SCIENTIFIC PAPER

Robotic-Assisted Total Laparoscopic Hysterectomy Versus Conventional Total Laparoscopic Hysterectomy

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ABSTRACT

Objectives: To compare patient characteristics, operative variables, and outcomes of 24 patients who underwent robotic-assisted total laparoscopic hysterectomy (TLH) with 44 patients who underwent conventional TLH. We retrospectively reviewed the charts of 44 patients with TLH and 24 patients with robotic TLH.

Results: Robotic TLH was associated with a shorter hospital stay (1.0 vs 1.4 days, P=0.011) and a significant decrease in narcotic use (1.2 vs 5.0 units, P=0.002). EBL and drop in hemoglobin were not significantly different. The operative time was significantly longer in patients undergoing robotic TLH (142.2 vs 122.1 minutes, P=0.027). However, only need for laparoscopic morcellation, BMI, and uterine weight, not robotic use, were independently associated with increased operative times.

Conclusions: Robotic hysterectomy can be performed safely with comparable operative times to those of conventional laparoscopic hysterectomy. Postoperative measures were improved over measures for conventional laparoscopy.

Key Words: Hysterectomy, Laparoscopic hysterectomy, Laparoscopy, Minimal invasive surgery, Robotic surgery.

INTRODUCTION

Every year about 600,000 hysterectomies are performed in the United States, the majority of them via laparotomy.[1] The introduction of advanced laparoscopic technology made total laparoscopic hysterectomy more feasible. Conventional laparoscopy however has its limitations. Limited dexterity, range of movement, 2-dimensional vision, and a slow learning curve make complex surgical tasks difficult. As a result, many physicians are deterred from utilizing a laparoscopic approach to hysterectomy, especially in patients with larger uteri, obesity, and prior surgery.

Robotic surgical systems attempt to improve the shortcomings of conventional laparoscopy. In 2002, the first small case series on robotic-assisted total laparoscopic hysterectomy (TLH) was published.[2] While data suggested safe use of the techniques in humans, operative times ranging from 4.5 hours to 10 hours and an estimated blood loss of 50 mL to 1500 mL made it seem unacceptable for routine clinical use.[2] With improved robotic systems however, operative times improved significantly. Reynolds and Advincula[3] performed robotic-assisted laparoscopic hysterectomy on 16 patients in 2006 with a mean operating time of 242 minutes and estimated blood loss of 50 mL to 300 mL.

In 2005, the FDA approved robotic surgical systems for gynecologic applications. Since then, an increasing number of case reports have demonstrated the safety of robotic-assisted laparoscopic hysterectomy and several other gynecologic procedures.[4] Often criticized are high costs and still longer operating times associated with robotic-assisted procedures. Payne and Dauterive[5] demonstrated a difference in operative times between robotic-assisted TLH and conventional TLH of only 27 minutes with a conversion rate to laparotomy of 0% compared with 11% with the conventional approach. With a mean robotic docking time of only 2.9 minutes, Kho[6] demonstrated an operative time of 122 minutes in 91 patients operated on between 2004 and 2005.

With operative times approaching those of conventional laparoscopy, the robotic approach became more feasible for routine clinical use. Increased precision, 3-dimensional vision and faster learning curves are possible ad-

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vantages that might enable more providers to offer a laparoscopic approach to a broader patient population with more advanced pathology. This could ultimately lead to decreasing numbers of total abdominal hysterectomies.

The goal of our study was to compare the patient characteristics, operative variable, and outcomes of 24 patients who underwent robotic-assisted total laparoscopic hysterectomy (TLH) with 44 patients who underwent conventional TLH. We wanted to demonstrate that robotic-assisted TLH could be performed with similar operating times and comparable outcomes, especially in more challenging patients.

MATERIALS AND METHODS

The study was approved by the AIMMC and the Macneal/Weiss IRB by expedited review.

Forty-four consecutive woman who underwent total laparoscopic hysterectomy between January 2003 through May 2005 were compared with 24 consecutive women who had robotic-assisted TLH between May 2005 and November 2007. The cases were performed at Advocate Illinois Masonic Medical Center (AIMMC), Chicago and Weiss Memorial Hospital, Chicago. All cases were performed by the same surgeon, assisted by OB/GYN residents from AIMMC with different levels of training. The total laparoscopic hysterectomies were performed with a 12-mm camera port and three 5-mm operative ports. The surgical technique used was similar to that previously described by Koh.[7] The da Vinci Robotic Surgical System (Intuitive, Inc., Sunnyvale, CA) was used for all robotic-assisted procedures. A 12-mm camera port, 5-mm assistant port, and 3 working 8-mm robotic ports were utilized. Data were collected via retrospective chart review. Excluded were laparoscopic-assisted vaginal hysterectomies, laparoscopic supracervical hysterectomies, and cases with concomitant sacral colpopexies. Additional other surgeries performed at the same time were salpingo-oophorectomies, hernia repairs, and mid urethral sling procedures. These cases were noted but not excluded.

