GYNECOLOGY

Does surgical platform impact recurrence and survival? A study of utilization of multiport, single-port, and robotic-assisted laparoscopy in endometrial cancer surgery

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BACKGROUND: Minimally invasive hysterectomy is the standard of care in the majority of women diagnosed with endometrial cancer via robotic-assisted, multiport, and single-port laparoscopy technology. Although safe and efficacious, it is unclear how oncologic outcomes are impacted by surgical platform.

OBJECTIVE: To identify differences in progression-free survival and overall survival in women undergoing minimally invasive surgery for endometrial cancer staging via either multiport, single-port, or robotic-assisted laparoscopy.

STUDY DESIGN: A multicenter, single-institution retrospective cohort study was performed in women with a diagnosis of endometrial cancer who underwent minimally invasive surgery from 2009 to 2015. Data were collected for demographics, pathologic information, adjuvant treatment, and disease status. Pearson χ^2 and Fisher exact tests were used to evaluate risk factors for outcomes, Kaplan—Meier estimates and Cox proportional hazards were used to evaluate differences in time to progression or death, and multivariate regression analysis was performed.

RESULTS: In total, 1150 women with endometrial cancer underwent robotic-assisted laparoscopy (n=652), multiport laparoscopy (n=214), or single-port laparoscopy (n=284). The median age and body mass index of women was 62.0 years and 33.5 kg/m^2, respectively. The majority of patients had endometrioid histology (88.1%), stage IA (74.7%) or IB disease (13.1%) and International Federation of Gynecology and Obstetrics grade 1 (57.4%) or 2 (26.0%) histology. Lymphovascular space invasion was present in 24.7% (n=283). Adjuvant radiation was given in 34.2% of cases, with 21.9% receiving vaginal brachytherapy, 6.6% pelvic radiation, and 5.4% both. For the entire cohort, there were no differences in progression-free survival at 2, 3, and 5 years for multiport laparoscopy (94.2%, 91.4%, 87.4%), robotic-assisted laparoscopy (94.5%, 92.9%, 88.8%), and single-port laparoscopy (93.6%, 91.2%, 90.0%) (P=.93), respectively. Similarly, there were no differences in overall survival at 2, 3, and 5 years for multiport laparoscopy (94.4%, 91.8%, 91.8%), robotic-assisted laparoscopy (95.6%, 93.4%, 90.7%), and single-port laparoscopy (95.0, 93.1, 91.8) (P=.99), respectively. Among women with stage IA and IB disease, no difference existed for progression-free survival at 2, 3, and 5 years for multiport laparoscopy (94.2%, 91.4%, 87.4%), robotic-assisted laparoscopy (94.5%, 92.9%, 88.8%), and single-port laparoscopy (93.6, 91.2, 90.0) (P=.93), respectively. Similarly, among women with stage I disease, there was no difference in overall survival at 2, 3, and 5 years for multiport laparoscopy (96.2%, 95.0%, 95.0%), robotic-assisted laparoscopy (96.6%, 95.4%, 93.3%), and single-port laparoscopy (96.6%, 95.0%, 93.4%) (P=.89). Rather, progression-free survival and overall survival were predicted by age >65 years, stage, grade, and histology (P<.05). On multivariate analysis, modality of surgery did not impact overall survival or progression-free survival (robotic-assisted laparoscopy, hazard ratio, 1.28, P=.50; single-port laparoscopy, hazard ratio, 0.84, P=.68 vs multiport laparoscopy). Age >65 years (hazard ratio, 5.42, P<.001) and advanced stage disease (P=.003) were associated with decreased overall survival.

CONCLUSION: In this retrospective cohort, there was no difference in progression-free survival or overall survival in women undergoing surgery for endometrial cancer via robotic-assisted laparoscopy, single-port laparoscopy, or multiport laparoscopy.

Key words: endometrial cancer, laparoscopy, minimally invasive surgery, robotic-assisted laparoscopy, single-port laparoscopy

Endometrial cancer (EC) is the most common gynecologic malignancy in the United States, with more than 60,000 cases diagnosed annually.[1] Although the prognosis of EC is largely determined by stage at diagnosis and histology, the majority of women are diagnosed with low-risk disease and have good prognosis, with 5-year survival rates approaching 90% in women with early-stage disease.[2] In women with a diagnosis of EC, surgery is the primary modality used for both staging and treatment. A minimally invasive total hysterectomy and bilateral salpingo-oophorectomy with or without lymphadenectomy is first-line management for the majority of newly diagnosed ECs.[3–5] Previous studies have demonstrated that minimally invasive surgery (MIS) has many benefits compared with laparotomy, including lower rate of adverse perioperative outcomes, including wound complications, blood transfusion, intensive care unit stay, and readmission.[6–10]

To date, studies have demonstrated no difference in recurrence and survival outcomes with MIS approaches compared with laparotomy for EC staging.[3,4,11–14] In the LAP2 randomized controlled trial by Walker et al,[3] no difference in both progression-free survival (PFS) and overall survival (OS) was identified in women with EC undergoing surgical staging via laparoscopy or laparotomy. Following this, MIS was adopted as the standard-of-care for EC surgery.

Cite this article as: Chambers LM, Carr C, Freeman L, et al. Does surgical platform impact recurrence and survival? A study of utilization of multiport, single-port, and robotic-assisted laparoscopy in endometrial cancer surgery. Am J Obstet Gynecol 2019;221:243.e1-11.

0002-9378/$36.00

https://doi.org/10.1016/j.ajog.2019.04.038

AJOG at a Glance

Why was this study conducted?

Minimally invasive hysterectomy is the standard of care for the majority of women diagnosed with endometrial cancer, with robotic-assisted, multiport, and single-port laparoscopy used in clinical practice. Although data demonstrate safety and efficacy of these modalities for endometrial cancer staging, it is unclear how oncologic outcomes are impacted by choice of surgical platform.

Key findings

In women with endometrial cancer undergoing either robotic-assisted, multiport, or single-port laparoscopy, there is no difference in progression-free survival or overall survival in all disease stages and early-stage disease.

What does this add to what is known?

In this large retrospective cohort, we identify no difference in oncologic outcomes in robotic-assisted, multiport, and single-port laparoscopy for endometrial cancer staging.

