ONCOLOGY

A comparative study of 3 surgical methods for hysterectomy with staging for endometrial cancer: robotic assistance, laparoscopy, laparotomy

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OBJECTIVE: The purpose of this study was to compare outcomes in women who underwent endometrial cancer staging by different surgical techniques.

STUDY DESIGN: Three hundred twenty-two women underwent endometrial cancer staging: 138 by laparotomy (TAH); 81 by laparoscopy (TLH) and 103 by robotic technique (TRH).

RESULTS: The TRH cohort had a higher body mass index than the TLH cohort ($P = .0008$). Lymph node yield was highest for TRH ($P < .0001$); hospital stay ($P < .0001$) and estimated blood loss ($P < .0001$) were lowest for this cohort. Operative time was longest for TLH (213.4 minutes) followed by TRH (191.2 minutes) and TAH (146.5 minutes; $P < .0001$. Postoperative complication rates were lower for TRH, compared with TAH (5.9% vs 29.7%; $P < .0001$). Conversion rates for the robotic and laparoscopic groups were similar.

CONCLUSION: TRH with staging is feasible and preferable over TAH and may be preferable over TLH in women with endometrial cancer. Further study is necessary to determine long-term oncologic outcomes.

Key words: endometrial cancer, hysterectomy, laparoscopy, laparotomy, robotic assistance

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Endometrial cancer is the most common gynecologic cancer in the United States; it affects 42,100 women every year.[1] Endometrial cancer is often diagnosed in early stages; however, 20% of women with clinical stage I have evidence of extrauterine disease at the time of laparotomy.[2] As a result, in 1988 the International Federation of Gynecology and Obstetrics recommended comprehensive surgical staging as part of the treatment of endometrial cancer.[3,4] Although this improved patient outcomes, it also resulted in increased postoperative morbidity.[5]

Minimally invasive endoscopic surgical techniques can decrease patient morbidity for women who undergo endometrial cancer staging. Laparoscopic-assisted surgical staging results in decreased blood loss and a shorter recovery time; however, its use is still limited because of the prolonged learning curve, longer operative time, and limitations in the ability to perform complex surgical procedures.[6] Studies have shown that it can take 20-100 surgeries for a surgeon to reach stable operating times and lymph node yields.[7-13] In addition, differences in technique can affect morbidity and vaginal cuff recurrence rates.[13] The da Vinci Surgical System (Intuitive Surgical, Inc, Sunnyvale, CA) offers certain advantages over traditional laparoscopy hysterectomy (TLH), including 3-dimensional imaging of the operating field, instruments with wrist-like range of motion, the lack of a fulcrum effect, and a faster learning curve.[14] It has been used effectively for benign hysterectomies; however, its use in the comprehensive staging of endometrial cancer is relatively new.[15-17] Recent reports on robotic-assisted laparoscopic surgical staging have suggested its feasibility as an alternative treatment for gynecologic cancers, with no reported increase in complication rates, reasonable operative times, equivalent lymph node counts, and lower blood loss rates than laparotomy hysterectomy (TAH) and TLH.[17-19] However, the number of patients in these reports is small, with only a few patients staged for endometrial adenocarcinoma.[17-19] In addition, these early reports do not have control or comparison groups and are descriptive in nature.[17-19] In this study, we compare robotic-assisted hysterectomy (TRH) with staging to both TLH and TAH in women with endometrial cancer and address perioperative and early postoperative outcome.

Materials and Methods

From June 2005 to December 2007, 103 patients who were examined by 1 surgeon and could be accommodated on the surgical schedule in a timely fashion underwent total hysterectomy with staging

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FIGURE 1
Patient placement in the low dorsolithotomy position

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for endometrial cancer with a novel technique that was developed at the University of North Carolina at Chapel Hill with the da Vinci Surgical System (TRH). These cases were compared with 2 historic cohorts: Between April 2000 and September 2004, 138 patients underwent total hysterectomy with staging by TAH, and 81 patients underwent total hysterectomy with staging by TLH. Most cases were performed under the guidance of 1 gynecologic oncologist, with resident and fellow participation. In the case of the TAH cohort, the cases were completed by 4 gynecologic oncologists. Institutional review board approval was granted by the Office of Human Research Ethics. Data were verified for distributional assumptions with a Kolmogorov-Smirnov test. Continuous variables were analyzed with a 2-sampled *t*-test; discrete variables were compared by a chi-squared test with or without continuity correction. Fisher's exact test was used in the case of small cell comparisons. Statistical significance was defined as a probability value of $< .05$.

