ELECTRICAL PROSTATE MORCELLATOR: AN ALTERNATIVE TO MANUAL MORCELLATION FOR LAPAROSCOPIC NEPHRECTOMY SPECIMENS? AN IN VITRO STUDY

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ABSTRACT

Objectives. To compare the safety and efficacy of morcellation with the electrical prostate morcellator (EPM) or manual morcellation of the kidney, using an internal view within the morcellation sac.

Methods. Thirty porcine kidneys, mean renal mass 174.5 g, were divided into three groups of 10. All morcellations were performed inside the LapSac. Groups 1 and 2 underwent morcellation using the EPM, monitored inside the LapSac using the nephroscope and outside the LapSac with the laparoscope, respectively. Group 3 underwent manual morcellation with ring forceps. The groups were assessed for morcellation time, fragment size, and LapSac integrity.

Results. In group 1, one pinhole perforation occurred; in group 2, nine perforations occurred (five large and four pinhole). No perforations occurred (P < 0.001) in group 3 (manual morcellation). The mean morcellation time for groups 1 through 3 was, respectively, 86.9, 47.1, and 15.1 minutes (P < 0.0001). The corresponding mean fragment size was 0.011, 0.015, and 1.36 g. The difference in mean fragment size was significantly different between the manual morcellation group and the EPM groups (P < 0.001), but not between the two EPM groups (P = 0.12).

Conclusions. Manual morcellation was safe, fast, and superior to morcellation with the EPM monitored either inside or outside the LapSac. The high rate of LapSac perforation precludes the use of EPM after laparoscopic radical nephrectomy in the clinical forum.


The first laparoscopic radical nephrectomy (LRN) was performed in 1990 by Clayman and colleagues. They used morcellation and extraction of the kidney specimen through an 11-mm trocar site. For some surgeons, the preferred means of organ removal remains controversial. One concern is tumor seeding. Clinical reports of local recurrence of renal tumor cells and port site seeding after LRN have been published. The LapSac (Cook Urological, Spencer, Ind) is a retrieval sack that is impermeable to tumor cells and fluid leakage. It is a thicker, sturdier bag and is the only entrapment sack currently used for clinical morcellation of laparoscopic nephrectomy specimens.

Other retrieval bags exist, such as the EndoCatch II (U.S. Surgical, Norwalk, Conn), but the EndoCatch II, with its thin wall, is contraindicated for morcellation and is indicated only for intact specimen removal through at least a 5-cm or larger incision. Maintaining the integrity of the LapSac is crucial for safe organ extraction. The risk of perforation occurring during morcellation of solid organs, the extraction time, and the size of the fragmented specimens are important measures to consider when choosing the optimal method of morcellation.

Renal morcellation after laparoscopic nephrectomy has traditionally been performed either with the high-speed electrical laparoscopic morcellator or by manual morcellation. Some studies reported manual morcellation to be tedious and time consuming. Unforeseen morbidity has also led to the removal of the high-speed electrical laparoscopic morcellator from clinical availability. A newer, safer method of morcellation would therefore be of
great benefit. The Coherent electrical prostate morcellator (EPM; Coherent, Sturgbridge, Mass) was constructed for intravesical morcellation and extraction of prostatic tissue after holmium laser transurethral prostatectomy. It is specifically designed to work in a fluid environment. Landman et al. investigated the use of the Coherent EPM for renal morcellation and proved the EPM was feasible for morcellation of the kidney. However, they used the EPM to perform morcellation under laparoscopic visualization outside a clear plastic retrieval sack, the EndoCatch II, using an external view. The present study used the LapSac, which is a sturdier and thicker bag. Furthermore, we hypothesized that electrical morcellation under direct visualization using the nephroscope within the LapSac might decrease the risk of perforation and increase the efficiency of morcellation. In this study, we evaluated the safety and efficacy of morcellation with the EPM under both internal and external visualization, as well as using manual morcellation.

MATERIAL AND METHODS

All morcellations were performed inside a LapSac, in a pelvic trainer constructed to mimic in vivo morcellation by way of two 12-mm trocar sites through a 0.5-in. thick abdominal wall. All procedures were performed under direct laparoscopic visualization. We collected 30 porcine kidneys that had been discarded from a local butcher store and randomly divided them into three groups of 10 for evaluation. The frozen porcine kidneys were thawed to room temperature and then warmed in a 37°C water bath. Each kidney was weighed. The time required for complete morcellation was recorded for each trial. After complete morcellation, the fragments were counted and weighed, and the mean fragment weight was determined. After morcellation, LapSac perforation was assessed in each trial. The sacks were visually inspected, cleaned with tap water, dried overnight, and filled with indigo carmine-stained saline. The sacks were again visually inspected for pinholes.

For group 1, morcellation using the EPM was performed under direct visualization, with the nephroscope inside the LapSac (Fig. 1). The EPM is designed for use in a fluid medium. Therefore, liquid-filled LapSacs (0.9% saline) were first accessed through a laparoscopic trocar. During the course of morcellation, a 26F nephroscope with saline irrigation was introduced into the containment sack to provide internal, direct visualization to test the hypothesis that an internal view may prevent perforation. After morcellation, all fragments were removed through the trocar.