In clinical practice, a wide variation exists among surgical platforms. The surgical management of EC commonly incorporates robotic-assisted (RL), multiport (MPL), and single-port laparoscopy (SPL) technology.[6–10] Although the use of RL, MPL, and SPL has proven to be safe and efficacious for MIS EC staging, intrinsic differences do exist between each of these surgical modalities and, to date, it is unclear how these differences impact cancer recurrence and survival.[11–15] Insight into disease-specific outcomes based on MIS surgical platform in patients with EC will add to the growing body of literature regarding optimal delivery of care to women with EC. The objective of this study was to determine whether MIS platform, specifically, RL, MPL, or SPL, impacts PFS and OS among women undergoing surgical staging for EC.

Materials and Methods

This study is an institutional review board–approved single-institution, retrospective cohort study performed at 3 academic hospitals in women with a diagnosis of EC who underwent MIS from 2009 to 2015 with the gynecologic oncology division. Patients underwent surgery through either a MPL, SPL, or RL approach. No patients were excluded from the analysis. The SPL technique was performed as previously published by the Cleveland Clinic Foundation, Division of Gynecologic Oncology.[6] No robotic SPL surgeries were included in this analysis.

Subjects were carefully identified from the electronic medical record by *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision*, codes for uterine cancer (C54, 55). All data were collected and stored securely within a RedCAP database.[16] Patient demographic data that were collected included age, body mass index (BMI), and race. Oncologic variables collected included date of surgery and approach, stage of malignancy, histology, grade (International Federation of Gynecology and Obstetrics [FIGO] 1, 2, 3), presence of lymphovascular space invasion (LVSI), and adjuvant treatment given (chemotherapy, hormonal therapy, or radiation therapy [RT]). Adjuvant treatment decisions were made on the basis of patient and pathologic factors by using recommendations from National Comprehensive Cancer Network guidelines with or without multidisciplinary tumor board recommendations.

Surgical procedures were performed by 10 attending physicians at 3 hospitals within a single institution with the assistance of fellow and resident trainees. Choice of surgical platform was at the discretion of the primary surgeon based on previous training and additional factors, including patient and oncologic characteristics. The majority (7) of surgeons used at least 1 surgical platform. Of the 8 physicians performing RL, 6 also used either MPL or SPL for EC surgeries. Decision for full or sentinel lymphadenectomy were performed based on preoperative endometrial biopsy and/or intraoperative frozen section at the discretion of the surgeon.

Disease outcomes were collected using last institutional follow-up, recurrence, and death. PFS and OS were determined for all patients and for each surgical modality (RL, MPL, SPL). PFS was defined as time from surgery to first EC recurrence or date of last follow-up. OS was defined as time from surgery to death. Given the retrospective nature of the study, a priori power calculation was not performed. In light of the heterogenous cohort of patients with EC, assuming an expected recurrence rate of 20%, 199 patients would need to be enrolled within each group to detect a 10% difference in recurrence at 80% power.

PFS and OS were the primary endpoints of the study. Categorical factors were summarized using frequencies and percentages, whereas continuous measures summarized used means and standard deviations. To evaluate risk factors for early outcomes, Pearson χ^2 tests, the Fisher exact test, and Kruskal–Wallis test were used, whereas Kaplan–Meier estimates were used to evaluate differences in time to progression and death. Multivariate Cox proportional hazard models were performed to identify independent risk factors for PFS and OS. Age, surgical stage, histology, tumor grade, surgical modality, LVSI, and use of RT were used to produce the models. Risk estimates were provided as odds ratios with 95% confidence intervals (CIs) for early outcomes, and hazard ratios (HRs) with 95% CIs for time to progression or death. P values of $<.05$ were considered statistically significant. Multivariate logistic regression models were fit to evaluate factors associated with PFS and OS, while

TABLE 1
Patient demographic and oncologic data for women with endometrial cancer undergoing surgical staging

Factor	All patients (N=1150)	RL (n=652)	MPL (n=214)	SPL (n=284)	*P* value
Patient demographics					
Age, y	62.0 (55.5, 68.0)	62.0 (56.0, 68.0)	62.0 (56.0, 68.0)	63.6 (55.2, 70.1)	.09
BMI, kg/m^2	33.5 (27.6, 40.4)	34.5 (28.2, 42.3)	33.4 (27.4, 39.5)	31.7 (26.7, 37.4)	<.001[a]
Race					
White	1020 (88.7)	575 (88.2)	195 (91.1)	250 (88.0)	.01[a]
African American	95 (8.3)	50 (7.6)	13 (6.1)	32 (11.3)	
Asian	6 (0.5)	4 (0.6)	1 (0.5)		
Hispanic	15 (1.3)	13 (2.0)	1 (0.5)		
Other	8 (0.7)	6 (0.9)	2 (0.9)		
Oncologic factors					
Stage					
IA	854 (74.7)	478 (73.7)	158 (74.9)	218 (77.0)	.003[a]
IB	150 (13.1)	97 (14.9)	28 (13.3)	25 (8.8)	
II	32 (2.8)	14 (2.2)	9 (4.3)	9 (3.2)	
IIIA	28 (2.4)	14 (2.2)	3 (1.4)	11 (3.9)	
IIIB	4 (0.4)	3 (0.5)	0 (0.0)	1 (0.4)	
IIIC	60 (5.2)	38 (5.9)	5 (2.4)	17 (6.0)	
IVA	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
IVB	15 (1.3)	5 (0.77)	8 (3.8)	2 (0.8)	
Histology					
Endometrioid	1017 (88.4)	588 (90.7)	189 (89.2)	240 (84.5)	<.001[a]
Serous	64 (5.6)	35 (5.4)	11 (5.2)	18 (6.3)	
Clear cell	20 (1.7)	10 (1.5)	3 (1.4)	7 (2.5)	
Carcinosarcoma	21 (1.8)	9 (1.4)	3 (1.4)	9 (3.2)	
Mucinous	7 (0.6)	2 (0.3)	0 (0.0)	5 (1.8)	
Leiomyosarcoma	4 (0.4)	3 (0.5)	1 (0.5)	0 (0.0)	
Low-grade ESS	3 (0.3)	0 (0.0)	3 (1.4)	0 (0.0)	
High-grade ESS	3 (0.3)	1 (0.2)	2 (0.9)	0 (0.0)	
Other	5 (0.4)	0 (0.0)	0 (0.0)	5 (1.8)	
Grade					
FIGO 1	648 (57.4)	366 (57.3)	128 (61.8)	154 (54.5)	.15
FIGO 2	294 (26.0)	177 (27.7)	46 (22.2)	71 (25.1)	
FIGO 3	187 (16.6)	96 (15.0)	33 (15.9)	58 (20.5)	

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(continued)

adjusting for potential confounders. For the models, variables that were considered clinically relevant and/or were statistically significant on univariate analysis were included. Analysis was performed using SAS software (version 9.4; Cary, NC).