Description of surgical procedure

The policy for all surgical approaches was complete endometrial staging that included hysterectomy, bilateral salpingo-oophorectomy, and periaortic and pelvic lymph node dissection according to the International Federation of Gynecology and Obstetrics staging system.[3] Traditional techniques were used for abdominal hysterectomy and endometrial staging. TLH and endometrial staging was performed in the same manner, as described elsewhere.[20] All 3 methods incorporated hysterectomy, pelvic washings, and bilateral pelvic lymphadenectomy and periaortic lymphadenectomy, at least to the level of the inferior mesenteric artery. With robotic assistance, the left periaortic lymph nodes were obtained more easily.

The surgical technique for robotic-assisted endometrial staging included hysterectomy, bilateral salpingo-oophorectomy, bilateral periaortic, and pelvic lymph node dissection. A video demonstration of this procedure may be accessed in the National Library of Medicine (February 2007).[20] All patients received a mechanical bowel preparation with 1 gallon of Golytely (Braintree Laboratories Inc, Braintree, MA), perioperative antibiotics, and lower extremity sequential compression devices for deep venous thrombosis prophylaxis.

All procedures were performed with general anesthesia with the patient placed in the low dorsolithotomy position with the use of universal Allen stirrups (Figure 1). A gel pad was placed on the surgical table under the patient; the patient's arms were tucked at the sides, and shoulder blocks were used. The patient was prepped and draped, and a Foley catheter was placed to gravity. A uterine manipulator (ZUMI; CooperSurgical Inc, Trumbull, CT) and a (KOH) colpotomizer ring (CooperSurgical Inc) were placed in the uterus after dilation of the cervix, and an uninflated pneumooccluder balloon was placed over the ZUMI (Figure 2).

A 5-trocar transperitoneal approach was used (Figure 3). We injected 1% lidocaine at each trocar site before incision to reduce postoperative pain. A 2-mm laparoscopic port was placed first in the left upper quadrant, then all subsequent ports were placed under direct visualization. The patient subsequently was placed in steep Trendelenburg, and the secondary trocar sites were measured and marked after insufflation of the abdomen to a maximum pressure of 15 mm Hg. The daVinci Surgical System was then docked at the foot of the bed, and the entire procedure was performed with this single docking position. The zero-degree camera was used for the entire procedure.

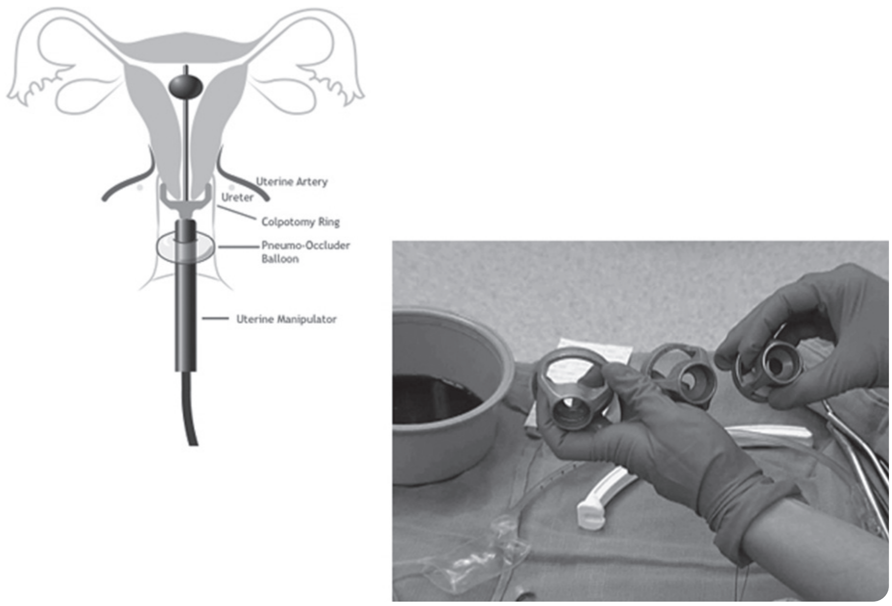
Dissection of the periaortic lymph nodes was performed with monopolar scissors (EndoWrist; Intuitive Surgical, Inc) in the left "hand" and the bipolar grasper (EndoWrist; Intuitive Surgical, Inc) in the right "hand. " These instruments can be reversed when the left-sided periaortic node dissection is performed, if desired. A second bipolar grasper was placed in the fourth arm and used to retract the ascending colonic mesentery and ureter after a transperitoneal incision was created over the right common iliac artery. The assistant can help retract superiorly with a long laparoscopic grasper. The right periaortic node dissection was completed from the common iliac to the insertion of the gonadal vein into the vena cava, and the left periaortic dissection was completed from the common iliac artery to the inferior mesenteric artery. After the periaortic lymph node dissection was completed, the lymphatic tissue bundles were placed in EndoCatch bags (Ethicon Endosurgery, Cincinnati, OH) and were delivered vaginally after the completion of the hysterectomy.

