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Original Article

Laparoscopic Hysterectomy: Impact of Uterine Size

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ABSTRACT **Objective:** To analyze surgical results of women having Type VII laparoscopic hysterectomy to determine whether differences in outcomes exist on the basis of uterine size.

Methods: This is an analysis of data from 983 cases of type VII laparoscopic hysterectomy performed from September 1996 through August 2010. Demographic and surgical data were stratified by uterine weight (range 14–3,131 g) less than 250 g (n = 720) and 250 g or more (n = 263). Analyses were done by Pearson's χ^2, Wilcoxon rank-sum, and Kruskal-Wallis tests with significance set at 2-sided ($p < .05$). Outcomes examined include estimated blood loss, skin-to-skin operative time, complications (non-reoperative and reoperative), and duration of hospital stay. Estimated blood loss, skin-to-skin operative time, and length of hospital stay were further analyzed using backwards, stepwise, multivariable, linear regression to control for and identify independent predictors affecting these outcomes. Baseline demographic data were included in the multivariable model. Only covariates that were significant in both multivariable and univariable analyses are presented as statistically significant.

Design: A case-controlled, retrospective study (Canadian Task Force Classification II-2).

Results: Median operating time varied by uterine weight, with a shorter duration of surgery in patients with uteri less than 250 g at 97 minutes (range 29–330), and patients with uteri greater than 250 g at 135 minutes (range 45–345) ($p < .001$). Median estimated blood loss was also less in patients with uteri less than 250 g at 50 mL, (range 0–1400), than in patients with uteri weighing 250 g or more, at 150 mL, (range 0–2100) ($p < .001$). There was no significant difference by uterine weight in median duration of hospital stay of 1 day (range 0–13), total complication rate (7.0%), reoperative complications (3.7%), or non-reoperative complications (3.4%). Duration of surgery, volume of blood lost, and length of hospital stay all decreased with the surgeon's increasing experience.

Conclusions: Laparoscopic hysterectomy is feasible and safe, resulting in a short hospital stay, minimal blood loss, minimal operating time, and few complications for patients regardless of uterine weight. Journal of Minimally Invasive Gynecology (2011) 18, 85–91 © 2011 AAGL. All rights reserved.

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Type VII laparoscopic hysterectomy (LH) is a laparoscopic hysterectomy in which all surgical dissections, ligations, and sutures are completed entirely through the trocars, including closure of the vagina [1]. Consistently, LH has been reported to result in less pain, lower blood loss and shorter hospital stay when compared with abdominal hysterectomy (AH) [2,3], and shorter operating time and less blood loss when compared to laparoscopically-assisted vaginal hysterectomy (LAVH) [4,5], especially for obese patients. To date, however, the impact of larger uterine weight on surgical outcomes associated with a laparoscopic approach has not been well addressed. This analysis provides patient demographics and surgical outcome data stratified by uterine size from 13.9 years in one surgeon's practice.

Materials and Methods

In this practice, consecutive patients undergoing hysterectomy were scheduled for a laparoscopic approach unless they had prior operative records documenting severe abdominal/intestinal adhesions or documented significant cardiopulmonary disease. Cardiopulmonary disease was defined as any history of heart failure, myocardial infarction, unstable angina, or moderate pulmonary obstructive disease contraindicating prolonged steep Trendelenburg position.

The author is a consultant and speaker for Covidien and Novare Surgical Instruments. There is no off-label use of any medical device in this manuscript.

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No patient was refused a laparoscopic approach on the basis of body mass index (BMI) or uterine size (Table 1). For each of these patients, a simple hysterectomy was performed alone or with other procedures as indicated by the patient's history and physical and radiologic examination results. Patients were all offered appendectomy, because this has been shown to take 1 to 3 minutes and has no impact on blood loss, duration of surgery, duration of hospital stay, or risk of complication [6].

