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Original Article

The Adoption of Single-port Laparoscopy for Full Staging of Endometrial Cancer: Surgical and Oncology Outcomes and Evaluation of the Learning Curve

Hayley Barnes, MD, Ross Harrison, MD, Laura Huffman, MD, Erin Medlin, MD, Ryan Spencer, MD, and Ahmed Al-Niaimi, MD*

From the Department of Obstetrics and Gynecology (Drs. Barnes, Harrison, Huffman, Spencer, and Al-Niaimi), University of Wisconsin, Madison, Wisconsin, and Department of Obstetrics and Gynecology (Dr. Medlin), University of Louisville, Louisville, Kentucky.

ABSTRACT **Study Objective:** To study the safety, feasibility, learning curve, and surgical outcome for single-port laparoscopic full staging of endometrial cancer.

Design: A retrospective study (Canadian Task Force classification II-3).

Setting: A university academic hospital.

Patients: Women with endometrial cancer undergoing single-port laparoscopic full surgical staging.

Interventions: This was a single-center, retrospective consecutive study of patients undergoing single-port laparoscopic full staging of endometrial cancer from March 2012 to December 2015.

Measurements and Main Results: One hundred ten consecutive cases were included in the study. The mean age was 63 years (standard deviation = 14), and the mean body mass index was 34 kg/m^2 (standard deviation = 7). Medical comorbidity was noted in 62% (68/110) of patients, and 55% (61/110) of patients had previous abdominal surgery. Preoperative histology included grade 1 (63%), grade 2 (23%), grade 3 (4%), papillary serous (6%), clear cell (3%), and mixed (1%). Postoperatively, 73% of patients were stage I, 2% were stage II, 21% were stage III, and 4% were stage IV. The conversion rate to multiple ports or to laparotomy was 6.3%. The average total surgical time was 186 minutes. Comparing the last 30 cases of our cohort with the first 20, there was a significant improvement in the reduction of the total operative time (191 vs 152 minutes, p = .036), estimated blood loss (389 vs 121 mL, p = .002), conversion rate (20 % vs 0%, p = .02), and rate of surgical complication (10% vs. 0%, p = .03). The readmission rate was 11% (12/110) with 75% of those patients being readmitted for surgical indications and 25% for medical indications. The rate of ventral hernia was 1.8% (2/110) with an average follow-up of 298 days (31–1085 days).

Conclusion: Single-port laparoscopic staging of endometrial cancer is a safe and feasible technique to introduce into a gynecologic oncology practice that is compatible with other minimally invasive modalities with similar complication rates, discharge timing, and operative times. Drastic improvement in surgical time can be seen after approximately the first 20 cases. Journal of Minimally Invasive Gynecology (2017) 24, 1029–1036 © 2017 Published by Elsevier Inc. on behalf of AAGL.

Keywords: Endometrial cancer staging; Learning curve; Outcome; Single port laparoscopy; Surgical techniques

Endometrial cancer remains the most commonly diagnosed gynecologic cancer and is the 10th most common cancer of women in the United States [1]. The number of new cases for this tumor is increasing; in 2015, 54 870 new cases of endometrial cancer were reported in the Surveillance, Epidemiology, and End Results Program compared with 32 000 new cases in 2012 [1]. Because unopposed estrogen exposure constitutes a major risk factor for endometrial hyperplasia and malignancy [2], the number of new cases of uterine cancer can be expected to rise proportionately with the rate of obesity. Commonly, surgical management of endometrial cancer includes total hysterectomy, bilateral salpingo-oophorectomy (BSO), and pelvic and para-aortic lymphadenectomy [2]. There is controversy surrounding

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Corresponding author: Ahmed Al-Niaimi, MD, Division of Gynecologic Oncology, Department of Obstetrics and Gynecology, University of Wisconsin Hospitals and Clinics, 600 Highland Avenue, Office H4/636, Madison, WI 53792.
E-mail: alniaimi@wisc.edu

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the need for lymphadenectomy based on the large ASTEC study that showed no benefit of lymphadenectomy in overall or recurrence-free survival [3]. However, the majority of patients included in the ASTEC trial had grade 1 endometrial cancer, and subsequent literature expressed concern for inadequate power to detect a difference in survival for higher-grade endometrial cancer [4].