The TRH was performed in the same manner as a traditional abdominal hysterectomy with scissors and monopolar cautery for isolation and ligation of small vessels and bipolar cautery for the ovarian vessels, uterine artery, and vascular branches of the cardinal ligament. After the ureter was identified, the infundibulopelvic ligament was isolated and divided. The posterior leaf of the broad ligament was dissected to where the uterosacral ligament crossed the posterior KOH ring. The anterior leaf of the broad ligament was dissected anteriorly, and the bladder flap was created. The uterine artery was then skeletonized, cauterized with the bipolar grasper, and divided with the monopolar scissors. Once this was completed bilaterally, the pneumooccluder balloon was inflated, and a circumferential colpotomy was performed over the KOH ring with the monopolar scissors. After the uterine specimen was delivered vaginally, the pneumooccluder balloon was replaced in the vagina to restore pneumoperitoneum.

After completion of the right and left pelvic nodal dissections from the common iliac artery to the circumflex iliac vein, the specimens were placed in EndoCatch bags (Ethicon Endosurgery) and delivered vaginally along with the periaortic lymph nodes. The right robotic instrument was then exchanged for a needle driver, and with intracorporeal suturing, the vaginal cuff was closed with a running 0-Vicryl suture on a CT-1 needle cut to 12 inches.

A regular diet was ordered the day of surgery, and the option of either an oral narcotic or nonsteroidal pain medicine was prescribed. Intravenous fluids were maintained until the patient could tolerate oral fluids, and a hematocrit was checked 6 hours after the procedure to exclude any occult postoperative bleeding. For all surgical approaches, patients were discharged home if they had demonstrated the ability to ambulate independently, tolerate a regular diet, and control pain adequately.

FIGURE 2
ZUMI uterine manipulator and KOH colpotomizer ring



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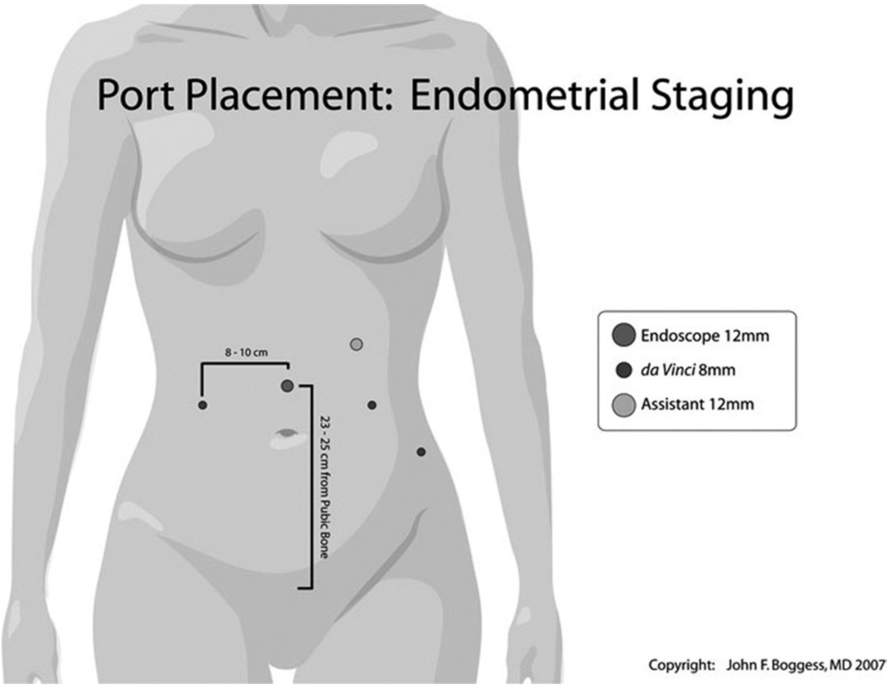
RESULTS

Between June 2005 and December 2007, 103 patients underwent TRH for endometrial cancer staging. They were compared with a historic cohort of 138 patients who underwent TAH and a cohort of 81 patients who underwent TLH between April 2000 and September 2004. The mean age of the patients ranged from 62.0-64.0 years and was not found to differ between cohorts (Table 1). Although body mass index was comparable between patients who underwent TAH and those who underwent TRH, the patients in the robotic cohort had a higher body mass index, compared with the TLH cohort (29.0 vs 32.9; P = .0008). Women who underwent TAH had an average of 14.9 total nodes retrieved, compared with 23.1 and 32.9 nodes in the TLH and TRH cohorts, respectively ($P <$ .0001). Table 1 shows the breakdown of the total, pelvic, and periaortic nodes for the 3 groups.