Results

Patient demographics

In total, 1150 women with EC underwent MIS staging with RL (n=652; 56.7%), MPL (n=214; 18.6%), or SPL (n=284; 24.7%) from 2009 to 2015 at the Cleveland Clinic Foundation. All patients were included in the analysis. Patient demographic information is included in Table 1. The median age and BMI of all women were 62.0 years and 33.5 kg/m^2, respectively. There were no significant differences in median age among different surgical groups (*P*=.09).

TABLE 1
Patient demographic and oncologic data for women with endometrial cancer undergoing surgical staging *(continued)*

Factor	All patients (N=1150)	RL (n=652)	MPL (n=214)	SPL (n=284)	*P* value
LVSI	283 (24.7)	162 (24.9)	57 (27.0)	64 0 (22.6)	.53
Radiation					
VBT	251(21.9)	149 (22.9)	42 (19.6)	60 (21.6)	.01[a]
Pelvic RT	76 (6.6)	32 (4.9)	15 (7.0)	29 (10.4)	
VBT + pelvic RT	62 (5.4)	44 (6.7)	4 (1.9)	14 (5.0)	
None	753 (65.8)	426 (65.3)	152 (71.0)	175 (62.9)	
Adjuvant chemotherapy	237 (20.7)	142 (22.0)	38 (17.8)	57 (20.1)	.39
Adjuvant hormonal therapy	22 (1.9)	10 (1.6)	11 (5.2)	1 (0.35)	<.001[a]

Statistics presented as N (column %).

LVSI, lymphovascular space invasion; *RT*, radiation therapy; *VBT*, vaginal brachytherapy.

[a] Statistically significant.

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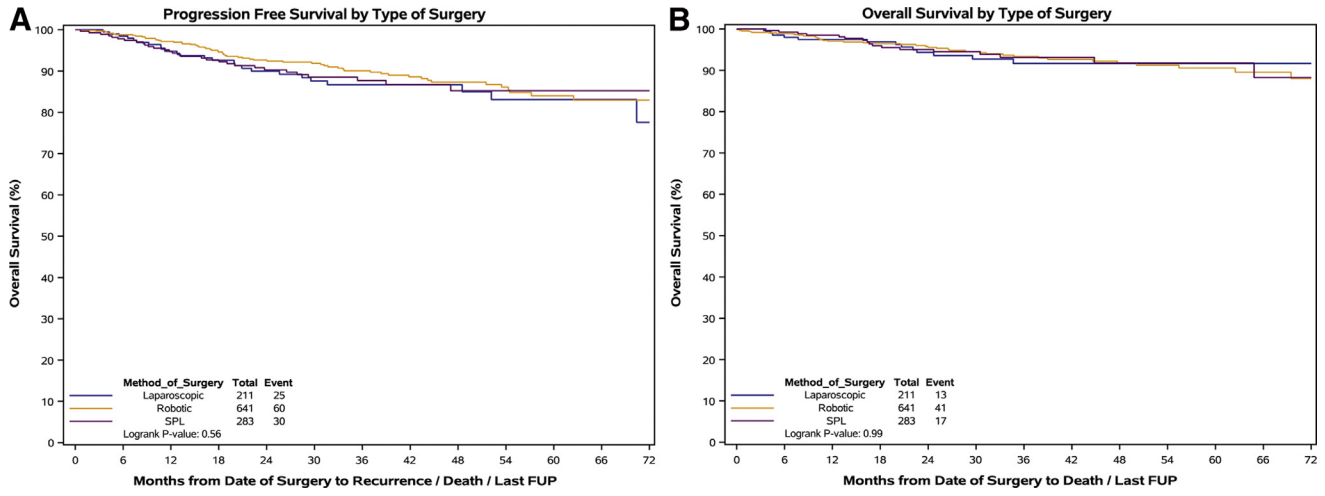
BMI was lower in patients who underwent SPL compared with other surgical platforms (31.7 kg/m^2 vs 33.5 kg/m^2 for all patients, 34.5 kg/m^2 for RL, and 33.4 kg/m^2 for MPL; $P<.001$). The majority of women were white (n=1020; 88.7%) or African American (n=95; 8.3%).

Oncologic factors

Oncologic factors and adjuvant treatment regimens are included in Table 1. The majority of patients had endometrioid (n=230; 88.4%) or serous (n=64; 5.6%) histology and stage IA (n=854; 74.7%) or IB disease (n=150; 13.1%). More than 80% of patients were diagnosed with FIGO grade 1 (n=648; 57.4%) or 2 EC (n=294; 26.0%). LVSI was present in approximately one-quarter of pathologic specimens (n=283; 24.7%). There was no difference in the distribution of FIGO grade (*P*=.15) or presence of LVSI for patients undergoing RL, MPL, or SPL (*P*=.53).

Adjuvant radiation (RT) was administered in approximately one-third of patients (34.2%; n=391), with 21.9% (n=251) receiving vaginal brachytherapy (VBT), 6.6% (n=76) pelvic RT (EBRT), and 5.4% (n=62) both EBRT and VBT. Adjuvant chemotherapy was given to 20.7% (n=237) of patients, with carboplatin and paclitaxel used most

FIGURE 1
EC survival by route of surgery



A, PFS; **B,** OS.

EC, endometrial cancer; *MPL*, multiport laparoscopy; *OS*, overall survival; *PFS*, progression-free survival; *RL*, robotic-assisted laparoscopy; *SPL*, single-port laparoscopy.