The modality of this surgical approach has also evolved with time. The Lap-2 study from the Gynecologic Oncology Group showed that the use of multiple-port laparoscopy in staging uterine cancer is safe and feasible, has less operative morbidity, and has similar rates of disease-free survival and overall survival when compared with laparotomy [5].

Recently, single-port laparoscopic surgery (SILS) was adopted to further minimize the morbidity associated with conventional laparoscopy [6]. The literature shows that this technique is correlated with low operative morbidity, decreased postoperative pain, a shorter recovery period, and superior cosmesis [7]. SILS has been traditionally referenced in the general surgery and urology literature, but recently it has been adopted for the management of malignant gynecologic cancer [8,9]. In gynecologic oncology, surgical outcome data with this technique are still growing [10]. The largest multi-institution study using single-port laparoscopy in the staging of uterine cancer included 100 patients and showed that single-port laparoscopic staging is both feasible and safe [11]. However, this study included nonconsecutive cases, and less than half of those patients had systematic lymphadenectomy [11]. Thus, there is still a need to understand the impact of the full staging of uterine cancer when hysterectomy and pelvic and para-aortic lymphadenectomy are consecutively used in all cases.

To further develop our understanding of SILS, we performed full staging of uterine cancer with bilateral pelvic and para-aortic lymphadenectomy in patients with grade 1 endometrial cancer who meet the high-risk uterine criteria before surgery [12] as well as those with grade 2, grade 3, and nonendometrioid adenocarcinoma of the uterus.

The objective of this study was to report our cumulative 2 years of experience with consecutive single-port laparoscopic full staging of uterine cancer that included hysterectomy and salpingo-oophorectomy with pelvic and para-aortic lymphadenectomy. The primary outcomes were the surgical measures (both immediate and long-term), pathology outcome, and cancer recurrence rate. The secondary outcome was to evaluate and study the surgeon's learning curve to understand how the primary outcomes changed with surgeon experience.

Materials and Methods

Study Population

Institutional review board approval was obtained to review the single-port laparoscopic endometrial cancer surgical cases performed from its adoption on March 1, 2012 through December 31, 2015. We included patients with biopsy-proven endometrial cancer who consented for single-port surgical staging that included total hysterectomy, BSO and bilateral para-aortic and pelvic lymphadenectomy, peritoneal washing for cytology and omentectomy, or omental biopsy when indicated. We excluded patients who decided not to have the surgery, and those who did not have at least 6 weeks of postoperative follow-up.

Patient demographics and perioperative outcomes were assembled from a retrospective chart review of our institutional prospective database. Abstracted demographic data included patients' age, body mass index, race, ethnicity, coexisting medical conditions (diabetes mellitus, hypertension, and chronic obstructive pulmonary disease), surgical history (previous laparotomy and abdominal laparoscopy), preoperative cancer histology and grade, postoperative stage, and grade. Abstracted surgical data included the total operative time (from skin incision to skin closure), estimated operative blood loss (defined at the end of surgery), intraoperative complications (unexpected organ injury that included gastrointestinal, urinary, vascular, muscular, or nerve injuries), and conversion rate (conversion from single port laparoscopy to either multiple port laparoscopy or laparotomy) as well as the reason for this conversion. Postoperative complications included hospital readmission (from the time of discharge up to 6 weeks after surgery), the reason for readmission (surgical or medical indication), surgical site infection (superficial, deep, and organ space according to the 1999 Centers for Disease Control and Prevention criteria), and ventral hernia formation (defined as an incisional hernia at the site of the singe port seen clinically up to the last follow-up clinic). All data were compiled in our division's prospective data system (GOLD CUP [Gynecologic Oncology Longitudinal Data Collection and Utilization Program]).