We compared the following preoperative and operative variables between both groups: patient age, BMI, present or absent history of prior abdominal or pelvic surgery, uterine weight, additional other procedures performed, type of morcellation if necessary, operative times, and room time in the OR and EBL.

Postoperative factors investigated were length of stay, drop in hemoglobin and number of parenteral narcotic units needed for pain control. Parenteral narcotics used in the 2 centers were intravenous or intramuscular injections of morphine, Demerol or fentanyl. One narcotic unit was defined as either 2 mg of morphine or 25 mg of Demerol or 0.4mg of fentanyl.

Descriptive statistics (mean SD) for continuous data and [N (%)] for categorical data were calculated on all patient characteristics. Between groups (TLH vs robotic-assisted) statistical comparisons were performed via independent *t* test for continuous data, chi-square test or Fisher's Exact test for categorical data, and Mann-Whitney test for non-parametrically distributed data. Bivariate correlations and Forward Stepwise Multiple Regression was performed to examine the effect of BMI, uterine weight, group and other potential predictor variables, on the dependent variable operative time. Predictor variables were selected a priori by the investigators. A 3-tailed P level of 0.05 was considered statistically significant in all analyses. Analyses were performed with SPSS software (version 16.0, SPSS, Chicago).

RESULTS

Indications for surgery are listed in **Table 1**. The 2 groups were of similar age and BMI. More patients in the TLH group than the robotic hysterectomy group had prior surgery **(Table 2)**. All cases were completed without conversion to laparotomy. We did not encounter any procedure-related operative complications. One patient with conventional TLH was readmitted for vaginal cuff dehiscence, which was repaired vaginally with the patient

Table 1.
Indications for Hysterectomy

Conventional Total Laparoscopic Hysterectomy	n
Uterine leiomyomata	19
Pelvic pain/adenomyosis	5
Endometriosis	5
Menometrorrhagia	13
Endometrial hyperplasia	1
Endometrial CA	1
Robotic Total Laparoscopic Hysterectomy	**n**
Uterine leiomyomata	12
Pelvic pain/ adenomyosis	6
Endometriosis	1
Menometrorrhagia	4
Endometrial hyperplasia	2
CA in situ of the cervix	1

Table 2.
Patient Demographics

	TLH* (n = 44)	Robotic TLH* (n=26)	P Value
Mean Age	42.2 (24–78)	44.9 (27–74)	.234†
Mean BMI*	30.5 (18.6–47.7)	30.3 (18–46.3)	.902†
Prior Surgery	84.1%	57.7%	.026‡

*TLH=total laproscopic hyateretomy; BMI=body mass index.
†Ind. *t* test.
‡Chi-square test

under spinal anesthesia. One patient developed pneumonia 2 weeks after robotic-assisted TLH **(Table 3)**.

Robotic-assisted TLH was associated with a shorter hospital stay (1.0 vs 1.4 days, P<0.05) and a significant decrease in narcotic use (1.2 vs 5.0 units, P<0.005) **(Table 3)**. EBL and drop in hemoglobin were not significantly different in both groups. The operative time was significantly longer when robotic-assisted TLH was performed (142.2 vs 122.1 minutes, P<0.05). The total room time was also longer in the robotic arm (185.7 vs 161.7 minutes, P<0.5). The uterine weight was higher in patients who underwent robotic-assisted TLH, but did not reach statistical significance (212.1 g vs 170.4 g, P=0.120). A higher number of patients undergoing robotic hysterectomy had laparoscopic morcellation (23.1% vs 2.3%, P=0.010) **(Table 4)**. The relationship between operative time and BMI is shown in **Figure 1**. The relationship between operative time and uterine weight is shown in **Figure 2**.

Multiple linear regression analysis was performed. We found that laparoscopic morcellation, a higher uterine weight, and a larger BMI were independently associated with longer operative times **(Table 5)**. After controlling for these 3 variables, robotic assistance was no longer associated with increased operative times.

DISCUSSION

Robotic-assisted TLH can be performed safely, with acceptable operative times even in challenging patients. Average uterine weight and BMI were considerably greater in our series than in those recently published.[3,4,5,6] Despite this, average operative time compares favorably with operative times in previous reports. Within our series, need for laparoscopic morcellation, uterine size, and BMI were independently associated with longer operative times. After controlling for these factors, robotic assistance was no longer associated with longer operative times. Postoperative outcomes were improved with robotic assistance.