Operative time, which was defined as first skin incision to skin closure, was 146.5 ± 48.8 minutes for the TAH group, compared with 191.2 ± 36.0 minutes for the robotic group ($P <$ .0001). The TLH group experienced the longest average operative time at 213.4 ± 34.7 minutes ($P <$ .0001). Patients who underwent TRH experienced a shorter hospital stay (1 day) in comparison with the open cohort (4.4 days; $P <$ .0001) and the laparoscopic cohort (1.2 days; P = .001). The estimated blood loss (EBL) for patients who underwent TRH was 74.5 ± 101.2 mL, compared with those who underwent TAH (266.0 ± 184.5 mL; $P <$ .0001) and TLH (145.8 ± 105.6 mL; $P <$ .0001). There was a decrease in the maximum EBL and in the number of patients with high EBL. The 95% CI for EBL in the robotic cohort was (54.8-94.2), whereas the 95% CI for EBL in the laparoscopic cohort was (122.5-169.2) and in the open cohort was (235.0-297.1).

Intraoperative and postoperative complications are listed in Table 2. There was 1 small bowel leak in the robotic cohort, 1 enterotomy in the TAH cohort, and 3 intraoperative complications in the TLH cohort (a caval injury, a bowel injury, and a cystotomy). The overall incidence of postoperative complications

FIGURE 3
Five trocar transperitoneal approach



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was 29.7% in the open cohort, 13.6% in the laparoscopic cohort, and 5.8% in the robotic cohort ($P < .0001$). The most prevalent types of postoperative complications were wound separation, which was seen in 10% of patients in the TAH group, and readmission for ileus, which was seen in 5% of patients who underwent TAH. There was a statistically significant difference in the incidence of postoperative complications between the TAH and TRH cohorts ($P < .0001$). Although the incidence of postoperative complications in the laparoscopic group was > 2 times greater than that in the robotic cohort, this difference, although not statistically significant, is clinically meaningful.

A total of 4 of 81 patients (4.9%) in the laparoscopic group were converted to TAH because of poor visualization (n = 2), uterine size that prevented laparoscopic retrieval (n = 1), and intolerance of Trendelenburg position (n = 1). Three patients in the robotic cohort (2.9%) required conversion to open surgery because of adhesions (n = 1) and tumor that eroded through the uterine serosa and involved the rectosigmoid colon (n = 2). The incidence of blood transfusions was highest among patients who underwent TLH at 2.5%. Transfusion rates for TRH and TAH were comparable at 1% and 1.5%, respectively.

COMMENT

In this series, we compare TRH with staging for endometrial cancer to TLH and TAH and report an increased lymph node yield, decreased blood loss, and shorter length of stay in the TRH cohort, compared with the other 2 cohorts.

The TRH and TLH cohorts were comparable with respect to both conversions to TAH and perioperative complications. There were also significantly fewer postoperative complications, when compared with the TAH cohort, and a clinically meaningful trend towards fewer postoperative complications, when compared with the TLH cohort.

Average EBL for the TRH group was 3 times less than that seen in the TAH group and one-half that of the TLH group. Patients in the TRH group had a shorter length of stay, when compared with both the TAH and TLH groups. From a clinical standpoint, the EBL and length of stay results from both the laparoscopic and robotic cohorts were excellent. However, the surgeons in this study had extensive previous laparoscopic experience and still saw significant improvements after the implementation of the robotics program. The robotic platform offers an increase in visibility, precision, and dexterity during surgery, which translates into lower values for these parameters. Specifically, although the magnitude of the differences reported for these measures (TRH vs TLH) may seem small when considering an individual patient, a decrease by one-half of the average EBL is reflective of fewer patients with large EBL because of a decrease in intraoperative complications (such as vessel injury) and an increased ability to deal with difficult anatomy (such as adhesions). In addition, because discharge time was not measured in terms of hours, there is a bottom limit of 1.0 day for length of hospital stay. This reduces the ability to see large differences. Therefore, for a difference of 0.2 days to be statistically significant, the standard deviation must be very small. This is indicative of consistently improved outcomes for each patient and is reflective of lower patient morbidity (fewer patients staying longer than the average because of complications). Therefore, although a decrease in these parameters may not be clinically significant for a single patient, it is clinically significant for the patient population as a whole and reflects an increase in the safety of the procedure. Furthermore, the average body mass index of patients in the robotic cohort was significantly higher than that of patients in the laparoscopic cohort, which suggests that robotic surgery could broaden the patient population that is eligible for minimally invasive surgery.

It has been suggested that the number of lymph nodes that are removed is the most important oncologic parameter for lymphadenectomy.[13] We report an increase in the lymph node yield in the robotic cohort, compared with both the TAH and TLH cohorts, and a shorter operating time in the robotic cohort, compared with the laparoscopic cohort. This in part is due to optimization of port placement that requires a single docking of the robotic instrument and greater ease in overcoming anatomic barriers with robotic assistance, which allows for a more comprehensive lymphadenectomy, such as when obtaining the left periaortic lymph nodes.