The actual technique used for LH, including the sterile preparation and all surgical dissections, is described elsewhere in the gynecologic literature [7]. Every surgery was performed by the author (K.A.O'H.), using the described technique, from September 5, 1996, to August 30, 2010, at 1 of 4 San Francisco Bay Area hospitals, assisted by a categorical obstetrics and gynecology resident, a gynecologist, or a general surgeon.

With Investigational Review Board approval maintained at Sequoia Hospital in Redwood City, CA, all cases of laparoscopic hysterectomy performed for benign gynecologic indications, as well as for microinvasive cervical cancer, or early endometrial cancer were reviewed. Surgical duration was abstracted from hospital records. Estimated blood loss (EBL) was measured at the end of the case from a collimated collection canister. Uterine weight was measured in grams after surgery and stratified into 2 primary groups; less than 250 g (n = 720) and 250 g or more (n = 263). Many patients underwent cystoscopy at the conclusion of their hysterectomy, and these patients are also included in the data reported herein, because this procedure also takes only a few minutes and does not contribute to patients' morbidity [8]. To focus on the impact of uterine size, patients undergoing LH were excluded from analysis if they had lymphadenectomy, omentectomy, debulking or radical hysterectomy or vaginectomy; unrelated urologic procedures; or general surgical procedures such as panniculectomy, cholecystectomy, and excision of lipoma or herniorrhaphy. Eight nulligravid, morbidly obese patients had a planned 6-cm Pfannenstiel minilaparotomy for excision of the disconnected uterine tissue when their estimated uterine mass was greater than 750 g; these are included in the analysis. All complications are reported in Table 6, and all complicated cases are included in the analysis of surgical duration and estimated blood loss. The study had a power of 0.90 to detect a 30-mL difference in estimated blood loss between uterine weight strata at an alpha of 0.05.

All analyses were done with Stata/IC 11.1 (StataCorp, College Station, TX). Continuous variables were tested for normality by the Shapiro-Wilk test. Because assumptions of normality were not met for continuous variables, data were analyzed with nonparametric Wilcoxon rank-sum and Kruskal-Wallis tests and are reported as medians and ranges. Binary data were analyzed by Pearson's χ^2 testing. Significance was set at 2-sided $p < .05$ for all tests. Estimated blood loss, skin-to-skin operative time, and length of hospital stay were further analyzed with multivariable linear regression to identify and control for independent predictors affecting these outcomes. Logistic regression was used to identify and control for predictors affecting complications. Only covariates that were significant by multivariable and univariable analyses are presented as statistically significant.

Table 1
Indications for hysterectomy

Diagnosis	No. (%)
Leiomyomata	279 (28.4)
Pelvic mass	212 (21.6)
Pelvic pain	96 (9.8)
Endometrial carcinoma	84 (8.6)
Female-to-male transgender	60 (6.1)
Adenomyosis	51 (5.2)
BrCa gene mutation	67 (6.8)
Endometrial hyperplasia	49 (5.0)
Cervical dysplasia	21 (2.1)
Prolapse	18 (1.8)
Menorrhagia	16 (1.6)
Polyps	9 (0.9)
Ovarian carcinoma	7 (0.7)
Cervical carcinoma	6 (0.6)
Stress urinary incontinence	49 (0.5)
Choriocarcinoma	1 (0.1)
Fallopian tube carcinoma	1 (0.1)
Polycystic ovarian syndrome	1 (0.1)
Pelvic inflammatory disease	1 (0.1)
Stronmal uterine neoplasms	1 (0.1)
Total	983

Results

Of 1267 consecutive patients undergoing LH over 13.9 years by a single surgeon, 125 were excluded from this analysis because of the confounding effect of oncologic procedures, 96 were excluded for other concomitant procedures, and 63 were excluded for not obtaining uterine weight data (Fig. 1). Indicators for hysterectomy are shown in Table 1. The typical patient in this series had a median age of 49 years (range 15 to 90) (Table 2). Their median BMI was 26.3 kg/m^2 (range 17.2–70.4), with 59.5% (n = 585) of the women in the overweight or higher BMI category ($\geq$25.0 kg/m^2). The median parity was 1 (range 0 to 9), with 40.9% (n = 402) of patients being nulliparous. Median uterine weight was 146 g (range 14–3131), with 26.8% of patients (n = 263) having uteri weighing 250 g or more. Additionally, 11.5% of patients (n = 113) had uteri weighing 500 g or more, and 2.7% of patients (n = 27) had a uterine weight greater than or equal to 1000 g.

