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CLINICAL ARTICLE

Comparison of 2 minimally invasive routes for hysterectomy of large uteri

Noam Smorgick [a,*], Vanessa K. Dalton [a], Kristin E. Patzkowsky [b], Mark R. Hoffman [a], Arnold P. Advincula [c], Sawsan As-Sanie [a]

[a] Department of Obstetrics and Gynecology, University of Michigan Health Center, Ann Arbor, USA
[b] Montefiore Medical Center, Centennial Women's Center, NY, USA
[c] Celebration Hospital, Celebration, USA

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ABSTRACT

Objective: To compare the perioperative outcomes associated with 2 minimally invasive surgical routes for the hysterectomy of large fibroid uteri. *Methods:* Retrospective review of 84 women undergoing hysterectomy via minilaparotomy (n = 54) or robot-assisted laparoscopy (n = 30) for uteri weighing at least 500 g. Outcome measures included hemorrhage (blood loss of 500 mL or more) and postoperative length of stay. *Results:* Unadjusted mean blood loss (560.2 ± 507.4 mL versus 165.0 ± 257.5 mL, $P < 0.001$), rate of hemorrhage (40.7% versus 6.7%, $P = 0.001$, odds ratio 6.1 [95% confidence interval 1.5–24.2]), and rate of blood transfusion (14.8% versus 0%, $P = 0.03$) were all higher with minilaparotomy than with robot-assisted surgery, while the median postoperative stay was significantly shorter with robotic surgery (2 [range 1–4] days versus 1 [range 0–7] days, $P < 0.01$). After adjusting for differences in uterine weight using a multivariate linear regression analysis, the mean blood loss and the rate of hemorrhage were no longer significantly different between the 2 groups. *Conclusion:* The minilaparotomy approach may be used to remove very large uteri and does not require specialized and expensive equipment, or advanced endoscopic training. The robotic approach, when feasible, allows for early postoperative discharge.

1. Introduction

Randomized controlled trials [1] have identified advantages of laparoscopic hysterectomy over hysterectomy via laparotomy in terms of reduced hospital stay, postoperative pain, and blood loss. However, the laparoscopic approach is not feasible for all women undergoing hysterectomy, with large uterine size being a major limiting factor. Experienced laparoscopic surgeons have reported successful and safe laparoscopic hysterectomy for large uteri, although operative time, intraoperative blood loss and the conversion rate to open surgery may be increased in these circumstances [2–4]. Nevertheless, it is questionable whether the results would be reproducible in general gynecologic practice because advanced laparoscopic skills are required. When the laparoscopic route is deemed impracticable or unsafe for a woman with a large uterus, alternative minimally invasive surgical approaches may be considered. These include the use of the robotic surgical platform, enabling surgeons to perform robot-assisted laparoscopic surgeries, and the minilaparotomy route, typically using a small abdominal incision.

The use of the robotic platform for hysterectomy of uteri weighing more than 500 g has been recently reported by Payne et al. [5]. Although operative time and blood loss were significantly increased compared with hysterectomy of uteri weighing less than 500 g, there were no differences in major or minor complications, including blood transfusion and viscus injury. The robotic technique may therefore provide an alternative minimally invasive approach for these challenging cases.

Minilaparotomy is another minimally invasive technique that could be employed for hysterectomy, with slightly shorter hospital stay and reduced risk of wound infection when compared with midline vertical laparotomy [6]. This technique does not require specialized equipment or advanced laparoscopic or robotic skills, and may be less costly than robotic surgery.

The aim of the present study was to compare the feasibility and perioperative outcomes (focusing on blood loss and postoperative length of stay) of hysterectomy performed via minilaparotomy or robot-assisted laparoscopy in patients with uteri weighing 500 g or more.

2. Materials and methods

All consecutive hysterectomies performed for benign indications from July 1, 2004, to June 30, 2010, by faculty surgeons of the Minimally Invasive Gynecologic Surgery Division were retrospectively identified

* Corresponding author at: Department of Obstetrics and Gynecology, Asaf Harofe Medical Center, Zerifin, Israel 70300. Tel.: +972 8 9779000; fax: +972 153 505191572.
E-mail address: noam_yossi@yahoo.com (N. Smorgick).

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through a computerized search of the billing records of the Department of Obstetrics and Gynecology. The present study included hysterectomies where the primary surgical approach was minilaparotomy (defined as either a midline vertical or a low transverse abdominal incision of 6 cm or less) or robot-assisted laparoscopy and the hysterectomy specimen weighed at least 500 g at pathology. The study was approved by the Institutional Review Board of the University of Michigan, Ann Arbor, MI, USA.