The literature on the use of robotic surgery in gynecologic oncology is limited. The first report of TRH (American Association of Gynecologic Laparoscopists type IIB) was by Diaz-Arrastia et al[21] in 2002. The authors reported on 11 women who were treated for a variety of conditions, 1 of which was endometrial cancer. The data were combined, with an operative time range of 4.5-10 hours, an average blood loss of 300 mL, an average length of hospital stay of 2 days, and 1 conversion to mini-TAH. In a second study by the same group, the authors reported on 41 patients; 20 women were treated for endometrial, ovarian, or cervical cancer.[18] The data from all cancer types were combined, with zero conversions to TAH, EBL (253 mL), short hospital stay (average, 2.5 days), and a low overall complication rate of 7.3%. Marchal et al[19] published a report of their initial experience with a series of 30 patients, 5 of whom were treated for endometrial cancer. The authors reported an operating time of 181 minutes and no cancer-related deaths with 10 months of follow-up. In another case series, the authors reported on 7 patients who were staged for cancers of the endometrium, fallopian tubes, and ovaries. Four of the patients were staged for endometrial cancer. They reported a good lymph node yield (average, 15 pelvic and periaortic lymph nodes combined), minimal blood loss (average, 50 mL), a short hospital stay (2 days), and no conversions to TAH. Their procedure required redocking the robotic surgical cart to complete lymph node dissection.[5] In our experience of 103 patients, we have optimized the port placement to require docking of the robot only once to complete the entire procedure, thus simplifying the operation, decreasing operative time, and making it more generalizable.

TABLE 1

Preoperative characteristics and operative results of patients who underwent hysterectomy by TAH, TLH, and TRH

Variable	TAH (n = 138)	TLH (n = 81)	TRH (n = 103)	*P* value
Age (y)				
Mean	64.0	62.0	61.9	.06[a]
SD	12.8	10.8	10.6	.95[b]
Body mass index (kg/m^2)				
Mean	34.7	29.0	32.9	.17[a]
SD	9.2	6.5	7.6	.0008[b]
Stage				
IA	37	23	38	
IB	49	28	41	
IC	13	11	10	
IIA	5	4	1	
IIB	8	0	2	
IIIA/IIIB/IIIC	17	14	10	
IVA/IVB	3	1	0	
Unstaged	6	—	1	
Total nodes				
Mean	14.9	23.1	32.9	< .0001[a]
SD	11.3	11.4	26.2	< .0001[b]
Total pelvic nodes				
Mean	11.5	17.4	20.5	< .0001[a]
SD	8.2	8.9	13.6	.06[b]
Total periaortic nodes				
Mean	3.0	6.3	12.0	< .0001[a]
SD	2.9	3.7	9.0	< .0001[b]
Operative time (min)				
Mean	146.5	213.4	191.2	< .0001[a]
SD	48.8	34.7	36.0	< .0001[b]
EBL (mL)				
Mean	266.0	145.8	74.5	< .0001[a]
SD	184.5	105.6	101.2	< .0001[b]
Length of hospital stay (d)				
Mean	4.4	1.2	1.0	< .0001[a]
SD	2.0	0.5	0.2	.001[b]
Conversion	—	4/81 (4.9%)	3/103 (2.9%)	.70[c]

TAH, laparotomy; *TLH*, laparoscopy; *TRH*, robotic technique.

[a] *T*-tests have been used for all continuous variables comparison of TAH to TRH cohort.

[b] *T*-tests have been used for all continuous variables comparison of TLH to TRH cohort.

[c] Mantel-Haenszel chi-square test for discrete variables.

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TABLE 2
Intraoperative and postoperative complications

Variable	TAH (n = 138)	TLH (n = 81)	TRH (n = 103)	*P* value[a]
Intraoperative complications				
Caval injury		1		
Bowel injury		1	1	
Enterotomy	1			
Cystotomy		1		
Total intraoperative complications	1 (0.7%)	3 (3.7%)	0 (1.0%)	
Postoperative complications				
Atrial fibrillation	2			
Stroke	1			
Reoperation for port site hernia		1	1	
Readmission for ileus	7	1		
Deep vein thrombosis	1			
Respiratory failure/reintubation	1			
Pulmonary edema	2			
Pulmonary embolism	1		1	
Cholecystitis	1			
Umbilical hernia		1		
Femoral nerve palsy		1		
Lymphocyst		1	1	
Lymphedema			1	
Cellulitis	5			
Urinary tract infection	3			
Wound separation	14			
Vaginal leak			1	
Vaginal cuff hematoma	1			
Vaginal dehiscence		1		
Vaginal seroma	1	1		
Rectovaginal fluid collection/abscess		1		
Total postoperative complications	40 (28.9%)	8 (9.9%)	5 (4.9%)	
Overall complication rate	41 (29.7%)	11 (13.6%)	6 (5.8%)	$<$ .0001 .07
Transfusion	2 (1.5%	2 (2.5%)	1 (1%)	.81 .58

Fisher exact test used for comparison between TAH and TRH transfusion rates (.81) and comparison between TLH and TRH cohorts (.58). $P <$ .0001 refers to the comparison of the overall complication rate between TAH and TRH. $P =$ .07 refers to the comparison of the overall complication rate between TLH and TRH. $P =$ .81 refers to the comparison of transfusion rate between TAH and TRH. $P =$ .58 refers to the comparison of transfusion rate between TLH and TRH.