Included procedures, shown in Table 3, were simple hysterectomy (6.3%), hysterectomy with bilateral salpingo-oophorectomy (91.4%), and hysterectomy with unilateral salpingo-oophorectomy (2.3%). Incidental appendectomy was performed in 48.1% of procedures [6].

Median skin-to-skin operative time was 105 minutes (range 29–345) (Table 3). Median operative time varied by uterine weight strata, with a shorter duration of surgery in patients with smaller uteri at 97 minutes (range 29–330), and patients with larger uteri at 135 minutes (range 45–345) ($p < .001$; Table 3 and Fig. 2). Multivariable linear

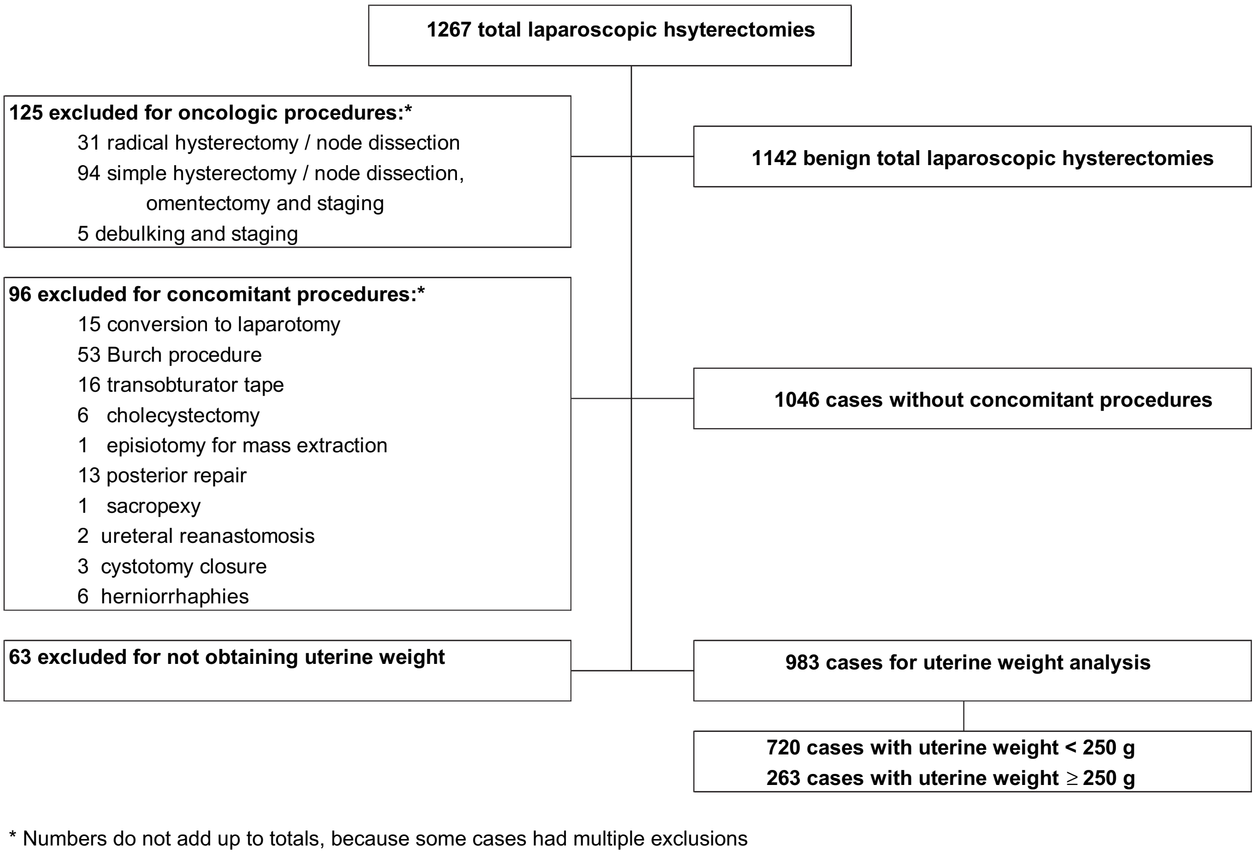

Fig. 1. Case exclusions from total practice.

regression confirmed that uterine weight was independently predictive of operative time (p <.001) (Table 4). The surgeon's increasing experience was the only other independent predictor of operative time identified by backward-stepwise multivariable linear regression and confirmed by univariable test (Table 4). Patients in the first half of the series (years 1-6) had a median operating time of 130 minutes (range 40–330), whereas patients in the second half (years 7–13) had a median skin-to-skin operative time of 91 minutes (range 29-345; p <.001).

Median estimated blood loss for all patients was 50 mL (range 0–2100) and was significantly less in patients with smaller uteri (50 mL, range 0-1400), than in patients with larger uteri (150 mL, range 0–2100) (p <.001; Table 3 and Fig. 3). Multivariable linear regression confirmed uterine weight as an independent predictor of EBL (p <.001)

Table 2
Baseline characteristics stratified by uterine weight