The primary objective of this study was to report both surgical and postoperative pathology outcomes of adopting single-port laparoscopy for full staging of uterine cancer. The secondary outcome was to evaluate and study the surgeon's learning curve by studying the impact of the number of cases performed on all of the primary outcomes. We studied this secondary outcome in increments of 20 patients at a time.

Single-port Laparoscopy Protocol in Our Institution

At our cancer center, we perform systematic lymphadenectomy at the time of hysterectomy for uterine cancer when the patient meets specific preoperative criteria. This preoperative selection of patients who will undergo lymphadenectomy allows better operative room use because frozen pathology is not required. Our criteria for performing systematic lymphadenectomy includes (1) patients with higher than grade 1 endometrioid adenocarcinoma or any type II endometrial cancer histology and (2) those with grade 1 histology with preoperative cancer antigen 125 (CA-125) >30

IU/mL or preoperative diffusion magnetic resonance imaging (MRI) of the pelvis showing tumor volume >3.6 cm^2, tumor invasion >50% of the myometrium, cervical or adnexal involvement, or radiologic enlarged pelvic or para-aortic lymph node enlargement [12]. Our surgical technique and postoperative care follow-up are unified. This has lowered the heterogeneity of outcomes.

Surgical Technique

After completely averting the umbilicus, a 2.5-cm single incision was created. The abdominal cavity was entered directly. The single-port gel point (Applied Medical, Rancho Santa Margarita, CA) was used with 3 trocars: 1 for the 10-mm 30° camera and the other 2 for the laparoscopic instruments. Closure of the single incision and umbilical reconstruction were performed using two 0-PDS on a UR6 needle and 4-0 Monocryl consecutively (Ethicon, US, LLC, Cincinnati, OH). A total of 40 mL 0.25% Bupivacaine was injected around the umbilicus at the fascial level for postoperative pain control.

Postoperative Management and Follow-up

Patients were admitted postoperatively, and an advanced recovery protocol was initiated to include intraoperative urinary catheter removal, advancement to immediate postoperative general diet, and oral analgesics once tolerating a diet. Recommendation for discharge was made after re-establishment of a normal diet, spontaneous voiding, adequate pain control, and no signs of postoperative complications. Patients were seen in outpatient follow-up 2 weeks after discharge. Adjuvant therapy was recommended based on risk stratification for recurrence according to the postoperative pathologic report. After the completion of primary treatment, clinical follow-ups were scheduled at 3-month intervals for 2 years, then at 6-month intervals for the subsequent 3 years, and then annually thereafter.

Statistical Analysis

Statistical analysis was performed using the C program: Libxlsxriter/Wizard version 1.8.15 (181) (Los Angeles, California). Descriptive statistics was to report the mean, standard deviation (SD), and range when needed. A confidence interval of 95% with a p-value of 0.05 was defined. ANOVA analysis was utilized for the secondary outcome. The Student *t* test was used to analyze the difference between the first group of patients and the last group of patients.

Results

We identified 115 consecutive patients who met the inclusion criteria. We excluded 5 patients: 2 patients who decided not have surgery and 3 patients who did not have any follow-up beyond the postoperative visit. Six weeks after surgery, consecutive cases were reviewed, and inconsecutive cases were excluded.

Data from a total of 110 patients were analyzed. Patient characteristics are shown in Table 1. The mean age was 63 years (SD = 14), and the body mass index was 34 kg/m^2 (SD = 7). The majority of the patients were white (108/110, 98%) and non-Hispanic (107/110, 97 %). Concomitant medical comorbidities included hypertension (68/110, 62%), diabetes mellitus (27/110, 25%), and chronic obstructive pulmonary disease (3/110, 2.7%). A history of prior abdominal surgery was noted in 61 of 110 (55%) patients. Preoperative histology indicated grade 1 (69/110, 63%), grade 2 (25/110, 23%), grade 3 (5/110, 4%), papillary serous (7/110, 6%), clear cell (3/110, 3%), and mixed (1/110, 1%). Table 2 shows surgical operative and postoperative outcome measures.