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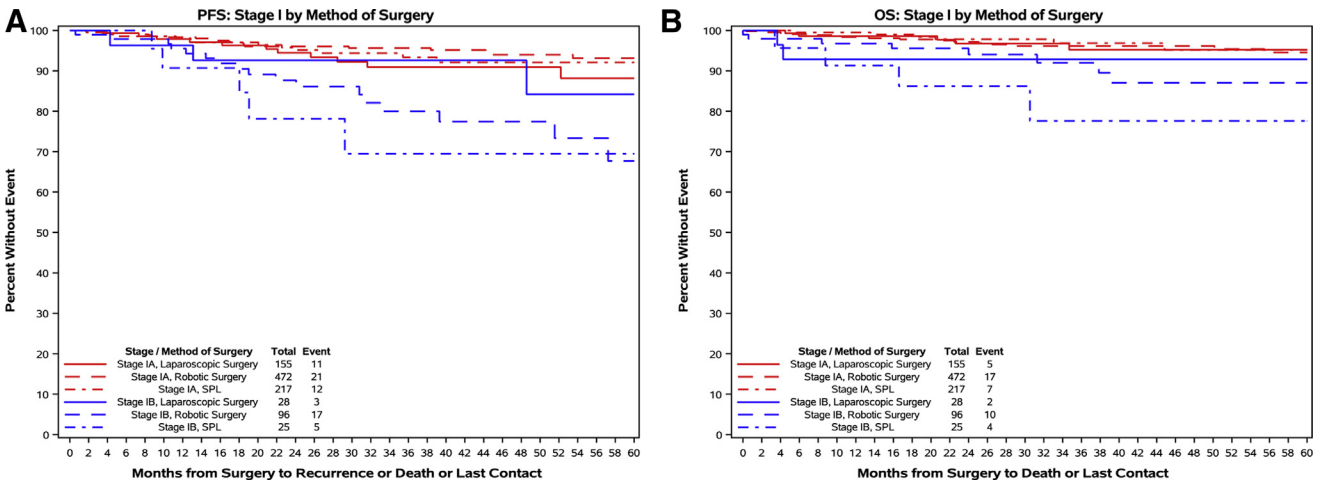
FIGURE 2
Survival for stage IA and B patients with EC undergoing surgical staging with MPL, SPL, and RL



A, PFS; **B,** OS.

EC, endometrial cancer; *MPL*, multiport laparoscopy; *OS*, overall survival; *PFS*, progression-free survival; *RL*, robotic-assisted laparoscopy; *SPL*, single-port laparoscopy.

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frequently. Hormonal therapy was used in 1.9% of all patients (n=22), including 1.6% (n=10) of RL, 5.2% (n=11) of MPL, and 0.4% (n=1) of SPL ($P<.001$).

Recurrence and survival outcomes

The median follow-up duration was 31.9 months for MPL (range 0.5–92.7 months), 33.0 months for RL (range 0.2–91.7 months), and 31.1 months for SPL (range 0.5–86.3 months). For the entire cohort of women with EC undergoing MIS, PFS at 2, 3, and 5 years was 91.6%, 88.9%, and 84.1%, respectively. When stratified by method of surgery, there was no difference between the entire cohort PFS at 2, 3, and 5 years for MPL (90.1%, 86.8%, 83.4%) RL (92.7%, 90.2%, 84.2%), and SPL (90.3%, 87.7%, 85.2%) ($P=.56$), respectively. For all patients with EC who underwent MIS, the OS at 2, 3, and 5 years was 91.6%, 88.9%, and 84.1%, respectively. Similarly, there were no differences in OS at 2, 3, and 5 years for MPL (94.4%, 91.8%, 91.8%), RL (95.6%, 93.4%, 90.7%), and SPL (95.0%, 93.1%, 91.8%) ($P=.99$), respectively. Kaplan–Meier estimates of PFS and OS for all patients with EC undergoing MPL, RL, and SPL are demonstrated in Figure 1.

Among women with stage IA and IB disease who underwent MIS for EC, there were no differences in PFS at 2, 3,

TABLE 2
Predictors of overall survival for patients with endometrial cancer undergoing surgical staging with RL, MPL, or SPL

	N	Year 2 % (95% CI)	Year 3 % (95% CI)	Year 5 % (95% CI)		
Overall	**1150**	**91.6 (89.8–93.4)**	**88.9 (86.8–91.0)**	**84.1 (81.0–87.2)**	**HR (95% CI)**	***P* value**
Surgery						
MPL	213	94.4 (91.0–97.9)	91.8 (87.4–96.3)	91.8 (87.4–96.3)	1.00	.99
RL	645	95.6 (93.9–97.3)	93.4 (91.2–95.7)	90.7 (87.6–93.9)	1.03 (0.55–1.93)	
SPL	283	95.0 (92.3–97.8)	93.1 (89.8–96.7)	91.8 (87.6–96.2)	1.01 (0.49–2.08)	
Race						
White	1013	95.7 (94.4–97.1)	95.5 (93.9–97.1)	94.9 (92.8–97.1)	0.64 (0.30–1.36)	.41
Black	93	89.3 (82.5–96.7)	89.3 (82.5–96.7)	89.3 (82.5–96.7)	1.00	
Other	35	96.4 (89.8–100.0)	96.4 (89.8–100.0)	96.4 (89.8–100.0)	0.34 (0.04–2.78)	

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TABLE 2
Predictors of overall survival for patients with endometrial cancer undergoing surgical staging with RL, MPL, or SPL
(continued)