		Uterine weight		
	Total (n = 983)	<250 g (n = 720)	≥250 g (n = 263)	p Value
Age (y) (median [range])	49 (15–90)	49 (15–90)	48 (34–77)	.033
Height (in) (median [range])	65 (56–73)	65 (56–71)	65 (58–73)	.545
Weight (lb) (median [range])	157 (90–385)	155 (90–356)	160 (98–356)	.163
BMI (kg/m^2) (median [range])	26.3 (17.2–70.4)	26.2 (17.2–70.4)	26.6 (18.1–65.6)	.146
Uterine weight (g) (median [range])	146 (14–3131)	114 (14–249)	447 (250–3131)	<.001
Parity (no. delivered) (median [range])	1 (0-9)	1 (0–9)	1 (0–6)	.854
BMI (kg/m^2)				.307
<25 (ideal)	398 (40.5%)	303 (42.1%)	95 (36.1%)	
25 to <30 (overweight)	293 (29.8%)	205 (28.5%)	88 (33.5%)	
30 to <40 (obese)	207 (21.1%)	152 (21.1%)	55 (20.9%)	
≥40 (morbidly obese)	85 (8.7%)	60 (8.3%)	25 (9.5%)	
Parity				.210
Parous	581 (59.1%)	417 (57.9%)	164 (62.4%)	
Nulliparous	402 (40.9%)	303 (42.1%)	99 (37.6%)	

Table 3
Intraoperative and postoperative data stratified by uterine weight

	Total (n = 983)	Uterine weight <250 g (n = 720)	Uterine weight ≥250 g (n = 263)	p Value
Procedure				<.001
LH	62 (6.3%)	21 (2.9%)	41 (15.6%)	
LH + BSO	898 (91.4%)	684 (95.0%)	214 (81.4%)	
LH + USO	23 (2.3%)	15 (2.1%)	8 (3.0%)	
Incidental appendectomy	473 (48.1%)	359 (49.9%)	114 (43.4%)	.070
Operative time (min) (median [range])	105 (29–345)	97 (29–330)	135 (45–345)	<.001
Estimated blood loss (mL) (median [range])	50 (0–2100)	50 (0–1400)	150 (0–2100)	<.001
Length of stay (d) (median [range])	1 (0–13)	1 (0–13)	1 (1–12)	.962

(Table 4). Additional independent predictors of EBL identified by multivariable analysis and confirmed by univariable analysis were parity and early surgeon experience (Table 4).