Primary Outcomes

Surgical outcomes are detailed in Table 2. The average length of surgery was 186 minutes (SD = 25). The mean estimated blood loss in milliliters was 242 (SD = 89). Our total conversion rate was 7 of 110 (6.3%). Conversion to multiple port conventional laparoscopy occurred in 1 of 110 (0.9%) and laparotomy in 6 of 110 (5.3%). Three major complications were observed, 2 inferior vena cava

Table 1

Patient characteristics

Demographics	n	Percentages or SD
Age	63	14
Race		
White	108	98%
Black	1	1%
Asian	1	1%
Ethnicity		
Non-Hispanic	107	97%
Hispanic	3	3%
BMI	34	7
Medical comorbidity	n	%
Hypertension	68	62
Diabetes mellitus	27	25
COPD	3	2.7
Surgical comorbidities	n (%)	%
Previous surgical history	61	55
Laparotomy	20 (32)	18
Laparoscopy	41 (68)	37
Preoperative histology/grade		
Endometrioid G1	69	63
Endometrioid G2	25	23
Endometrioid G3	5	4
Papillary serous	7	6
Clear cell	3	3
Mixed	1	1

BMI = body mass index; COPD = chronic obstructive pulmonary disease; SD = standard deviation.

Table 2

Surgical operative and postoperative outcome measures

Operative outcome	Mean/SD or number
Length of surgery in minutes, mean ± SD	186 ± 25
Estimated blood loss in mL, mean ± SD	242 ± 89
Conversion, n (%)	7 (6.3)
Multiple ports	1 (0.9)
Laparotomy	6 (5.3)
Reasons for conversion, n (%)	
Complications (vascular = 2 and GI = 1)	3 (2.7)
Adhesions	1 (0.9)
Larger uterus	1 (0.9)
Cannot maintain Trendelenburg position	1 (0.9)
Patient cannot tolerate Trendelenburg position	1 (0.9)
Complications	4 (3.6)
IVC injury	2 (1.8)
GI Injury	1 (0.9)
Needle breakage in vaginal closure	1 (0.9)
Postoperative outcome (up to 6 weeks)	
Length of hospital stay in days, mean ± SD	1.3 ± 0.4
Readmission, n (%)	12 (11)
Surgical, n	9
Surgical site infection	2
Fever without infection	1
Vaginal bleeding from cuff	2
Fascial dehiscence	2
Pain	2
Medical	3
Long-term outcome (>6 weeks)	
Mean days of follow up in days, mean ± SD	298 ± 21
Ventral hernia formation, n (%)	2 (1.8)

GI = gastrointestinal; IVC = inferior vena cava; SD = standard deviation.

(IVC) injuries and 1 bowel injury. Both of the IVC injuries cause conversion as well as major blood loss. Interestingly, those 3 complications did occur in the early phase of our adoption. Reasons for conversion included major surgical complications (vascular and intestinal injury) in 3 of 7 (2.7%), adhesions in 1 of 7 (0.9%), a large uterus in 1 of 7 (0.9%), inability to maintain the Trendelenburg position on the operative table in 1 of 7 (0.9%), and patient inability to tolerate the Trendelenburg position in 1 of 7 (0.9%). Surgical complications were noted in 4 of 110 (3.6%) and included IVC injury in 2 of 110 (1.8%), gastrointestinal injury in 1 of 110 (0.9%), and equipment failure in 1 of 110 (0.9%).