The medical records were retrospectively reviewed to abstract patient characteristics, indications for surgery, intraoperative variables and complications, final pathology, specimen weight, and details pertaining to postoperative follow-up. Because this was a retrospective study, the need for informed consent was waived by the Institutional Review Board. Operative time was defined as the time from intubation to patient transfer to the postoperative recovery unit, in minutes. The estimated blood loss was recorded by the circulating operative room nurse and abstracted from the operative report. Operative hemorrhage was defined as an estimated blood loss of 500 mL or more, which was also the 77.4% percentile for the estimated blood loss in this cohort.

The medical records were specifically examined for known surgical complications of hysterectomy for large uteri, such as blood transfusion and conversion to laparotomy. Additional surgical complications identified were viscus injury (including bladder, bowel, and ureter), thrombotic events (pulmonary embolus and deep vein thrombosis), vaginal cuff complications (hematoma, abscess, dehiscence), wound complications (incisional hernia, seroma, infection) and infectious morbidity (pneumonia, lower urinary tract infection, pyelonephritis). Postoperative length of stay was determined in days, with a length of stay of 1 day referring to discharge on postoperative day 1, and a length of stay of 0 days referring to discharge on the day of surgery.

All hysterectomies were performed by faculty surgeons of the Minimally Invasive Gynecologic Surgery Division using similar surgical technique and instrumentation. The surgical approach was determined during the preoperative visit, according to the surgeons' assessment whether the robotic or the minilaparotomy approach would be feasible for the patient. The da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) was used for robotic surgery, with a PK bipolar forceps (Gyrus ACMI, Southborough, MA, USA) and monopolar shears placed in the robotic arms. Colpotomy was performed with monopolar shears, and the vaginal cuff was approximated using a series of figure-of-eight Vicryl 0 sutures (Ethicon, Somerville, NJ, USA) with intracorporeal knot tying. The ZUMI intrauterine manipulator with the KOH Cup, or the Uterine Positioning System with the RUMI manipulator and the KOH Cup (all by CooperSurgical, Trumbull, CT, USA) were used for uterine manipulation. For the minilaparotomies, a self-retaining wound retractor (Alexis; Applied Medical, Rancho Santa Margarita, CA, USA) was used. This exposure enabled the performance of selected myomectomies until the uterine size had decreased sufficiently and the hysterectomy could be completed. All women received prophylactic antibiotics, and pharmacologic thromboembolism prophylaxis was administered when indicated.

The primary outcome was the occurrence of operative hemorrhage. The secondary outcomes were the total estimated blood loss, the frequency of blood transfusion (during the intra- and/or postoperative period), any surgical complications, and conversion to laparotomy.

Statistical analysis was performed with SPSS version 19 (IBM, Armonk, NY, USA). $P < 0.05$ was considered statistically significant. The Pearson χ^2 test was used for the comparison of proportions. The *t* test and the Mann–Whitney test were used for the comparison of continuous variables. The odds ratio (OR) and the 95% confidence interval (CI) were calculated to estimate the odds of operative hemorrhage in the 2 groups. The post-hoc power analysis for the calculation of the primary outcome was 94.4%. A multivariable linear regression model was created to control for the difference in uterine weight between the 2 groups.

Table 1
Baseline characteristics of women undergoing hysterectomy of large uteri.[a]

	Minilaparotomy (n = 54)	Robotic assistance (n = 30)	*P* value
Age, y	45.9 ± 4.2	47.5 ± 5.3	0.2
BMI[b]	28.0 ± 5.7	30.0 ± 7.5	0.2
Parity	2 (0–6)	2 (0–4)	0.5
Race			
White	24 (44.4)	18 (60.0)	0.03
Black	21 (38.9)	3 (10.0)	
Asian	5 (9.3)	3 (10.0)	
Other	4 (7.4)	6 (20.0)	
Prior laparotomy	16 (29.6)	14 (46.7)	0.3
Prior cesarean delivery	8 (14.8)	8 (26.7)	0.4

Abbreviation: BMI, body mass index.
[a] Values are given as mean ± SD, compared via *t* test; number (percentage), compared via χ^2 test; or median (range), compared via Mann–Whitney test.
[b] Calculated as weight in kilograms divided by the square of height in meters.