TAH, laparotomy; *TLH*, laparoscopy; *TRH*, robotic technique.

[a] Chi-square test with continuity correction, for comparison between TAH and TRH cohorts ($P <$ .0001) as well as TLH and TRH cohorts ($P =$ .07).

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Tables 3 and 4 summarize data from a sample of current laparoscopic and open literature for staging uterine cancer. Our intent is not to present a comprehensive review of the literature but is to mention a sample of articles that report a similar type of study. Specifically, we have chosen articles with similarities of operating technique, indications for surgery, reported parameters, and size of study. When we compare our open cohort with other studies in which laparotomies were performed, our operating time (146.5 minutes), blood loss (266.0 mL), and complication rate (30.4%) fell mid range, and our length of hospital stay at 4.4 days was below the reported range of 5.0-15.5 days. With TAH, the average

TABLE 3
Summary of reports on hysterectomy with staging completed by TAH

Study	N	Pelvic nodes (n)	Periaortic nodes (n)	Operative time (min)	Mean EBL (mL)	Mean hospital stay (d)	Complications (n) (%)
Eltabbakh[22]	86	7.0	3.5	NR	250.0	5.0	16 (18.6%)
Kuoppala et al[27]	40	7.3	NA	96.0	238.0	7.6	16 (40%)
Kim et al[24]	168	23.9		150.5	NR	15.5	30 (17.9%)
Eltabbakh[28]	40	5.3	NR	137.7	303.3	5.6	5 (12.5%)
Frigerio et al[25]	55	17.0	NA	175.0	177.0	8.5	16 (29.1%)
Gil-Moreno	315	11.0	3.6	150.0	400.0	8.0	91 (28.9%)
Boggess et al (TAH current series)	138	11.5	3.0	146.5	266.0	4.4	41 (30.4%)

EBL, estimated blood loss; *TAH*, laparotomy.

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number of lymph nodes that were removed (11.5 pelvic and 3.0 periaortic) was lower than that of our laparoscopic and robotic cohorts but was in line with that seen in other studies that involved TAH.

In general, laparoscopic surgical staging of endometrial cancer results in good lymph node yield, longer operating times, comparable blood loss, shorter hospital stay, and a lower complication rate, compared with TAH. Table 4 summarizes the published literature for laparoscopic endometrial cancer staging. In a laparoscopic cohort of 100 patients, Eltabbakh[22] reported good lymph node yield, minimal blood loss (200 mL), and low conversion and complication rates. Holub et al[23] also demonstrated good lymph node yield, blood loss (201.2 mL), and a low conversion rate (4.2%). Their complication rate was higher at 20.6%, and their operating time was 173.8 minutes. In the article by Kim et al,[24] they reported a high lymph node yield at 27.4 (pelvic and periaortic combined), no conversions and a complication rate of 10.8%. Although the length of hospital stay in the Kim et al[24] study was 10.2 days, it was shorter than that observed in their TAH cohort (15.5 days); this is most likely due to cultural differences in discharge criteria. The Gil-Moreno group[25] reported zero conversions to TAH, with good lymph node counts (16.6 for pelvic and 7.0 for periaortic), and reasonable operative times (192.0 minutes), and blood loss (250.0 mL). Similar to the study by Frigerio et al,[26] they had an average hospital stay of 4 days and a complication rate of 16.4%.

Operating times for the studies listed in Table 4 for laparoscopic staging ranged from 145.0-220.0 minutes; our operating times for both the laparo-

TABLE 4
Summary of reports on laparoscopic hysterectomy with staging for endometrial cancer

Study	N	Pelvic nodes (n)	Periaortic nodes (n)	Operative time (min)	EBL (mL)	Length of hospital stay (d)	Complications (n) (%)	Conversion (n) (%)
Eltabbakh[22]	100	11.0	2.5	NR	200.0	2.0	9 (9%)	6 (6%)
Holub et al[23]	92	19.0	173.8	201.2	4.1	19 (20.6%)	4/92 (4.2%)	
Kuoppala et al[27]	40	11.1	NR	145.0	171.0	2.7	16 (40%)	1/40 (2.5%)
Kim et al[24,a]	74	27.4	146.6	NR	10.2	8 (10.8%)	0	
Frigerio et al[25]	55	18.5	NR	220.0	285.0	4.0	8 (14.5%)	3/55 (5.4%)
Gil-Moreno et al[26]	55	16.64	7.04	192.0	250.0	4.0	9 (16.4%)	0
Boggess (laparoscopic current series)	81	17.4	6.3	213.4	145.8	1.2	15/81 (18.5%)	4/81 (4.9%)
Boggess (robotic current series)	103	20.5	12.0	191.2	74.5	1.0	7/103 (6.8%)	3/104 (2.8%)

EBL, estimated blood loss; *NR*, Not reported.