We demonstrated a decrease in length of stay and parenteral narcotic use, while EBL and complication rate were equally low in both groups. While decreased pain associated with robotic surgery has been reported previously, it is unclear how this benefit is achieved. In this review, it is possible that physician experience with surgical technique improved over time. It is also possible that reduced tissue destruction with robotic dissection improves postoperative outcomes.

The difficulty of robotic surgery in obese patients has previously been reported. Herman et al[8] showed that increasing BMI negatively impacted operative time, blood loss, and positive surgical margin rate in men undergoing radical prostatectomy. Multiple factors may account for the difference in operative time we experienced with increasing BMI. Bowel retraction, limitation of Trendelenburg positioning, and limited vaginal access may all contribute to increased operative time.

Table 3.
Results-Postoperative Variables

Means	TLH*	Robotic TLH*	P Value
Length of stay (days)	1.4 (0–5)	1.0 (0–2)	.011†
Hgb* drop (g/dL)	1.81 (0–4.4)	1.87 (0.5–4.3)	.825‡
Narcotic use (Units)	5.0 (0–37)	1.2 (0–9)	.002†
Readmissions	1 (cuff dehiscence)	1 (pneumonia)	Not significant

*TLH=total laparoscopic hysterectomy; Hgb=hemoglobin.
†Mann-Whitney.
‡Ind. *t* test.

Table 4.
Operative Variables

	TLH*	Robotic TLH*	P Value
Uterine weight (g)	170.4 (35–510)	212 (72–520)	.120†
Operative time (min)	122.1 (60–245)	142.2 (90–218)	.027†
Room time (min)	161.7 (60–285)	185 (120–290)	.014†
EBL (mL)	98.8 (50–450)	113.5 (50–300)	.418†
Vaginal morcellation	15.9%	7.7%	.466‡
Laparoscopic morcellation	2.3%	23.1%	.010‡
Additional surgery	36.4%	34.6%	.883§

*TLH=total laparoscopic hysterectomy; EBL=estimated blood loss.

†Ind *t* test.

‡Fischer's exact.

§Chi-squared test.

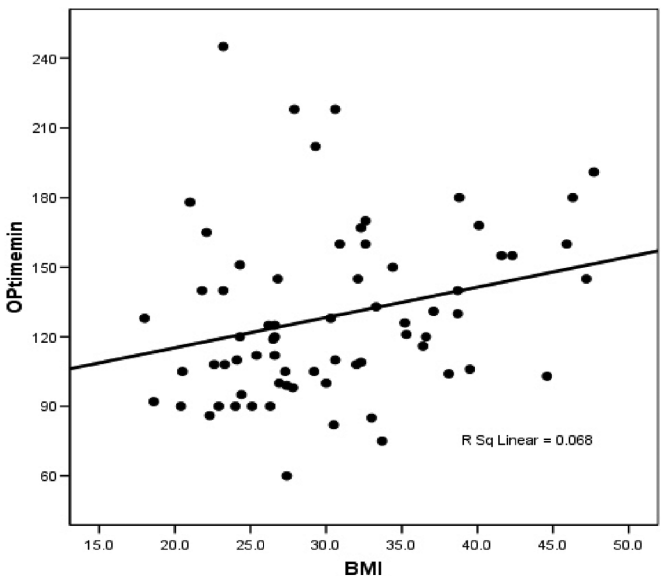

Figure 1. Operative times (min) with increasing body mass index (BMI).

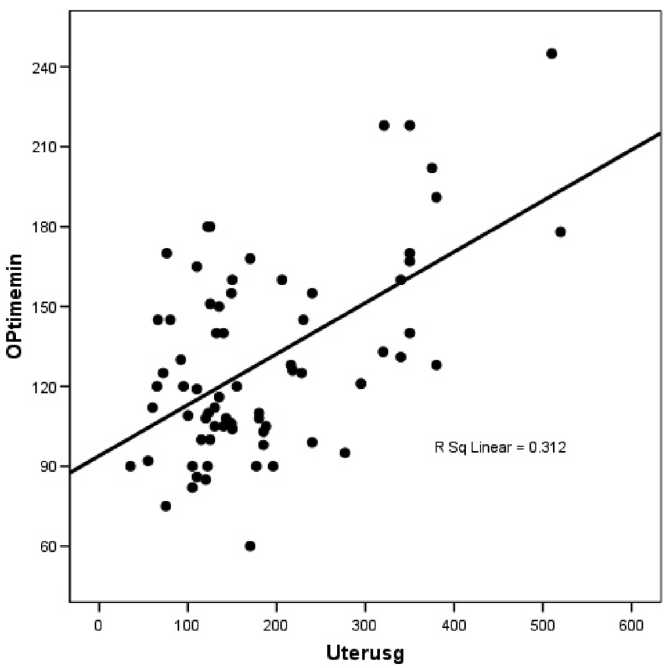

Figure 2. Operative times (min) with increasing uterine weight in grams.