Postoperatively, the mean length of hospital stay was 1.3 days. Readmission was noted in 12 of 110 (11%) patients, with 9 of 12 (75%) for surgical reasons and the rest for medical reasons (3/12, 25%). The reasons for surgical readmissions included surgical site infection (2/9), fever without infection (1/9), vaginal cuff hemorrhage (2/9), fascial dehiscence (2/9), and nonspecific abdominal pain (2/9). Patients were followed postoperatively for an average of 298 days (range, 31–1085 days). The rate of ventral hernia detection was 2 of 220 (1.8%), and both hernias were noted in asymptomatic patients.

Oncology Outcome Measures

Table 3 shows that 78 of 110 (71%) patients were diagnosed with stage 1 disease, 2 of 110 (2.7%) stage 2, 23 of 110 (21%) stage 3, and 2 of 110 (1.8%) stage 4. The average uterine tumor volume was 3.4 cm^2 (range, 0–12.5 cm^2). Lymphovascular space invasion was noted in 33 of 110 (30%) patients. The average number of pelvic lymph nodes removed was 30 (range, 2–40), whereas the average number of para-aortic lymph nodes was 15 (range, 1–29).

Postoperatively, adjuvant chemotherapy was given in 28 of 110 (25%) patients, whereas 26 of 110 (24%) had adjuvant radiotherapy. Of those who had radiotherapy, 4 of 26 underwent external beam radiation therapy, whereas all 26

Table 3

Oncology outcome measures

Oncology outcome		
Stage/Grade	Mean/ Number	Percentages/ Ranges
I	78	71
IA, G1	58	52
IB, G1	8	7
IA, G2-3	0	
IB, G2-3	12	11
II	3	2.7
III	23	21
IIIA	4	3.6
IIIB	0	
IIIC	19	17
IIIC1	13	12
IIIC2	6	5.5
IV	2	1.8
Pathology details		
Uterine tumor volume	3.4 cm^2	0–12.5 cm^2
LVSI	33	30%
Number of pelvic lymph nodes	30	2–40
Number of para-aortic lymph nodes	15	1–29
Adjuvant therapy	27	25%
Chemotherapy	28	25%
Radiotherapy	26	24%
EBRT	4	
Vaginal brachytherapy	26	
Recurrence	6	5.4%
Death (cancer related)	2	1.8%

EBRT = external beam radiation therapy; LVSI = lymphovascular space invasion.