	N	Year 2 % (95% CI)	Year 3 % (95% CI)	Year 5 % (95% CI)		
Overall	**1150**	**91.6 (89.8–93.4)**	**88.9 (86.8–91.0)**	**84.1 (81.0–87.2)**	**HR (95% CI)**	***P* value**
Stage						
IA	849	97.3 (96.1–98.5)	96.2 (94.7–97.8)	94.8 (92.7–97.0)	1.00	<.001[a]
IB	149	92.6 (88.3–97.2)	90.2 (84.9–95.8)	86.9 (80.2–94.1)	3.20 (1.74–5.88)	
II	32	91.7 (81.3–100.0)	91.7 (81.3–100.0)	91.7 (81.3–100.0)	1.97 (0.47–8.33)	
IIIA	28	91.6 (81.0–100.0)	81.7 (66.8–99.9)	81.7 (66.8–99.9)	4.27 (1.51–12.06)	
IIIB	3	100.0 (100.0–100)	0.00	0.00	0.00 (0.00–0.00)	
IIIC	58	85.1 (76.0–95.2)	73.6 (61.3–88.3)	68.3 (54.1–86.2)	7.45 (3.95–14.06)	
IVA	0	N/A	N/A	N/A	N/A	
IVB	15	71.1 (50.5–100.0)	56.9 (32.6–99.2)	0.00	16.20 (7.07–37.12)	
Grade						
FIGO 1	647	98.9 (98.0–99.8)	97.5 (96.1–99.0)	95.1 (92.5–97.7)	1.00	<.001[a]
FIGO 2	291	92.9 (89.8–96.2)	92.3 (89.0–95.8)	92.3 (89.0–95.8)	2.57 (1.38–4.79)	
FIGO 3	182	88.6 (83.8–93.7)	82.0 (75.6–88.9)	79.8 (72.5–87.9)	5.23 (2.93–9.33)	
Histology						
Endo	1010	96.7 (95.5–97.9)	94.9 (93.3–96.5)	93.6 (91.5–95.7)	1.00	<.001[a]
UCCC	20	90.8 (77.8–100.0)	90.0 (77.8–100.0)	77.1 (55.1–100.0)	2.82 (0.90–8.86)	
USC	63	88.7 (80.6–97.7)	77.9 (66.4–91.5)	72.4 (58.3–89.8)	3.88 (2.05–7.36)	
CS	21	60.9 (41.4–89.4)	60.9 (41.4–89.4)	45.6 (23.0–90.5)	9.04 (3.77–21.67)	
LMS	4	66.7 (N/A)	66.7 (N/A)	66.7 (N/A)	6.15 (N/A)	
ESS	5	100.0 (N/A)	100.0 (N/A)	100.0 (N/A)	N/A	
MUC	12	83.3 (N/A)	83.3 (N/A)	83.3 (N/A)	2.51 (N/A)	
LVSI	278	90.1 (86.4–94.0)	85.1 (80.3–90.2)	80.7 (74.6–87.3)	4.12 (2.57–6.59)	<.001[a]
RT						
None	747	96.5 (95.0–98.0)	94.5 (92.6–96.5)	92.2 (89.5–95.1)	1.00	<.001[a]
VBT	250	95.1 (92.3–98.0)	95.1 (92.3–98.0)	95.1 (92.3–98.0)	0.97 (0.50–1.78)	
PRT	76	87.0 (79.4–95.3)	77.8 (67.4–89.9)	77.8 (67.4–89.9)	3.71 (2.02–6.80)	
VBT + PRT	61	92.9 (85.5–100.0)	86.9 (76.7–98.5)	81.5 (68.2–97.4)	2.02 (0.87–4.69)	
CT	233	90.9 (87.0–94.9)	86.7 (81.8–91.8)	83.1 (77.0–89.6)	2.61 (1.63–4.18)	<.001[a]
HT	21	90.0 (77.8–100.0)	90.0 (77.8–100.0)	90.0 (77.8–100.0)	1.56 (0.37–6.64)	0.55

Overall survival is presented as n, indicating the percentage of patients alive at each time point (interquartile range). HRs are presented along with 95% CIs and *P* values, with $P<.05$ considered significant.

CI, confidence interval; *CS*, carcinosarcoma; *CT*, chemotherapy; *Endo*, endometrioid; *ESS*, endometrial stromal sarcoma (high and low grade); *FIGO*, International Federation of Gynecology and Obstetrics; *HR*, hazard ratio; *HT*, hormonal therapy; *LMS*, leiomyosarcoma; *LVSI*, lymphovascular space invasion; *MPL*, multiport laparoscopy; *MUC*, mucinous adenocarcinoma; *N/A*, not available; *PRT*, pelvic radiation; *RL*, robotic-assisted laparoscopy; *RT*, radiation therapy; *SPL*, single port laparoscopy; *UCCC*, uterine clear cell carcinoma; *USC*, uterine serous carcinoma; *VBT*, vaginal brachytherapy.

[a] Statistically significant.

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and 5 years for MPL (94.2%, 91.4%, 87.4%), RL (94.5%, 92.9%, 88.8%), and SPL (93.6%, 91.2%, 90.0%) ($P=.93$), respectively. Similarly, there was no difference in OS at 2, 3, and 5 years for MPL (96.2%, 95.0%, 95.0%), RL (96.6%, 95.4%, 93.3%), and SPL (96.6%, 95.0%, 93.4%) ($P=.89$). Kaplan–Meier estimates of PFS and OS for stage IA and IB patients with EC undergoing MIS surgery with MPL, RL, and SPL are shown in Figure 2.

TABLE 3
Predictors of overall survival for stage IA/B patients with endometrial cancer