3. Results

During the study period, 84 women underwent hysterectomy for benign indications by either minilaparotomy (54 [64.3%]) or robot-assisted laparoscopy (30 [35.7%]) and had a uterine weight of 500 g or more. The demographic characteristics of the 2 groups were similar (Table 1), although black women were more likely to undergo minilaparotomy than robotic surgery (38.9% versus 10.0%, respectively; $P = 0.03$). The most common primary indication for hysterectomy in the 2 groups was symptomatic uterine fibroids (50 [92.6%] and 27 [90.0%], respectively) followed by abnormal uterine bleeding (4 [7.4%] and 3 [10.0%], respectively) ($P = 0.1$ for both comparisons).

The estimated blood loss and the mean uterine weight were significantly higher in the minilaparotomy group than in the robotic group ($P < 0.001$ and $P < 0.001$, respectively) (Table 2). The operative time was significantly longer for women in the robotic group ($P < 0.001$). The proportions of total versus supracervical hysterectomy and the incidence rates of endometriosis were similar in the 2 groups (Table 2). In 5 (16.7%) women in the robotic group, myomectomy was performed prior to completing the hysterectomy.

Surgical outcomes are compared in Table 3. The unadjusted rate of hemorrhage was significantly higher in the laparotomy group ($P = 0.001$), as was the rate of blood transfusion ($P = 0.03$). Although the rate of conversion to laparotomy was higher in the minilaparotomy group, this difference did not reach statistical significance. The median postoperative length of stay was significantly shorter in the robotic group.

A multivariable linear regression analysis model was constructed to compare the mean blood loss, the rates of hemorrhage and blood transfusion, and the postoperative length of stay with the 2 surgical approaches while controlling for uterine weight (Table 3). Mean blood loss and the rates of hemorrhage and blood transfusion were not found to be significantly different between the 2 groups after controlling for uterine weight ($P = 0.08$, $P = 0.08$, and $P = 0.9$, respectively). The postoperative length of stay remained

Table 2
Surgical characteristics of women undergoing hysterectomy of large uteri.[a]

	Minilaparotomy (n = 54)	Robotic assistance (n = 30)	*P* value
Total hysterectomy	17 (31.5)	11 (36.7)	0.6
Estimated blood loss, mL	560.2 ± 507.4	165.0 ± 257.5	<0.001
Operative time, min	197.8 ± 53.4	272.9 ± 49.9	<0.001
Early-stage endometriosis	0 (0.0)	2 (6.7)	0.4
Advanced-stage endometriosis	2 (3.7)	1 (3.3)	0.4
Uterine weight, g	990.4 ± 395.0	688.4 ± 148.6	<0.001

[a] Values are given as mean ± SD, compared via *t* test; or number (percentage), compared via χ^2 test.

Table 3
Surgical outcomes among women undergoing hysterectomy of large uteri.[a]

	Minilaparotomy (n = 54)	Robotic assistance (n = 30)	*P* value	Adjusted odds ratio[b] (95% CI)	Adjusted *P* value[b]
Hemorrhage ≥500 mL	22 (40.7)	2 (6.7)	0.001	6.1 (1.5–24.2)	0.08
Blood transfusion	8 (14.8)	0 (0.0)	0.03	NA	0.90
Conversion to laparotomy	5 (9.3)	0 (0.0)	0.08	NA	0.08
Postoperative length of stay, d	2 (1–4)	1 (0–7)	0.01	NA	0.02

Abbreviations: CI, confidence interval; NA, not applicable (because there were no cases of this outcome in the robotic group).
[a] Values are given as number (percentage), compared via χ^2 test; or median (range), compared via Mann–Whitney test.
[b] Multivariate linear regression analysis controlling for uterine weight.

significantly longer in the minilaparotomy compared with the robotic approach ($P = 0.02$).

Additional surgical complications in the present cohort included 1 occurrence of bladder injury in the minilaparotomy group, and 2 occurrences of vaginal cuff abscess in the robotic group. The infectious complications included 1 occurrence each of wound infection, pneumonia, pyelonephritis, and cystitis in the minilaparotomy group versus 1 patient with cystitis in the robotic group. There were no statistically significant differences in the frequency of these surgical complications between the 2 surgical groups (data not shown). There were no cases of vascular injury, bowel injury, pulmonary embolism or deep vein thrombosis, or vaginal cuff dehiscence.