Table 4

Surgical learning curve

	Number (total = 110)	1st group (First 20 patients)	2nd group (Second 20 patients)	3rd group (Third 20 patients)	4th group (Fourth 20 patients)	5th group (Last 30 patients)	p Value
Demographics							
Age	64	65 (53–85)	61 (41–81)				
Race, n (%)							
White	108	19 (95)	20 (100)	19 (95)	20 (100)	30 (100)	.7
Black	1	1 (5)	0	0	0	0	
Asian	1	0	0	1	0	0	
Ethnicity, n (%)							
Not Hispanic	107	19 (95)	19 (95)	19 (95)	20	28 (93)	.6
Hispanic	3	1 (5)	1 (5)	1 (5)	0	2 (7)	
BMI	35	35.7	34.6	35.8	35.2	33.6	.21
Medical Comorbidity, n (%)							.10
Hypertension	68 (62)	10 (50)	14 (70)	6 (30)	7 (355)	13 (43)	
Diabetes Mellitus	27 (25)	4 (20)	3 (15)	6 (30)	5 (25)	9 (30)	
COPD	3 (2.7)	1 (5)	0	1 (5)	1 (5)	0	
Surgical comorbidities, n (%)							.45
Previous surgical history	61 (55)	9 (45)	8 (40)	9 (45)	8 (40)	13 (65)	
Laparotomy	20 (32)	5 (25)	6 (30)	4 (20)	2 (10)	3 (10)	
Laparoscopy	41 (68)	9 (45)	6 (30)	10 (50)	5 (25)	10 (30)	
Preoperative histology/grade, n (%)							
Endometrioid G1	69 (63)	12 (60)	12	13	11	21	
Endometrioid G2	25 (23)	4	5	5	4	6	
Endometrioid G3	5 (4)	1	1	1	1	1	
Papillary serous	7 (6)	1	1	0	4	1	
Clear cell	3 (3)	1	1	1	0	0	
Mixed	1 (1)	1	0	0	0	0	
Operative outcomes							
Length of surgery in minutes, mean (SD)	186 (25)	191 (31)	174 (36)	184 (27)	169 (21)	152 (19)	.036
Estimated blood loss (mL), mean (SD)	242 (89)	389 (117)	164 (65)	348 (99)	180 (65)	121 (56)	.02
Conversion, n (%)	7 (6.3)	4 (20)	1 (5)	1 (5)	1 (5)	0	.02
To multiple ports	1 (0.9)	0	1	0	0	0	
To laparotomy	6 (5.3)	4	0	1	1	0	
Reasons for conversion	7						
Vascular complications	3 (2.7)	2	0	0	1	0	
Adhesions	1 (0.9)	0	1	0	0	0	
Larger uterus	1 (0.9)	0	0	1	0	0	
Cannot maintain Trendelenburg position	1 (0.9)	0	0	1	0	0	
Patient cannot tolerate Trendelenburg Position	1 (0.9)	0	1	0	0	0	
Surgical complications, n (%)	4 (3.6)	2 (10)	0	0	1 (5)	0	.03
IVC injury	2 (1.8)	2	0	0	0	0	
GI injury	1 (0.9)	0	0	0	1	0	
Needle break in vaginal closure	1 (0.9)	0	0	0	1	0	
Postoperative outcome (up to 6 weeks)							
Length of hospital stay in days, mean (SD)	1.3 (0.4)	1.8 (0.4)	1.1 (0.3)	1.1 (0.2)	1 (0.3)	1.1 (0.2)	0.01
Readmission, n (%)	12 (11)	2 (10)	3 (15)	4 (20)	2 (10)	0 (0)	0.001
Surgical	9	1	2	4	2	0	
Surgical site infection	2	0	1	1	0	0	
Fever (no infection)	1	1	0	0	0	0	
Vaginal cuff bleeding	2	0	0	2	0	0	
Fascial dehiscence	2	0	0	1	1	0	
Postoperative Pain	2	1	1	0	1	0	
Medical readmission	3	1	1	0	0	0	

(*Continued*)

Table 4

Continued

	Number (total = 110)	1st group (First 20 patients)	2nd group (Second 20 patients)	3rd group (Third 20 patients)	4th group (Fourth 20 patients)	5th group (Last 30 patients)	p Value
Long-term outcome (>6 weeks)							
Days of follow-up in days, mean (SD)	298 (21)	289 (23)	442 (58)	309 (42)	147 (18)	49 (15)	.01
Ventral hernia formation, n (%)	2 (1.8)	1 (0.6)	1 (0.6)	0	0	0	
Oncology outcome (stage/grade), n (%)							.43
I	78 (71)	13 (65)	17 (85)	18 (90)	19 (95)	22 (73)	
IA, G1	58	8	11	8	10	12	
IB, G1	8	1		1	3	6	
IA, G2-3, UPSC, clear	0	5	2	1	3	2	
IB, G2-3, UPSC, clear	12	4	0	4	2	2	
II	3 (3.7)	1 (5)	1 (5)	1 (5)	0	1 (3)	
III	23 (21)	5 (25)	2 (10)	1 (5)	1 (5)	6 (20)	
IIIA	4	1	1	0		2	
IIIB	0	0	0	0	0	0	
IIIC	19	4	1	1	0	4	
IIIC1	13	1	1	1	1	2	
IIIC2	6	3	0	0	0	2	
IV	2 (1.8)	1 (5)	0	0	0	1 (3)	
Pathology details							
Uterine tumor volume	3.4 cm^2	2.7 cm^2	2.7 cm^2	3.9 cm	2.5 cm^2	4.1 cm^2	.07
LVSI, n (%)	33 (30)	5 (25)	5 (25)	4 (20)	4 (20)	11 (36)	.03
Number of pelvic lymph nodes	30	40	40	29	30	37	.07
Number of para-aortic lymph nodes	15	11	10	12	14	17	.04
Adjuvant therapy, n (%)							.21
Chemotherapy	28 (25)	4 (20)	4 (20)	4 (20)	6 (30)	8 (27)	
Radiotherapy	26 (24)	5 (25)	5 (25)	6 (30)	6 (30)	8 (27)	
EBRT	4 (3.6)	1 (5)	1 (5)	1 (5)	0	1 (3)	
Vaginal Brachytherapy	26 (24)	5 (25)	5 (25)	6 (30)	6 (30)	8 (27)	
Recurrence	6 (5.4)	0	0	3 (15)	0	1 (3)	
Death (cancer related)	2 (1.8)	0	1 (5)	0	1 (5)	0	