[a] Laparoscopically assisted vaginal hysterectomy.

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scopic and robotic cohorts fit within this range.[22-27] Our conversion rate at 3.7% for the laparoscopic cohort and 2.8% for the robotic cohort fall within the range of the published studies (range, 0-6%).[22-27] Our complication rate for laparoscopy (18.5%) falls mid way in the range (9-40%), whereas our complication rate for the robotic cohort falls well below this range at 6.8%.[22-27] Blood loss in our case series fell below the range (74.5 mL) reported in Table 4 in the robotic cohort, which was less than one-half of that in our laparoscopic cohort at 145.8 mL. The length of hospital stay in our study also fell below the range (2.0-10.2 days) that was seen in the other studies that are summarized in Table 4 at 1.2 days for the laparoscopic and 1.0 days for the robotic cohort.

There has been a single prospective randomized trial of laparoscopy for the comprehensive surgical staging of endometrial cancer (Gynecologic Oncology Group-LAP2). In this study of 2616 women with endometrial cancer who were assigned randomly to TLH vs TAH, the authors reported that laparoscopic surgical staging is feasible for most women with clinical stage I-IIA uterine cancer. The study demonstrated a 23% conversion rate to TAH from laparoscopy, a median 3-day hospital stay (range, 0-95 days), and a 3.3-hour operative time (range, 0.7-10.1 hours).[29]

We report a shorter average length of stay for all 3 cohorts than has been reported in the literature (Tables 3 and 4). This could be due to differences in discharge criteria. The patients in our study were discharged if they were able to ambulate independently, could tolerate a regular diet, and control pain adequately. Our lymph node yield was comparable, with an average of 17.4 for pelvic and 6.3 for periaortic in the laparoscopic cohort, and was higher in the robotic cohort, with an average of 20.5 for pelvic and 12.0 for periaortic. Our length of hospital stay and conversion rates were also lower than those reported from the Gynecologic Oncology Group -LAP2 study.[29]

Robotic assistance may allow for an easier and more comprehensive lymphadenectomy and overcoming anatomic barriers to the process of staging for endometrial cancer without increasing patient morbidity and may result in an increase in minimally invasive treatment of uterine cancer in the field of gynecologic oncology. The weakness of this study is that it was not randomized; because of our relatively recent incorporation of robotic technology, we could not examine long-term oncologic results. However, the study is strengthened by the fact that the patient population represents consecutive cases that were completed by surgeons with extensive previous experience with laparoscopic surgery. TRH with staging appears to be a safe and effective surgical alternative for patients with early stage endometrial cancer. ■