For group 2, morcellation using the EPM was also performed in a fluid environment, but was monitored by external laparoscopic visualization outside the LapSac. After morcellation, the fragments were also removed through the trocar.

For group 3, manual morcellation was performed with ring forceps. The mouth of the sack was brought to the body surface through a port site. A sponge stick was inserted into the bag by way of the morcellation port. Under direct visualization, when the forceps touched a portion of the kidney, we clinched a piece of specimen and pulled it out of the bag. This procedure was done step by step. The collecting system, which could not be destroyed, was pulled outside the body with the LapSac. This morcellation process was also monitored using the laparoscopic camera inside the LapSac.

RESULTS

The experimental data are shown in Table I. In group 1, using the EPM under internal visualization, one pinhole perforation occurred. In group 2, using the EPM monitored by laparoscopic visualization outside the LapSac, nine perforations, including five large (Fig. 2) and four pinhole, occurred. In the manual morcellation group, no perforations occurred (P <0.001).

The mean kidney weight was 174.5 g, and the difference was not statistically significant among the groups. The mean morcellation time for manual morcellation was 15.1 minutes. This was significantly faster than the morcellation trials with the EPM under internal visualization (86.9 minutes, P <0.0001) and external visualization (47.1 minutes, P <0.0001).

The mean fragment size for manual morcellation was 1.36 g (Fig. 3). This was significantly larger than the morcellation products using the EPM under internal visualization (P <0.0001) and external visualization (P <0.0001). No statistically significant difference was noted between the two EPM groups (P = 0.12), with a mean fragment size of 0.011 g and 0.015 g.

COMMENT

During the past decade, laparoscopy has become a practical and acceptable alternative to treat complex surgical diseases. In treating urologic lesions, laparoscopy was used first to remove pelvic lymph nodes of patients with urologic cancer. In June 1990, the first laparoscopic nephrectomy was accomplished. Laparoscopy rapidly evolved from a diagnostic modality to a radical extirpative procedure. However, the optimal method of morcellation and specimen extraction remains to be defined.
A concern with the use of laparoscopy in the treatment of renal malignancies has generated a great deal of controversy because of the fear of inadequate cancer control. Early laparoscopic experiences in surgical and gynecologic published reports have raised concerns regarding the risk of port site seeding after morcellation. Port site recurrence after laparoscopic procedures in patients with other cancers, including colon cancer, gallbladder cancer, bladder cancer, and prostate cancer, has been described.\textsuperscript{11–18} To date, two reports of port site seeding after LRN for renal cell carcinoma have been published.\textsuperscript{6,7} Fentie \textit{et al.}\textsuperscript{6} reported 1 case of port site recurrence after laparoscopic resection of renal cell carcinoma, during which the specimen was fragmented with the electrical mechanical morcellator in combination with sponge-holding forceps to remove the larger pieces. Castilho \textit{et al.}\textsuperscript{7} also reported 1 case of port site recurrence after LRN using mechanical morcellation.

To prevent port site seeding and tumor spillage, a series of strict steps are necessary, including respecting the basic principles of cancer surgery, wide en bloc dissection of the organ to obtain an adequate surgical margin, including Gerota’s fascia, entrapment of all potentially cancerous tissue in an impermeable sack, having the field draped before morcellation or extraction, removal of all possible contaminated instruments from the operative field, cytologic examination of any ascitic fluid suspicious for malignancy, and irrigation with sterile water after nephrectomy to lyse any potential cells.

However, the risk of sack perforation after mechanical laparoscopic morcellation still exists even with direct visualization within the LapSac. If the activated high-speed electrical laparoscopic morcellator is left in contact with 1 area of the LapSac for a few seconds, significant frictional heating may occur, which can result in perforation of the bag.\textsuperscript{8} Incision of the bag with the morcellator blade can also result in perforation of the bag.\textsuperscript{8} Perforation is difficult to discern during morcellation. These reasons caused urologists to seek a safer morcellator for renal morcellation.

The optimal method of specimen morcellation has not yet been developed. Some investigators studied the use of the EPM for renal morcellation using external visualization.\textsuperscript{10} The EPM was constructed for use in transvesical morcellation and extraction of prostatic tissue after holmium laser prostatectomy; it is specifically designed to work in a fluid environment. In their studies, morcellation was conducted using the EPM in a fluid environment, monitored by laparoscopic visualization outside a clear plastic retrieval bag, the EndoCatch II. Our study differed in respect to the view, as well
as the type of retrieval bag evaluated. In the present study, we designed a new method of introducing the endoscope within the LapSac to monitor the morcellation under direct visualization. Our hypothesis was that direct, internal visualization would prevent perforation of the LapSac. During the course of the morcellation trials, to avoid perforating the LapSac, we focused on the orientation of the blade and kept a constant flow of irrigant into the sack to both cool the blades and keep the sack expanded. Currently, we discourage manual morcellation of renal specimens within a clear plastic retrieval sack because of fragility and high potential for perforation of the bag. The Endo-Catch II is currently only used for intact specimen extraction. At present, we only perform manual morcellation of human renal tissue using manual morcellation within a LapSac.