BMI = body mass index; COPD = chronic obstructive pulmonary disease; EBRT = external beam radiation therapy; GI = gastrointestinal; IVC = inferior vena cava; LVSI = lymphovascular space invasions; SD = standard deviation; UPSC = uterine papillary serous cancer.

received vaginal brachytherapy. Recurrence was noted in 6 of 110 (5.8%) patients, whereas cancer-related death occurred in 2 of 110 (1.8%).

Secondary Outcomes

To evaluate and study the surgeon's learning curve, the overall cohort was divided in advancing chronologic order into 5 subgroups, starting with 20 patients in each group, although the last group had 30 patients. We studied the effect of cumulative experience in terms of all of the previously described outcomes (Table 4).

The mean operative time was reduced by 38 minutes between groups 1 and 5 (191 vs 152 minutes, p = .036). The average surgical estimated blood loss was significantly reduced between the first and fifth subgroups (389 vs 121 mL, p = .02). Most of the cases requiring conversion to laparotomy or conventional laparoscopy (4/7 [57%]) occurred in the first subgroup. In the fifth subgroup, no major intraoperative complications occurred, and no cases were converted from single port to conventional laparoscopy or laparotomy. A significantly greater number of para-aortic lymph nodes was removed in the fifth subgroup compared with the first subgroup (17 vs 11, p = .07).

Postoperative outcomes also significantly improved over time between the first and fifth groups. The length of hospital admission was shorter (1.8 vs 1.1 days, p = .01), and the rate of hospital readmission was lower (10% vs 0%, p = .001). No hospital readmissions were observed in the fifth subgroup for medical or surgical complications. The 2 ventral hernias identified occurred in patients in the first and second subgroups. No differences in tumor grade, postoperative stage, uterine tumor volume, number of pelvic lymph nodes, or type of adjuvant therapy administered were noted.

Discussion

We have shown that the safe completion of full staging of endometrial cancer via SILS is feasible as evidenced by the outcomes in our consecutive case series. As surgeon experience and comfort level with single-port laparoscopy increases, so does the literature on the feasibility of SILS in gynecologic oncology. Several prior studies addressed the outcomes of using SILS in early-stage endometrial cancer. In 2010, Ali et al [2] introduced the concept of using SILS to perform laparoscopic hysterectomy and BSO for endometrial cancer in a 20-patient consecutive case review. They successfully completed all cases without conversion to multiple ports or laparotomy and achieved operative outcomes similar to conventional laparoscopy. A follow-up study by Fagotti et al [11] showed the usefulness of single-port laparoscopy to complete full surgical staging of endometrial cancer, including para-aortic and pelvic lymphadenectomy. In their multicentric retrospective study, 100 patients underwent hysterectomy and BSO, whereas 48 and 27 of those patients underwent pelvic and para-aortic lymph node dissection, respectively. The median operating time and blood loss were comparable with multiple-port laparoscopy. More recently, Park et al [9] conducted a study of 37 consecutive patients undergoing SILS staging of endometrial cancer and compared those outcomes with those of 74 consecutive patients who underwent 4-port laparoscopic staging. This case-control series was novel in demonstrating no statistically significant difference in lymph nodes retrieved, estimated blood loss, operating time, or peri- and postoperative complications between the 2 groups [9]. These studies substantiate the feasibility and safety of SILS in early-stage endometrial cancer.