Several challenges are also present with larger uteri. Port positioning and the ability to limit instrument exchanges are compromised in the presence of a large uterus. Additionally, vaginal removal of the specimen is difficult when the specimen is >150 grams. In patients undergoing traditional total laparoscopic hysterectomy, our preference was to vaginally morcellate the specimen. Robotic surgery limits visualization for morcellation and may require undocking the robot to safely remove the specimen vaginally. This may have led to a greater utilization of laparoscopic morcellation in this series.

Our study has some limitations. It is a retrospective review of a small number of patients. Procedure time may be impacted by the experience of the operating room staff, a factor not taken into account in our review. In addition, as with other series published on robotic surgery,[3,4,5,6] the primary surgeon had extensive experience with advanced laparoscopy prior to implementing robotics. As robotic surgery gains popularity, further studies are needed to

Table 5.
Multiple Linear Regression Analysis Model Summary

Model	R	R Square	Adjusted R Square	Standard Error of the Estimate
1	.595*	.354	.344	30.055
2	.689†	.474	.458	27.323
3	.728‡	.529§	.507	26.049

*Predictors: (Constant), Laparoscopic Morcellation

†Predictors: (Constant), Laparoscopic Morcellation, Uterine weight in gram

‡Predictors: (Constant), Laparoscopic Morcellation, Uterine weight in gram, Body Mass Index

§With R square value of .529, the model explains 52.9% of the difference in operative time. P value < .001.

examine operative times, learning curve, costs and clinical outcomes for less experienced surgeons.

We do not believe laparoscopic or robotic hysterectomy should replace conventional vaginal hysterectomy. During the study period, vaginal hysterectomy was utilized when indicated. As with any new technology, however, there is opportunity for overutilization of robotic surgery as the approach is learned, with a reduction in the number of vaginal hysterectomies performed. While more costly, outcomes for laparoscopic and robotic hysterectomy are similar to costs for vaginal hysterectomy. A Cochrane review of surgical approaches to hysterectomy[9] found no evidence for a benefit of one technique over the other. A recent randomized prospective trial comparing laparoscopic and vaginal hysterectomy showed a shorter hospital stay, less blood loss, and less postoperative pain in the laparoscopic arm.[10]

Adoption of new technology is potentially costly to the healthcare system, but cost alone should not limit the use of new technologies. Determining return on investment for a hospital's robotic system is complicated. Multiple issues affect cost and revenue including operative time, length of stay, disposable instrument use, complication rate, payer mix, and payer contracting. Many hospitals now consider a robotic surgical system a sunk cost, or an unrecoverable cost of business, and do not include the capital outlay in the cost analysis of the hospital's robotic program. Certainly, if the capital outlay for a robotic system is included in determining cost of procedure, the cost of robotic hysterectomy increases significantly.

Based on our experience with robotic surgery, we believe patients should be counseled individually on mode of hysterectomy. The indication for surgery, uterine weight, patient weight, previous surgeries, uterine descent, known pelvic adhesive disease or significant endometriosis should be taken into account when considering the surgical plan. We currently use robotic surgery for hysterectomy in patients who are not good candidates for vaginal hysterectomy, and in whom the likelihood exists for significant pelvic adhesive disease or significant endometriosis. We also perform robotic hysterectomy for patients undergoing concomitant sacral colpopexy. We recommend total laparoscopic hysterectomy in patients who are not good candidates for vaginal hysterectomy and have pelvic pain as the indication for surgery. In patients with larger uteri that may require morcellation, we prefer traditional total laparoscopic hysterectomy over robotic hysterectomy. Further study is needed to validate this decision algorithm.

Multiple issues regarding the utilization of robotics in gynecology remain. Short- and long-term patient outcomes need to be further evaluated with randomized prospective trials. Surgical costs, taking into account postoperative variables, need critical review. Robotic surgical systems can facilitate a minimally invasive approach in very challenging surgical candidates who traditionally would have undergone abdominal hysterectomy. Randomized controlled trials evaluating this hypothesis are needed. Of concern are also issues related to resident training and the potential decline in vaginal hysterectomies with routine introduction of robotics. Further studies are needed to address these questions.

CONCLUSION

Robotic hysterectomy is safe. Operative times were reasonable, even in challenging cases. The use of robotics was not associated with longer operative times than traditional laparoscopy. In addition, we demonstrated a shorter hospital stay and reduced narcotic use in patients undergoing robotic-assisted TLH.

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