	N	Year 2 % (95% CI)	Year 3 % (95% CI)	Year 5 % (95% CI)		
Overall	993	96.5 (95.3–97.8)	95.3 (93.7–96.8)	93.6 (91.5–95.7)	HR (95% CI)	*P* value
Surgery						
MPL	183	96.2 (93.2–99.2)	95.0 (91.2–98.8)	95.0 (91.2–98.8)	1.00	.89
RL	568	96.6 (95.0–98.3)	95.4 (93.5–97.5)	93.3 (90.4–96.2)	1.23 (0.54–2.83)	
SPL	242	96.6 (94.2–99.1)	95.0 (91.7–98.4)	93.4 (89.0–98.0)	1.21 (0.47–3.13)	
Race						
White	882	96.9 (95.7–98.2)	95.5 (93.9–97.1)	93.6 (91.3–96.0)	1.00	.41
Other	81	92.4 (86.1–99.1)	92.4 (86.1–99.1)	92.4 (86.1–99.1)	1.49 (0.58–3.85)	
Stage						
IA	844	97.3 (96.1–98.5)	96.2 (94.7–97.7)	94.8 (92.7–97.0)	1.00	<.001[a]
IB	149	92.6 (88.3–97.2)	90.2 (84.9–95.8)	86.9 (80.2–94.1)	3.13 (1.71–5.73)	
Grade						
FIGO 1	629	98.8 (97.9–99.8)	97.7 (96.2–99.2)	95.5 (92.9–98.1)	1.00	.002[a]
FIGO 2	240	94.3 (91.2–97.5)	93.5 (90.1–97.1)	93.5 (90.1–97.1)	2.56 (1.27–5.15)	
FIGO 3	122	91.4 (86.2–97.0)	88.6 (82.3–95.3)	88.6 (82.3–95.3)	3.51 (1.63–7.57)	
Histology						
Endo	906	97.3 (96.2–98.5)	96.1 (94.6–97.6)	94.9 (93.0–97.0)	1.00	<.001[a]
CS	15	67.8 (45.8–100.0)	67.8 (45.8–100)	45.2 (18.5–100.0)	10.65 (4.07–28.43)	
USC	41	92.7 (85.0–100.0)	89.1 (79.4–100)	81.7 (66.5–100)	7.52 (1.14–49.60)	
UCCC	10	90.0 (73.2–100.0)	90.0 (73.2–100)	90.0 (73.2–100)	2.62 (0.35–19.65)	
ESS	2	100.0 (100.0–100.0)	100.0 (100.0–100.0)	100.0 (100.0–100.0)	0.00 (0.00–0.00)	
LMS	3	100.0 (100.0–100.0)	100.0 (100.0–100.0)	100.0 (100.0–100.0)	0.00 (0.00–0.00)	
LVSI	175	91.7 (87.4–96.1)	89.7 (84.8–94.9)	86.5 (80.1–93.3)	3.56 (1.98–6.41)	<.001[a]
RT						
None	711	97.5 (96.2–98.8)	95.9 (94.1–97.7)	93.9 (91.3–96.6)	1.00	.17
VBT	220	95.0 (92.0–98.1)	95.0 (92.0–98.1)	95.0 (92.0–98.1)	1.35 (0.68–2.68)	
PRT	40	88.1 (77.8–99.9)	88.1 (77.8–99.9)	88.1 (77.8–99.9)	2.88 (1.12–7.39)	
VBT + PRT	18	100.0 (100.0–100.0)	87.5 (67.3–100.0)	87.5 (67.3–100.0)	1.50 (0.21–10.72)	
CT	127	93.8 (89.5–98.4)	92.5 (87.6–97.7)	90.7 (84.8–97.0)	1.72 (0.85–3.48)	.13
HT	12	90.9 (75.4–100.0)	90.9 (75.4–100.0)	90.9 (75.4–100.0)	2.05 (0.27–15.45)	.48

Overall survival is presented as n, indicating the frequency of patients alive at each time point (interquartile range). HRs are presented along with 95% CIs and *P* values, with $P<.05$ considered significant.

CI, confidence interval; *CT*, chemotherapy; *CS*, carcinosarcoma; *ENDO*, endometrioid adenocarcinoma; *ESS*, endometrial stromal sarcoma (low and high grade); *FIGO*, International Federation of Gynecology and Obstetrics; *HR*, hazard ratio; *HT*, hormonal therapy; *LMS*, leiomyosarcoma; *LVSI*, lymphovascular space invasion; *MPL*, multiport laparoscopy; *PRT*, pelvic radiation; *RL*, robotic-assisted laparoscopy; *RT*, radiation therapy; *SPL*, single-port laparoscopy; *UCCC*, uterine clear cell carcinoma, *USC*, uterine serous carcinoma; *VBT*, vaginal brachytherapy.

[a] Statistically significant.

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Predictors of disease progression and survival

Table 2 demonstrates predictors for OS from univariate analysis for the entire cohort of women with EC who underwent MPL, SPL, or RL. OS was not impacted by route of surgery ($P=.99$) or race ($P=.41$). However, stage ($P<.001$), histology ($P<.001$), FIGO grade ($P<.001$), presence of LVSI ($P<.001$), receipt of RT ($P<.001$), or chemotherapy ($P<.001$) were associated with reduced OS.

Table 3 demonstrates predictors for OS from univariate analysis among

TABLE 4
Multivariate predictors of progression-free survival in endometrial cancer

Factor	Hazard ratio (95% CI)	*P* value
Method of surgery		.57
RL vs MPL	0.81 (0.48−1.37)	.44
SPL vs MPL	0.73 (0.40−1.31)	.29
Stage		
III/IV vs I/II	3.52 (1.88−6.60)	<.001[a]
Grade		
FIGO 3 vs FIGO 1/2	1.63 (0.87−3.05)	.13
Histology		.007[a]
CS vs endometrioid	8.49 (3.00−24.05)	<.001[a]
UCCC vs endometrioid	1.33 (0.51−3.46)	.55
LMS vs endometroid	3.60 (0.41−31.54)	.25
USC vs endometrioid	1.95 (0.93−4.10)	.07
Mucinous vs endometrioid	0.84 (0.11−6.32)	.86
LVSI	1.37 (0.80−2.36)	.26
Age >65 y	1.82 (1.21−2.75)	.004[a]
Radiation		.004[a]
VBT vs none	0.83 (0.47−1.50)	.54
Pelvic RT vs none	2.94 (1.46−5.90)	.002[a]
VBT + pelvic RT vs none	1.86 (0.82−4.20)	.14

Hazard ratios presented with 95% CIs.

CI, confidence interval; *CS*, carcinosarcoma; *ESS*, endometrial stromal sarcoma; *FIGO*, International Federation of Gynecology and Obstetrics; *LMS*, leiomyosarcoma; *LVSI*, lymphovascular space invasion; *MPL*, multiport laparoscopy; *RL*, robotic-assisted laparoscopy; *RT*, radiation therapy; *SPL*, single-port laparoscopy; *UCCC*, uterine clear cell carcinoma; *USC*, uterine serous carcinoma; *VBT*, vaginal brachytherapy.

[a] Statistically significant.

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women with stage IA and IB EC. In patients with stage IA and IB disease, OS was not impacted by surgical platform (*P*=.89) or race (*P*=.41). However, patients with stage IB disease (*P*<.001), FIGO grade 2 or 3 histology (*P*=.002), non-endometrioid histology (*P*<.001), and presence of LVSI (*P*<.001) had poorer OS. In patients with stage IA/B disease, regardless of surgical platform used, use of adjuvant RT (*P*=.17), chemotherapy (*P*=.13), and hormonal therapy (*P*=.48) did not impact OS.