Our in vitro model revealed that although the rate of LapSac perforation occurring under internal visualization using the EPM was significantly lower than with external visualization, it was still 10%. However, no perforations occurred using the manual morcellation technique. Therefore, manual morcellation was the safest technique in terms of decreasing perforations in the present study. Second, mechanical morcellation with an internal view required significantly more time than mechanical morcellation with an external view or manual morcellation. In contrast to the results of other studies, manual morcellation was significantly faster than mechanical morcellation using an EPM in our study, consistent with other reports.2 Manual morcellation in clinical practice follows strict principles: grasping only tissue parenchyma that is directly visualized, draping out the trocar site with towels, and, finally, using blunt instruments such as a sponge stick to grasp the tissue. Sundaram et al.19 described a technique of facilitating organ placement into the LapSac by placing a hydrophilic guidewire within holes through which the drawstrings reside within the LapSac. This technique helps keep the neck of the bag open. Our modification of this technique to facilitate the potentially cumbersome and time-consuming task of deployment of the LapSac within the peritoneal cavity was to use a 5F or 6F ureteral catheter instead of a hydrophilic wire. Ureteral catheters are readily available, are cost effective at $8 per ureteral catheter versus $30 for a Terumo guidewire, and are easily placed within the existing holes of the drawstring. The inherent elasticity of the ureteral catheter helps to spring open the opening of the sack, while facilitating appropriate orientation and delivery of the specimen. Once the specimen is within the LapSac, the ureteral catheter can be easily pulled out, and the drawstring pulled to close the neck of the bag. Finally, the tissue fragment size resulting after hand morcellation was the largest among the three groups, which would facilitate pathologic diagnosis and staging of the specimens. With hand morcellation, 15.1 minutes was the average time to morcellate the specimen. In the clinical forum, after laparoscopic nephrectomy, the insertion time of the kidney into the LapSac averaged 5 minutes from insertion of the LapSac through the 12-mm trocar to beginning morcellation using sponge sticks. This also allowed only three trocars to be used for the technique. Without the application of the ureteral catheter, the time for insertion into the LapSac increased by at least 50%.

Previous studies have demonstrated that morcellation of radical nephrectomy specimens was comparable in terms of tissue histologic type, tumor stage, and tumor grade compared with radical intact specimens. Landman et al.20 were able to make the diagnosis, even citing 4 cases of perinephric fat invasion, and demonstrated that morcellation can be safely performed without compromise of the pathologic diagnosis.

CONCLUSIONS

Despite use of the LapSac, which has been shown to be the most resistant retrieval system, a 90% perforation rate occurred in the group with mechanical morcellation and external laparoscopic visualization. Although direct visualization inside the LapSac allowed for safer use of the EPM with a decreased perforation rate to 10% in this in vitro study, the prohibitively long morcellation time would preclude its clinical use. Finally, manual morcellation was safe, fast, and superior to either EPM group in all categories.

REFERENCES


EDITORIAL COMMENT

In 1991 Clayman and colleagues introduced laparoscopic nephrectomy and opened the door for all advanced ablative and reconstructive urologic procedures. The value of the final accomplishment is indisputable and easy to appreciate. However, the most astonishing aspect of the first laparoscopic nephrectomy was success on the first clinical attempt. The initial success of the primary procedure was based on an extraordinary laboratory investigative effort that predated the clinical work and that remains a paradigm for surgical technical advancement. A collaborative effort among urologists, general surgeons, interventional radiologists, engineers, and industry resulted in a successful technical outcome on the first attempt, and the birth of the electrical tissue morcellator.

Happily, during the past decade, laparoscopic renal surgery has grown and become a standard of care. However, to the shame of surgical investigators and industry, the concept of electrical tissue morcellation has suffered and died.

The authors attempted to adapt currently existing prostate morcellation technology for renal ablation, and they introduced the concept of direct vision morcellation from within the entrapment sack. Unfortunately, the novel techniques described in this article do not adhere to the two basic principles of tissue morcellation: (a) removal of tissue without tumor seeding or spillage, and (b) preservation of all surrounding normal tissues and structures. Ideally, a morcellator should also be time and cost-effective and should allow for identification of histologic type and disease staging.

The 10% entrapment sack perforation rate described by the authors violates both basic principles of morcellation. Obviously, further work in this area is needed before considering clinical application of this investigational technique. Only by continued investment of investigative energy and resources to solid organ entrapment and ablation will we be able to further the goals of “minimally invasive” surgery and perpetuate the established tradition of innovative excellence to the benefit of our patients.

REFERENCE


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REPLY BY THE AUTHORS

The quest for the optimal kidney morcellator continues. We strive to evaluate, develop, and pursue a mechanical device that effectively adheres to morcellation principles. Although clearly the adaptation of the prostate morcellator to renal application does not translate into clinical use, we hope this study will stimulate collaboration between urologists and mechanical engineers to ultimately produce one that will.