Further stratification of the data by uterine weight (<250 g, 250 to <500 g, 500 to <1000 g, 1000 to <1500 g, and ≥1500 g) supports the correlation between increased uterine size and both increased blood loss and increased operating time (Table 5). In the 21 patients with uterine weights between 1000 and 1500 g, a 200-mL estimated blood loss was observed even though 8 of these patients in this group also required a 4-cm minilaparotomy to facilitate removal of the tissue.

The median hospital stay was 1 day (range 0–13) for all patients (Table 3). Originally, patients were instructed to expect a 2-day hospital stay; however, on May 1, 2001, preoperative instructions were changed to advise patients to anticipate only an overnight stay. After this change in instructions, all patients were discharged on postoperative day 1, unless they experienced a complication.

The median length of stay decreased in the second half of this patient series from 2.0 days (range 1–13) to 1.0 days (range 0–5). Backward stepwise, multivariable linear regression was used to identify independent predictors of reduced hospital stay. The only predictors remaining in the regression model that were also significant in the univariable analysis were the increasing experience of the surgeon over time and the change in hospital discharge planning orders in May 2001 (Table 4).

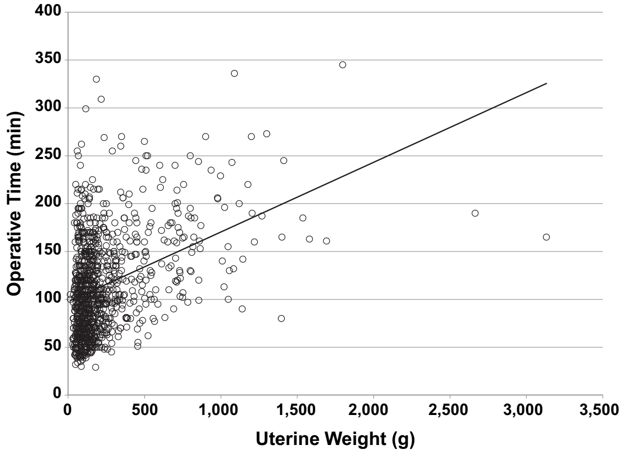

Fig. 2. Operative time, measured in minutes, increases with increasing uterine weight (p <.001).

There were no observable differences in the number or type of complications between the 2 uterine weight groups (Table 6). The total complication rate was 7.0%. The reoperative complication rate was 3.7% and included, most commonly, postoperative abdominal bleeding (0.9%) and vaginal cuff bleeding (0.7%). The non-reoperative complication rate was 3.4% and included, most commonly, intraoperative cystotomy repairs (0.8%) and pelvic cellulitis (0.7%). Infectious morbidity was equally rare in both groups, despite the thorough combined single field sterile preparation of the abdomen, vulva and vagina with povidone iodine, and the single glove, single surgical field approach used in all cases [8].

Transfusion was required in 13 patients. One patient had an admission hemoglobin level of 5.9 and received 2 units of packed red blood cells during the operation. Seven patients lost from 750 to 2000 mL blood during the hysterectomy for uteri weighing between 510 and 1025 g and had transfusions. Among these 7 patients, 1 had a 10-cm intraligamentous myoma with vascular supply arising from multiple branches of the uterine artery; 3 had large myomata that made it difficult to achieve hemostasis at the uterine artery; and 3 experienced blood losses largely because of back-bleeding from the massive ascending uterine artery complex or the mesosalpinx, whereas surgery was focused on the parametrium. The remaining 5 patients had postoperative bleeding: 1 patient had subcutaneous bleeding and did not require reoperation, and the other 4 required reoperation: 1 for vaginal cuff bleeding and 3 for intraperitoneal bleeding.