Table 4 displays results of the multivariate analysis for PFS. Among all patients with EC undergoing MIS, method of surgery did not impact PFS (RL vs MPL: HR, 0.81; 95% CI, 0.48− 1.37, *P*=.44; SPL vs MPL: HR, 0.73, 95% CI, 0.40−1.31, *P*=.29; *P*=.57). Advanced-stage disease was associated with reduced PFS (III/IV vs I/II: HR, 3.52; 95%, CI 1.88−6.60, *P*<.001). In addition, non-endometrioid histology (*P*<.001) and age older than 65 years (*P*=.004) were negatively associated with PFS. Presence of LVSI did not significantly impact PFS (HR, 1.37; 95% CI, 0.80−2.36, *P*=.26). PFS was not impacted by receipt of VBT (HR, 0.83; 95% CI, 0.47− 1.50, *P*=.54) and VBT with pelvic RT (HR, 1.86; 95% CI, 0.82−4.20, *P*=.14) but pelvic RT alone (HR, 2.94; 95% CI, 1.46−5.90, *P*=.002) was associated with worse PFS compared with patients who received no adjuvant RT.

Table 5 displays results of the multivariate analysis for OS. Among all patients with EC, method of surgery was not associated with change in OS (RL vs MPL: HR, 1.28; 95% CI, 0.63− 2.58, *P*=.50; SPL vs MPL: HR, 0.84, 95% CI, 0.38−1.87, *P*=.68). Patients with advanced-stage disease (III/IV vs I/II: HR, 3.27; 95% CI, 1.48−7.21, *P*<.003) had worse OS. Similarly, advancing FIGO grade (FIGO 1 vs 2: HR, 3.08; 95% CI, 1.54−6.14, *P*<.001; FIGO 1 vs 3: HR, 5.84; 95% CI, 2.66−12.79, *P*<.001) and age older than 65 years (HR, 6.03; 95% CI, 3.24−11.23, *P*<.001) were associated with worse OS. Neither presence of LVSI (HR, 1.88; 95% CI, 0.92− 3.85, *P*=.083), receipt of RT (*P*=.08), or chemotherapy (HR, 0.59; 95% CI, 0.27−1.27, *P*=.18) were associated with improved OS.

Comments

As the role of MIS in gynecologic oncology has evolved over the last 2 decades, both the variety and complexity of procedures performed via this route have increased. Although data exist demonstrating superior surgical outcomes and comparable oncologic outcomes for MIS compared with laparotomy for EC staging, to date, data are limited regarding the cancer-specific outcomes when compared by MIS platform. Because minimally invasive hysterectomy is considered first-line treatment for the majority of women with newly diagnosed EC, a deeper understanding of the impact of different surgical platforms on cancer outcomes is important. The objective of this study was to investigate the oncologic outcomes (PFS, OS) in women with EC undergoing initial surgical treatment via MPL, RL, or SPL. This large, retrospective cohort identified that both EC recurrence and survival are equivalent among women undergoing MIS staging regardless of surgical platform used. Similarly, in women with stage I disease, no differences exist between RL, MPL, and SPL for both PFS and OS.

To date, studies have found no significant differences in recurrence and survival outcomes with MIS approaches

TABLE 5
Multivariate predictors of overall survival in endometrial cancer

Factor	Hazard ratio (95% CI)	*P* value
Method of surgery		.43
RL vs MPL	1.28 (0.63–2.58)	.50
SPL vs MPL	0.84 (0.38–1.87)	.68
Stage		
III/IV vs I/II	3.27 (1.48–7.21)	.003[a]
Grade		
FIGO 3 vs FIGO 1/2	1.46 (0.66–3.23)	.35
Histology		
CS vs endometrioid	3.43 (0.98–12.04)	0.054
UCCC vs endometrioid	0.94 (0.25–3.53)	.93
USC vs endometrioid	1.83 (0.70–4.75)	.22
ESS vs endometroid	0.00 (0–0)	.99
LMS vs endometroid	0.00 (0–0)	.99
Mucinous vs endometroid	1.78 (0.22–14.05)	.59
LVSI	1.88 (0.92–3.85)	.083
Age >65 y	5.42 (2.92–10.07)	<.001[a]
Radiation		.08
VBT vs none	0.53 (0.25–1.12)	.10
Pelvic RT vs none	1.46 (0.64–3.30)	.37
VBT + pelvic RT vs none	0.67 (0.21–2.14)	.50
Chemotherapy	0.59 (0.27–1.27)	.18

Hazard ratios presented with 95% CIs.

CI, confidence interval; *CS*, carcinosarcoma; *ESS*, endometrial stromal sarcoma; *FIGO*, International Federation of Gynecology and Obstetrics; *LMS*, leiomyosarcoma; *LVSI*, lymphovascular space invasion; *MPL*, multiport laparoscopy; *RL*, robotic-assisted laparoscopy; *RT*, radiation therapy; *SPL*, single-port laparoscopy; *UCCC*, uterine clear cell carcinoma; *USC*, uterine serous carcinoma; *VBT*, vaginal brachytherapy.

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compared with laparotomy for EC staging.[3,4,11–14] In the LAP2 randomized controlled trial by Walker et al[3] that compared laparoscopy with laparotomy, no significant differences for both PFS and OS were identified in women with EC undergoing surgical staging. Following this, further investigation has demonstrated that use of RL affords equivalent oncologic outcomes compared with laparotomy.[17–20] In a study by Park et al[17] that compared robotic surgery vs laparotomy for EC, no differences were seen for both PFS and OS. They reported 3-year PFS of 90.9% for the robotic cohort and 78.3% for the laparotomy cohort and 5-year OS of 89.1% and 79.5% for robotic and laparotomy groups, respectively.[17] Similarly, in a retrospective matched cohort study by Corrado et al,[20] no difference in oncologic outcomes was seen among patients who underwent either traditional laparoscopy or robotic surgery compared with laparotomy.

Following the adoption of MIS as standard of care for EC surgery, RL, MPL, and SPL are all used for the surgical staging and treatment of EC.[6–15] Compared with RL and MPL, adoption of SPL in gynecologic oncology is more recent, first described at Cleveland Clinic Foundation in 2009.[21] Since then, the role and potential benefits of SPL in EC staging have been described in the literature.[6,21–26] In a matched, retrospective cohort of 90 patients by Escobar et al,[22] SPL was associated with comparable length of stay, hospital rates, and blood loss compared with MPL and RL. Park et al[23] performed a prospective study in women with EC who underwent SPL and compared their surgical outcomes with historical controls who underwent MPL with 4 ports. Equivalent operating time, rates of blood transfusion, and postoperative complications were noted, and they identified no differences in total, pelvic, and para-aortic nodal counts between the 2 cohorts.[23] In addition, SPL was associated with improved postoperative pain and lower analgesic use compared with MPL.[23] Recently, Barnes et al[24] reported on 110 consecutive cases of EC staging performed via SPL. They reported excellent postoperative adverse outcomes with a reasonable learning curve, demonstrating improved operative times following 20 cases.

