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Original Article

Assessing Basic "Physiology" of the Morcellation Process and Tissue Spread: A Time-action Analysis

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ABSTRACT **Study Objective:** To assess the basic morcellation process in laparoscopic supracervical hysterectomy (LSH). Proper understanding of this process may help enhance future efficacy of morcellation regarding the prevention of tissue scatter.
Design: Time-action analysis was performed based on video imaging of the procedures (Canadian Task Force classification II-2).
Setting: Procedures were performed at Leiden University Medical Centre and St Lucas Andreas Hospital, Amsterdam, the Netherlands.
Patients: Women undergoing LSH for benign conditions.
Interventions: Power morcellation of uterine tissue.
Measurements and Main Results: The morcellation process was divided into 4 stages: tissue manipulation, tissue cutting, tissue depositing, and cleaning. Stages were timed, and perioperative data were gathered. Data were analyzed as a whole and after subdivision into 3 groups according to uterine weight: $<$350 g, 350 to 750 g, and $>$750 g. A cutoff point was found at a uterine weight of 350 g, after which an increase in uterine weight did not affect the cleaning stage. The tissue strip cutting time was used as a measure for tissue strip length. With progression of the morcellation process, the tissue strip cutting time decreases. The majority of cutting time is of short duration (i.e., 60% of the cutting lasts 5 seconds or less), and these occur later on in the morcellation process.
Conclusion: With the current power morcellators, the amount of tissue spread peaks and is independent of uterine weight after a certain cutoff point (in this study 350 g). There is a relative inefficiency in the rotational mechanism because mostly small tissue strips are created. These small tissue strips occur increasingly later on in the procedure. Because small tissue strips are inherently more prone to scatter by the rotational mechanism of the morcellator, the risk of tissue spread is highest at the end of the morcellation procedure. This means that LSH and laparoscopic hysterectomy procedures may be at higher risk for tissue scatter than total laparoscopic hysterectomy. Finally, engineers should evaluate how to create only large tissue strips or assess alternatives to the rotational mechanism. Journal of Minimally Invasive Gynecology (2015) 22, 255–260 © 2015 AAGL. All rights reserved.

Keywords: Laparoscopy; Morcellation; Morcellator; Scatter; Spread; Tissue

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Morcellation has allowed laparoscopic surgeons to remove large uteri and myoma, thereby offering more women the benefits of a minimally invasive approach to their surgery. Yet, the United States Food and Drug Administration has recently discouraged the use of uterine power morcellation in laparoscopic hysterectomy and myomectomy because of serious safety concerns after the accidental use of this technique in women with occult uterine sarcoma (e.g., leiomyosarcoma). Patient outcome with respect to morbidity and mortality may be negatively influenced because of morcellation [1,2]. Unfortunately, the diagnosis of uterine sarcoma is complex because methods to rule out this condition with certainty do not exist. Furthermore, although considered difficult because of a paucity of studies with large series of patients, it was estimated by the Food and Drug Administration that 1 in 350 women undergoing hysterectomy or myomectomy for myomas will have unsuspected uterine sarcoma [3]. To prevent the unintentional morcellation of a uterine malignancy, it is proposed to stop using a power morcellator and return to traditional methods such as abdominal laparotomy or vaginal incision to remove the uterus or myoma. Methods to avoid tissue spread such as in-bag morcellation are under investigation [4–8]. In theory, contact between tissue and the abdominal wall and cavity is avoided; however, studies in urology and gastroenterology have, in fact, shown port site metastases after contained morcellation [9–12]. Although these occurrences have been rare and additional risk factors other than morcellation have been proposed, they stress the importance of larger studies to confirm the efficacy of in-bag morcellation in gynecology. Moreover, before any alternative can be proposed, it is essential to understand the actual problem at hand. Without solid knowledge of the process of morcellation, tissue spread, and tumor seeding, it is unlikely that a sustainable solution will be discovered. The aim of our study was to assess the occurrence and amount of tissue spread in the morcellation procedure and to identify any factors that influence the tissue spread. This study intends to contribute to the development of a more effective morcellation technique. Understanding the pattern of tissue spread may help us find a solution to a serious problem so that in the future the benefits of minimally invasive surgery will not be lost for women with larger uteri.