Overall, 12 patients had an unplanned conversion to laparotomy. This possibility, as well as all other potential complications, are discussed thoroughly in preoperative counseling sessions. Early in the series, 2 patients experienced intraoperative bleeding, causing conversion to open laparotomy, 1 because of a leaking ovarian artery retracting into the retroperitoneum, and 1 after a small vena cava injury from failure to follow established guidelines for primary trocar placement. One patient was opened because of poorly supplied and improperly matched electrosurgical equipment at 1 institution. Two patients had dissection difficulty because of massive myomas weighing 689 to 1120 grams,

Table 4
Multivariable regression results

	Coefficient	Standard error	95% Confidence interval	Multivariable p value	Univariable p value
Independent predictors of duration of surgery					
Age	0.405	0.124	0.161, 0.649	.001	.384
BMI	0.463	0.181	0.107, 0.819	0.011	.211
Physician experience	−0.050	0.004	−0.057, −0.042	<0.001	<.001
Uterine weight	0.071	0.005	0.061, 0.081	<0.001	<.0001
Independent predictors of estimated blood loss					
Parity	11.596	4.377	3.006, 20.185	0.008	<.001
Physician experience	−0.053	0.020	−0.084, −0.022	0.001	<.001
Uterine weight	0.269	0.016	0.229, 0.309	<0.001	<.001
Independent predictors of length of stay					
Age	0.005	0.002	0.002, 0.009	0.005	.330
Physician experience	−0.0002	0.00008	−0.00035, −0.00005	0.010	<.001
Protocol change	−0.911	0.078	−1.064, −0.758	<0.001	<.001
Uterine weight	0.0002	0.00008	0.00003, 0.00034	0.018	.962

measuring 8 to 12 cm in diameter, both of which were paracervical and retroperitoneal. One patient was admitted with life-threatening hemorrhage but had prolonged difficulty of dissection while bleeding continued. Four patients, with uteri weighing from 395 to 2072 g, were converted to open procedures because of severe adhesions, 1 from pelvic inflammatory disease, 1 from prior endometriosis surgery, and 2 from prior myomectomy. The final 2 patients who were converted to open procedures both had a BMI greater than 34.

Complications contributed to increased blood loss and surgical duration. Uncomplicated cases took 105 (range 29 to 345) minutes and had 50 (range 0–2100) mL EBL compared with cases with complications that took 123.5 (range 45 to 336) minutes and had 100 (range 5 to 1375) mL EBL.

Discussion

In the United States, where hysterectomy is the second-most frequently performed surgery [9], and minimally invasive approaches are rapidly becoming the standard of care, it is important to focus first on the feasibility and safety of using a laparoscopic approach on women with a broad range of physiological characteristics and disease profiles. Second, many factors, on their own or in combination, may be of concern when selecting a laparoscopic approach for indicated hysterectomy. These include high BMI, large uterine size, nulliparity, senior age, and complex disease. Third, it is appropriate to consider cost issues.

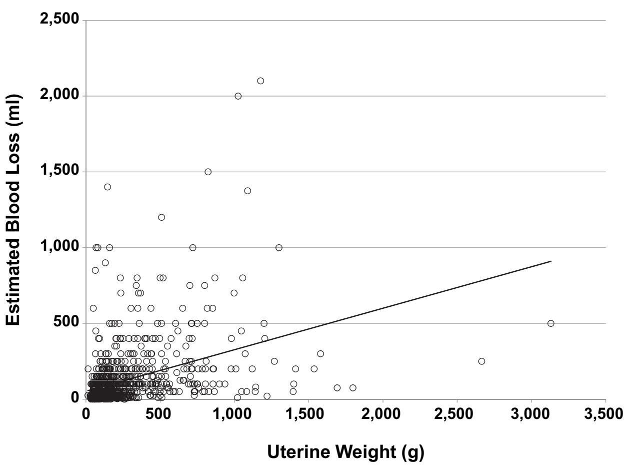

Fig. 3. EBL increases with increased uterine weight (p <.001).