At our institution, MRI was proposed as part of a clinical decision-making protocol in women with grade 1 endometrioid adenocarcinoma. The preoperative clinical parameters considered included the CA-125, MRI-determined tumor size, myometrial invasion, cervical invasion, extrauterine spread, and enlarged lymph nodes. If 1 or more of the following criteria were met, the surgeon would consider doing a pelvic and para-aortic lymph node dissection because these parameters increase the woman's risk of lymph node metastasis in women with grade 1 endometrioid adenocarcinoma: elevated CA-125, large tumor size (tumor index greater than 36 cm), greater than 50% myometrial invasion, cervical stromal invasion, extrauterine spread or enlarged lymph nodes. The results of our institutional protocol have been published, and they show that MRI and CA-125 are able to predict those women at risk for lymph node metastasis with a calculated sensitivity of 94%, specificity of 88%, positive predictive value of 79%, and negative predictive value of 97% when compared with the final pathology. There were only 2 false negatives out of 99 patients for a false-negative rate of 2.0% (2/99).

This study showed that the SILS approach is a safe and beneficial technique for full surgical staging of endometrial cancer. There was a learning curve of 20 to 40 patients as the surgeon adapted to the technique, which was consistent with many published studies regarding the adoption of any laparoscopic surgery [13,14]. As surgeon experience and comfort increased, there was a statistically significant reduction in operative time, estimated blood loss, surgical complication, and hospital readmission. In our study, the rate of ventral hernia formation (1.8%) was notably lower compared with other studies [7].

One important strength of this study is the standardized nature of the practice because a single surgeon at a single institution performed the surgeries. Selection bias is mitigated by the fact that the series includes consecutive patients and only 5 of 115 patients were excluded for analysis because 2 did not have surgery and 3 did not have any measurable follow-up. Given that this is the largest case series evaluating SILS for endometrial cancer staging, it is the best evidence available for the technique's safety and feasibility for implementation in a gynecologic oncology practice. Additionally, clinically relevant patient characteristics were consistent over periods of the series. This allows for an accurate assessment of an anticipated learning curve for the procedure.

This study has limitations that also merit discussion. First, there is no comparison group against which to compare the outcomes, and, therefore, results should be interpreted with caution. Also, because only 1 surgeon performed all the procedures, the outcomes and the learning curve reported may not necessarily be replicable for all surgeons. This surgeon has adopted single-port surgery for almost 6 months before starting to fully stage uterine cancers with a single port. This is very important because the authors advise that any surgeon who wants to apply full uterine cancer staging should have passed the general learning curve of single-port laparoscopy before adopting lymphadenectomy. The follow-up time in this study may not be sufficient to gain an accurate understanding of certain outcomes such as the rate of hernia formation [7]. Finally, this study primarily examined non-Hispanic white women although it is well-known that women of a variety of ethnic backgrounds are affected by endometrial cancer and may benefit from SILS staging.

Future studies should include a comparison of distinct minimally invasive modalities. Although a randomized study would minimize bias and maximize the ability to compare pertinent outcomes, it would be difficult to perform. A prospective observational study of patients undergoing the various minimally invasive modalities would be a useful next step to determine if one modality is superior to another. Studying SILS staging across multiple institutions could further validate our study by examining outcomes across a variety of ethnic backgrounds. In conclusion, the current study reaffirms prior evidence that SILS is a viable, safe option for surgical staging of early uterine cancer.

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