Methods and Materials

A prospective observational study was performed from January 2011 until May 2013 at the Leiden University Medical Centre and St Lucas Andreas Hospital, Amsterdam, the Netherlands. The morcellation procedure in total laparoscopic hysterectomy (TLH) procedures and laparoscopic supracervical hysterectomy (LSH) procedures were timed, and basic procedure and patient characteristics were gathered. Separately, LSH procedures were recorded for time-action analysis (TAA). All procedures were performed by 4 experts in minimally invasive gynecologic surgery, except for the procedures in the TAA, which were performed by 1 expert. The Gynecare Morcellex (Ethicon, Inc, Somerville, NJ) and LiNA Xcise (LiNA Medical, Glostrup, Denmark) were used during the procedures. No distinction was made in the data between the type of morcellator used because the Morcellex and LiNA Xcise rely on the same "motor peeling" working principle; have by approximation a similar instrument diameter, blade rotation speed, and weight; and are disposable [13]. Intraoperative data and basic patient characteristics were gathered. To accurately analyze the morcellation procedure, this procedure was divided into 4 stages: stage 1 or tissue manipulation: grasping and manipulation of the uterine tissue toward the cutting blade of the morcellator; stage 2 or tissue cutting: morcellation instrument actively cutting tissue and tissue being pulled through the morcellation tube; stage 3 or tissue depositing: morcellation instrument inactive, tissue strip being deposited in a retainer outside the patient, and reinsertion of the grasper through the morcellator (stages 1–3 were used to calculate the total morcellation time); and stage 4 or cleaning stage: inspection of the abdomen to detect and remove residual uterine tissue pieces and irrigation of the abdominal area. Tissue spread is determined by counting the number of visually detectable tissue pieces removed during stage 4 through grasping, suction, and rinsing. In addition, the duration of stage 4 was used to further estimate the amount of tissue spread. The morcellation rate is calculated in grams per minute as the weight of the excised tissue divided by the morcellation time. Statistical analysis using the 2-tailed *t* test under the assumption of homogeneity of variance was performed for the LSH and TLH groups separately with respect to the TAA group. For the TAA group, procedures were divided into 3 groups according to uterine weight (A: <350 g, B: 350–750 g, and C: >750 g). A 2-tailed *t* test was used for identifying significant differences between groups. Standard linear regression analysis was performed to assess the interdependence between recorded variables. A p value of .05 was considered statistically significant. All patients consented to participate in this study.

Results

A combined total of 52 TLH and LSH procedures were analyzed, of which 23 LSH procedures were analyzed by TAA. Table 1 shows that no statistical differences were observed in patient characteristics and morcellation-related parameters between the procedures that were timed and the procedures that were analyzed through TAA. The average operation time was 152 and 158 minutes, respectively, and the morcellation procedure comprises 13% and 15%, respectively, of the total operation time. The results from the TAA are provided in Table 2. Morcellation conditions were similar in all 3 groups because no significant differences were found in the morcellation rate and weight per removed tissue strip. Figure 1 is a graphic representation of the time division of the separate morcellation stages. It shows the stage percentages (stages 1–3) and total morcellation time compared with the cleaning stage time (stage 4). A large proportion of time is spent on manipulating tissue and depositing tissue and only a limited amount on cutting the tissue. With increasing uterine weight, the total morcellation time also increased. Analysis of the different stages of the total morcellation time showed a similar increase for stages 1, 2, and 3 but not for stage 4 (i.e., the cleaning stage). No significant difference was found in the cleaning stage between weight in groups B (350–750 g) and C (>750 g). No significant difference was found in the number of scattered tissue pieces between groups B and C.

To further analyze the cutting process, the tissue cutting time throughout the morcellation procedure was analyzed. The length of every single removed tissue strip was approximated by the time spent cutting that tissue strip in the TAA, thereby allowing an evaluation of the change in length of the