The demographics, diagnoses, and surgicopathologic data from this study reflect a wide-ranging diversity of consecutive patients and demonstrate a broad utility for LH. LH offers less blood loss, similar operating times, shorter hospital stays [10] and more rapid and vigorous recovery [11] than abdominal hysterectomy. Because type VII LH does not depend on vaginal descensus, capacity, or laxity, minimally invasive hysterectomy is available to essentially all women, including the nulliparous and obese. With a 40.9% nulliparity rate, many of the patients in this study might have required open laparotomy or conversion to laparotomy from LAVH if parametrial dissection and closure of the vagina could not be performed laparoscopically. Even for women with descensus and vaginal capacity, an approach from above and within may offer better support of the vaginal apex and a lower risk of vault prolapse compared with vaginal approaches [12].

The absence of significant infectious morbidity in this large series lends support to the use of a thorough but singular povidone sterile scrub and paint preparation of the entire

Table 5
Intraoperative results further stratified by uterine weight (median [range])

Uterine weight (g)	Operative time (min)	Estimated blood loss (mL)
<250 (n = 720)	97 (29–330)	50 (0–1400)
≥250 to 500 (n = 150)	120 (45–270)	100 (0–800)
≥500 to 1000 (n = 86)	160 (62–270)	200 (10–1500)
≥1000 to 1500 (n = 21)	165 (80–336)	200 (10–2100)
≥1500 (n =6)	175 (161–345)	225 (75–500)

Table 6
Non-reoperative and reoperative complications stratified by uterine weight

		Uterine weight		
	Total (n = 983)	<250 g (n = 720)	≥250 g (n = 263)	Δ% (95% CI)
Non-reoperative complications				
Cystotomy repair	8 (0.8%)	2 (0.3%)	6 (2.3%)	−2.0 (−3.8, −0.2)
Pelvic cellulitis	7 (0.7%)	7 (1.0%)	0 (0.0%)	1.0 (0.3, 1.7)
Retroperitoneal hematoma	4 (0.4%)	3 (0.4%)	1 (0.4%)	0.0 (−0.8, 0.9)
Vaginal cuff bleed	4 (0.4%)	3 (0.4%)	1 (0.4%)	0.0 (−0.8, 0.9)
Subcutaneous hematoma	3 (0.3%)	1 (0.1%)	2 (0.8%)	−0.6 (−1.7, 0.5)
Vaginal nonhealing	2 (0.2%)	2 (0.3%)	0 (0.0%)	0.3 (−0.1, 0.7)
Ureter injury with repair	1 (0.1%)	0 (0.0%)	1 (0.4%)	−0.4 (−1.1, 0.4)
C difficile infection	1 (0.1%)	1 (0.1%)	0 (0.0%)	0.1 (−0.1, 0.4)
Bladder fistula	1 (0.1%)	1 (0.1%)	0 (0.0%)	0.1 (−0.1, 0.4)
Diverticulitis	1 (0.1%)	1 (0.1%)	0 (0.0%)	0.1 (−0.1, 0.4)
Pelvic infection/abscess	1 (0.1%)	1 (0.1%)	0 (0.0%)	0.1 (−0.1, 0.4)
Total	33 (3.4%)	22 (3.4%)	11 (4.2%)	−1.1 (−3.9, 1.6)
Reoperative complications				
Postoperative bleeding	9 (0.9%)	7 (1.0%)	2 (0.8%)	0.2 (−1.1, 1.5)
Vaginal cuff bleeding	7 (0.7%)	6 (0.8%)	1 (0.4)	0.5 (−0.5, 1.5)
Ureter fistula reimplanted	4 (0.4%)	3 (0.4%)	1 (0.4%)	0.0 (−0.8, 0.9)
Ureter fistula stented	3 (0.3%)	2 (0.3%)	1 (0.4%)	−0.1 (−0.9, 0.7)
Vaginal nonhealing	3 (03%)	2 (0.3%)	1 (0.4%)	−0.1 (−0.9, 0.7)
Pelvic infection/abscess	2 (0.2%)	2 (0.3%)	0 (0.0%)	0.3 (−0.1 0.7)
Colon injury	2 (0.2%)	1 (0.1%)	1 (0.4%)	−0.2 (−1.0, 0.6)
SBO adhesions	2 (0.2%)	0 (0.0%)	2 (0.8%)	−0.8 (−1.8, 0.3)
Incisional hernia	1 (0.1%)	0 (0.0%)	1 (0.4%)	−0.4 (−1.1, 0.4)
Cystotomy repair	1 (0.1%)	0 (0.0%)	1 (0.45%)	−0.4 (−1.1, 0.4)
Retained device	1 (0.1%)	1 (0.1%)	0 (0.0%)	0.1 (−0.1, 0.4)
Suture granuloma	1 (0.1%)	1 (0.1%)	0 (0.0%)	0.1 (−0.1, 0.4)
Total	36 (3.7%)	25 (3.5%)	11 (4.2%)	−0.7 (−3.5, 2.1)

