizman N, *et al.* Open power morcellation versus contained power morcellation within an insufflated isolation bag: comparison of perioperative outcomes. J Minim Invasive Gynecol 2015; 22:433–438.
21. Arkenbout EA, van den Haak L, Driessen SR, *et al.* Assessing basic 'physiology' of the morcellation process and tissue spread: a time-action analysis. J Minim Invasive Gynecol 2015; 22:255–260.
22. Yu S, Lee B, Han M, *et al.* Irrigation after laparoscopic power morcellation and the dispersal of leiomyoma cells: a pilot study.(in review JMIG).
23. Milad MP, Milad EA. Laparoscopic morcellator-related complications. J Minim Invasive Gynecol 2014; 21:486–491.
24. ▪▪ Harris JA, Swenson CW, Uppal S, *et al.* Practice patterns and postoperative complications before and after Food and Drug Administration Safety Communication on power morcellation. Am J Obstet Gynecol 2016; 214: 98.e1–98.e13.

Analysis of a Michigan State healthcare outcome database found that since the FDA advisory on morcellation, laparoscopic hysterectomy rates decreased, abdominal hysterectomy rates increased and postoperative morbidity increased.