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REFERENCES

1. Greenlee RT, Murray T, Bolden S, Wingo PA. Cancer statistics, 2000. CA Cancer J Clin 2000;50:7-33.
2. Creasman WT, Morrow CP, Bundy BN, Homesley HD, Graham JE, Heller PB. Surgical pathologic spread patterns of endometrial cancer: a Gynecologic Oncology Group study. Cancer 1987;60:2035-41.
3. Mikuta JJ. International Federation of Gynecology and Obstetrics staging of endometrial cancer 1988. Cancer 1993;71:1460-3.
4. Hernandez E. ACOG practice bulletin no.:65: management of endometrial cancer. Obstet Gynecol 2006;107:952.
5. Reynolds RK, Burke WM, Advincula AP. Preliminary experience with robot-assisted laparoscopic staging of gynecologic malignancies. JSLS 2005;9:149-58.
6. Wattiez A, Soriano D, Cohen SB, et al. The learning curve of total laparoscopic hysterectomy: comparative analysis of 1647 cases. J Am Assoc Gynecol Laparosc 2002;9:339-45.
7. Abu-Rustum NR, Gemignani ML, Moore K, et al. Total laparoscopic radical hysterectomy with pelvic lymphadenectomy using the argon-beam coagulator: pilot data and comparison to laparotomy. Gynecol Oncol 2003;91:402-9.
8. Altgassen C, Possover M, Krause N, Plaul K, Michels W, Schneider A. Establishing a new technique of laparoscopic pelvic and para-aortic lymphadenectomy. Obstet Gynecol 2000; 95:348-52.
9. Childers JM, Hatch KD, Tran AN, Surwit EA. Laparoscopic para-aortic lymphadenectomy in gynecologic malignancies. Obstet Gynecol 1993;82:741-7.
10. Chu CS, Randall TC, Bandera CA, Rubin SC. Vaginal cuff recurrence of endometrial cancer treated by laparoscopic-assisted vaginal hysterectomy. Gynecol Oncol 2003;88:62-5.
11. Kohler C, Klemm P, Schau A, et al. Introduction of transperitoneal lymphadenectomy in a gynecologic oncology center: analysis of 650 laparoscopic pelvic and/or paraaortic transperitoneal lymphadenectomies. Gynecol Oncol 2004;95:52-61.
12. Kohler C, Tozzi R, Klemm P, Schneider A. Laparoscopic paraaortic left-sided transperitoneal infrarenal lymphadenectomy in patients with gynecologic malignancies: technique and results. Gynecol Oncol 2003;91:139-48.
13. Tozzi R, Malur S, Koehler C, Schneider A. Laparoscopy versus laparotomy in endometrial cancer: first analysis of survival of a randomized prospective study. J Minim Invasive Gynecol 2005;12:130-6.
14. Ahlering TE, Skarecky D, Lee D, Clayman RV. Successful transfer of open surgical skills to a laparoscopic environment using a robotic interface: initial experience with laparoscopic radical prostatectomy. J Urol 2003;170:1738-41.
15. Beste TM, Nelson KH, Daucher JA. Total laparoscopic hysterectomy utilizing a robotic surgical system. JSLS 2005;9:13-5.
16. Fiorentino RP, Zepeda MA, Goldstein BH, John CR, Rettenmaier MA. Pilot study assessing robotic laparoscopic hysterectomy and patient outcomes. J Minim Invasive Gynecol 2006;13:60-3.
17. Reynolds RK, Advincula AP. Robot-assisted laparoscopic hysterectomy: technique and initial experience. Am J Surg 2006; 191:555-60.
18. Field JB, Benoit MF, Dinh TA, Diaz-Arrastia C. Computer-enhanced robotic surgery in gynecologic oncology. Surg Endosc 2007;21: 244-6.
19. Marchal F, Rauch P, Vandromme J, et al. Telerobotic-assisted laparoscopic hysterectomy for benign and oncologic pathologies: initial clinical experience with 30 patients. Surg Endosc 2005;19:826-31.
20. Boggess J. 2007. Robotic-assisted hysterectomy for endometrial cancer. Available at: http://www.nlm.nih.gov/medlineplus/surgeryvideos.html. Accessed February 21, 2007.
21. Diaz-Arrastia C, Jurnalov C, Gomez G, Townsend C Jr. Laparoscopic hysterectomy using a computer-enhanced surgical robot. Surg Endosc 2002;16:1271-3.
22. Eltabbakh GH. Analysis of survival after laparoscopy in women with endometrial carcinoma. Cancer 2002;95:1894-901.
23. Holub Z, Jabor A, Bartos P, Eim J, Kliment K. Laparoscopic pelvic lymphadenectomy in the surgical treatment of endometrial cancer: results of a multicenter study. JSLS 2002;6:125-31.
24. Kim DY, Kim MK, Kim JH, et al. Laparoscopic-assisted vaginal hysterectomy versus abdominal hysterectomy in patients with stage I and II endometrial cancer. Int J Gynecol Cancer 2005;15:932-7.

25. Gil-Moreno A, Diaz-Feijoo B, Morchon S, Xercavins J. Analysis of survival after laparoscopic-assisted vaginal hysterectomy compared with the conventional abdominal approach for early-stage endometrial carcinoma: a review of the literature. J Minim Invasive Gynecol 2006;13:26-35.

26. Frigerio L, Gallo A, Ghezzi F, Trezzi G, Lussana M, Franchi M. Laparoscopic-assisted vaginal hysterectomy versus abdominal hysterectomy in endometrial cancer. Int J Gynaecol Obstet 2006;93:209-13.

27. Kuoppala T, Tomas E, Heinonen PK. Clinical outcome and complications of laparoscopic surgery compared with traditional surgery in women with endometrial cancer. Arch Gynecol Obstet 2004;270:25-30.

28. Eltabbakh GH, Shamonki MI, Moody JM, Garafano LL. Hysterectomy for obese women with endometrial cancer: laparoscopy or laparotomy? Gynecol Oncol 2000;78:329-35.

29. Walker JL. Phase III trial of laparoscopy (scope) vs TAH (open) for surgical resection and comprehensive surgical staging of uterine cancer: a Gynecologic Oncology Group (GOG) study funded by NCI. Gynecol Oncol 2006;101(suppl):S11-2.

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