surgical field, treating the abdomen, vulva, and vagina as one sterile area. It is not necessary to change gloves repeatedly after touching the vulvar or vaginal areas during a laparoscopic case if the vulva and vagina have been adequately prepped.

After controlling for quality of patient outcomes, it is reasonable to review cost issues. LH is less costly compared with TAH [13] and much less costly than a robotic approach [14,15]. In a recent report documenting outcomes of robotically-assisted hysterectomy in patients with large uteri, Payne et al [16] report median duration of surgery in 200 patients with uteri between 250 g and 500 g at 126 minutes, comparable to the 120 minutes in this series. For women with uteri larger than 500 g, Payne et al [6] report a median robotic operating time of 167 minutes, very similar to 161 minutes in this LH series. Median estimated blood loss documented in the Payne et al [6] report for cases with uteri between 250 and 500 g was 50 mL compared with 100 mL for the same uterine weight group in this series. For patients with uteri greater than or equal to 500 g, Payne et al [6] report a median 100-mL blood loss, clinically comparable to the median 200-mL blood loss experienced by that uterine weight group in this LH series.

Although the outcomes for robotically-assisted hysterectomy in patients with large uteri are clinically comparable to the outcomes for the same uterine weight groups reported in this LH study, the need for special training, combined with the expense of purchasing and maintaining the robotic machine, as well as the cost of downtime because of unanticipated repairs, limits the use of robotics and adds substantially to the unreimbursed costs of treatment. In a May 6, 2010, *Wall Street Journal* article reviewing complications from robotic surgery, it was revealed that “The price of the machine ranges from $1 million to $2.25 million, depending on the model. In addition, hospitals pay another $140,000 a year for the robot’s maintenance and $1,500 to $2,000 per surgery for replacement parts.” (Accessed May 19, 2010 at http://online.wsj.com/article/SB10001424052702304703104575173952145907526.html). If that is the case, then this series suggests that a laparoscopic approach to large myomatous uteri may be the most economical, feasible, universally available, minimally invasive option and may offer the best alternative to patients.

There are significant limitations regarding the utility and validity of the data from this observational series. The long observational period of nearly 14 years is 1 study limitation. However, we have studied this and identified the surgeon’s increasing experience as an independent predictor of outcomes. The assignment of all patients except those with documented metastatic disease or severe surgical adhesions to a laparoscopic approach introduces selection bias with regard to comorbidities, but these reflect the current standards of care. To most accurately understand the effects of hysterectomy only, we analyzed the data excluding all other major concomitant procedures, allowing only appendectomy and laparoscopic cystoscopy, which take only a few minutes each and entail virtually no blood loss [6,8]. Other minor gynecologic procedures such as lysis of adhesions and fulguration of mild endometriosis were performed, but not abstracted into the database. These may have prolonged the recorded durations and affected the EBL. Finally, many of these cases were teaching cases and as such do not reflect only one surgeon's experience. It is clear that a randomized trial of approach by laparoscopy, robotics, laparotomy, and vaginal routes for hysterectomy stratifying by uterine size is long overdue and should include cost comparisons and long-term follow-up for support issues.

Conclusions

Although operating times and blood loss do increase a significant but very modest amount with increasing size of the uterus, a laparoscopic approach for removing large uteri is safe and feasible and may reflect the most cost-effective surgical technique.

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