4. Discussion

Traditionally, very large fibroid uteri are removed via large vertical incisions and have conventionally been considered to be a relative contraindication for vaginal and laparoscopic hysterectomy. Several publications [2–4] from tertiary referral centers have reported on the feasibility of the laparoscopic approach for removal of fibroid uteri weighing more than 500 g, with the first of these reports published as early as 2002. However, the laparoscopic approach has not become the standard of care for these challenging surgical cases, possibly because advanced laparoscopic skills are often required and the training period to acquire those skills is relatively long. Thus, it seems reasonable to explore other minimally invasive techniques that could potentially be employed to treat these patients.

The minilaparotomy surgical approach for the removal of large fibroid uteri, using either a smaller vertical or a transverse abdominal incision, generally requires the removal of 1 or more fibroids, followed by the hysterectomy. Obviously, this approach has the potential disadvantage of larger blood loss because ligation of uterine blood vessels may not be feasible prior to the myomectomy [6]. Another surgical approach combining laparoscopy and minilaparotomy (the laparoscopic minilaparotomy) has also been described [7]. This approach allows the surgeons to perform some of the complex steps of the hysterectomy via the small laparotomy incision while retaining the advantages of laparoscopy [8]. In the present study, after controlling for uterine size, there was no difference in mean blood loss and transfusion rates between minilaparotomy and robot-assisted laparoscopy. Future studies may also assess whether the minilaparotomy approach is associated with lower intraoperative costs when compared with the robotic approach.

Robot-assisted laparoscopy is an enabling surgical technique that is designed to allow surgeons to perform challenging laparoscopic surgeries using the wristed instruments and the 3-dimensional view [8]. Payne et al. [5] recently compared robotic hysterectomy for uteri weighing less versus more than 500 g. They reported increases in operative time and blood loss in the larger uteri group, but did not identify differences in complications or conversion rate. From personal experience, the major drawback with the robotic platform while performing hysterectomy for large uteri is the extra space required in the upper abdomen to position the robotic camera and arms without excessive crowding or collision of the arms. Our practice is to place the insufflation needle in the umbilicus or in the left upper quadrant (depending on the uterine size and anticipated intra-abdominal adhesions), and to subsequently place the camera port in the supraumbilical position, approximately 10 cm above the elevated uterine fundus, slightly to the left of the midline to avoid the falciform ligament. The remaining robotic ports and the accessory port are then placed in the mid or upper abdomen. Accordingly, the preoperative physical examination is crucial for appropriate patient selection to ensure that the length of the torso is adequate for trocar placement. This would ultimately limit the uterine size that could be removed with this approach. However, whenever this approach is feasible, it does have the advantage of a shorter hospital stay.

Several surgical characteristics are notable in the present cohort. The majority of patients in the present study underwent supracervical hysterectomy. Although the supracervical hysterectomy does not confer any advantages over total hysterectomy in terms of sexual, bladder, or bowel function [9], it may allow for a shorter surgery, reduced blood loss, and faster recovery, which are important in women with a large uterus [10]. In addition, the mean operative time, in particular for the robotic group, is longer than that reported for total laparoscopic hysterectomy for similarly sized uteri [2–4]. This finding is not surprising because operative times have consistently been reported to be longer for robotic hysterectomy [11].

The present study is limited by its retrospective and nonrandomized design. This could account for the disparity in uterine weight in the 2 groups, pointing to the surgeons' preference to use the minilaparotomy approach for very large uteri. Another major limitation of the retrospective design is the possibility of incomplete or inaccurate data collection. However, because the primary and secondary outcomes of the present study occur in the operative and early postoperative periods, this limitation is less likely to affect the results. Although the present study was adequately powered to assess the primary outcome, it was certainly underpowered to look at rare complications of hysterectomy, such as viscus injury, vaginal cuff dehiscence, and conversion to laparotomy. The present study was conducted in a tertiary referral center, and outcomes were evaluated in patients operated by experienced surgeons. Thus, the present results may not be generalizable to all practicing gynecologists. The traditional laparoscopic approach could have been an appropriate third surgical approach in the present study. However, the number of patients who underwent this procedure was too small to allow for inclusion in the present study.

In conclusion, a minimally invasive approach is feasible for large uteri of 500 g or more. The robotic approach has the potential advantage of shorter hospital stay, but may not be feasible for extremely large uteri. Minilaparotomy may be used to increase patient access to a minimally invasive approach when laparoscopic equipment and/or expertise are not available, or when an extremely large uterus is encountered.

Conflict of interest

A.P.A. is a consultant for Intuitive Surgical, CooperSurgical, and Ethicon Women's Health & Urology. The other authors have no conflicts of interest.

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