Prior to this study, data comparing oncologic outcomes between RL, SPL, and MPL were limited. Cardenas-Goicoechea et al[27] performed a retrospective analysis of 415 women from 2003 to 2010 who underwent either RL or MPL for EC cancer. Their study demonstrated no difference in survival or recurrence between robotic or laparoscopic groups and that surgery was not an independent prognostic variable for survival. In a significantly larger cohort inclusive of patients undergoing SPL, the results of this current study provide further validation that surgical staging and treatment for EC via MPL, SPL, or RL are acceptable approaches with equivalent oncologic outcomes in both early-stage disease and among all disease stages,[27] On the basis of these data, there should be continued support for surgeon choice regarding surgical platform for EC surgery. In addition, prioritization of fellowship education in broad, surgical training for the management of patients with EC is important.

Areas of strength in this study include the large number of patients and the

inclusion of data from 3 hospitals within 1 academic institution. To our knowledge, this is the largest study reporting specifically on oncologic outcomes in patients who have undergone SPL for EC staging compared with MPL and RL. Building on previous studies focused on surgical parameters and short-term outcomes, these data provide further evidence that SPL affords equivalent outcomes to both MPL and RL for EC staging and treatment.[6,21–26]

Limitations include the retrospective design and follow-up duration of 31–33 months in all surgical cohorts. Since the majority of EC recurrences occur within 3 years of treatment, it is a possibility that a small number of recurrences occurring after the study period were not captured.[27] An additional limitation is that the study was underpowered to assess the direct impact of adjuvant treatment, including RT and chemotherapy, on oncologic outcomes. However, unfortunately, previous trials and studies have demonstrated no improvement in survival with receipt of RT or chemotherapy for EC.[3,4,9,18–20] Both safety and efficacy of RL, MPL, and SPL within gynecologic oncology has been well-documented within the scientific literature.[6–10] The investigators deliberately focused on oncologic outcomes in this study due to lack of data in this area.[6–10,21–26] An additional investigation is being performed into comparative analysis of short- and long-term surgical outcomes, including cost, with the 3 surgical modalities. Despite these limitations, to our knowledge, this study features a heterogenous group of women with EC and includes patients treated with 3 minimally invasive approaches to EC surgery, which increases generalizability.

This study demonstrates no difference in oncologic outcomes for women undergoing RL, SPL, or MPL for EC staging. Rather, similar to previous studies, stage, grade, and age predict recurrence and survival outcomes. These findings support continued investigation and prospective study to optimize oncologic outcomes for women undergoing minimally invasive surgery for EC. ■

Acknowledgments

We acknowledge Milena Radeva, MS, and Meng Yao, MS, of the Cleveland Clinic Quantitative Health Sciences Department for their assistance with statistical analysis.

References

1. Siegel RL, Miller KD, Jemal A. Cancer Statistics, 2019. CA Cancer J Clin 2019;69:7–34.
2. Lewin SN, Herzog TJ, Barrena Medel NI, et al. Comparative performance of the 2009 International Federation of Gynecology and Obstetrics' staging system for uterine corpus cancer. Obstet Gynecol 2010;116:1141–9.
3. Walker JL, Piedmonte MR, Spirtos NM, et al. Recurrence and survival after random assignment to laparoscopy versus laparotomy for comprehensive surgical staging of uterine cancer: Gynecologic oncology group LAP2 study. J Clin Oncol 2012;30:695–700.
4. Walker JL, Piedmonte MR, Spirtos NM, et al. Laparoscopy compared with laparotomy for comprehensive surgical staging of uterine cancer: Gynecologic oncology group study LAP2. J Clin Oncol 2009;27:5331–6.
5. Mourits MJ, Bijen CB, Arts HJ, et al. Safety of laparoscopy versus laparotomy in early-stage endometrial cancer: a randomised trial. Lancet Oncol 2010;11:763–71.
6. Moulton L, Jernigan AM, Carr C, Freeman L, Escobar PF, Michener CM. Single-port laparoscopy in gynecologic oncology: seven years of experience at a single institution. Am J Obstet Gynecol 2017;217:610.e1–8.
7. Bergstrom J, Aloisi A, Armbruster S, et al. Minimally invasive hysterectomy surgery rates for endometrial cancer performed at national comprehensive cancer network (NCCN) centers. Gynecol Oncol 2018;148:480–4.
8. Casarin J, Multinu F, Ubl DS, et al. Adoption of minimally invasive surgery and decrease in surgical morbidity for endometrial cancer treatment in the united states. Obstet Gynecol 2018;131:304–11.
9. Bregar AJ, Melamed A, Diver E, et al. Minimally invasive staging surgery in women with early-stage endometrial cancer: analysis of the national cancer data base. Ann Surg Oncol 2017;24:1677–87.
10. Maenpaa MM, Nieminen K, Tomas EI, Laurila M, Luukkaala TH, Maenpaa JU. Robotic-assisted vs traditional laparoscopic surgery for endometrial cancer: a randomized controlled trial. Am J Obstet Gynecol 2016;215:588.e1–7.
11. Seamon LG, Cohn DE, Henretta MS, et al. Minimally invasive comprehensive surgical staging for endometrial cancer: robotics or laparoscopy? Gynecol Oncol 2009;113:36–41.
12. Bell MC, Torgerson J, Seshadri-Kreaden U, Suttle AW, Hunt S. Comparison of outcomes and cost for endometrial cancer staging via traditional laparotomy, standard laparoscopy and robotic techniques. Gynecol Oncol 2008;111:407–11.
13. Gala RB, Margulies R, Steinberg A, et al. Systematic review of robotic surgery in gynecology: robotic techniques compared with laparoscopy and laparotomy. J Minim Invasive Gynecol 2014;21:353–61.
14. Leitao MM Jr, Bartashnik A, Wagner I, et al. Cost-effectiveness analysis of robotically assisted laparoscopy for newly diagnosed uterine cancers. Obstet Gynecol 2014;123:1031–7.
15. Scalici J, Laughlin BB, Finan MA, Wang B, Rocconi RP. The trend towards minimally invasive surgery (MIS) for endometrial cancer: an ACS-NSQIP evaluation of surgical outcomes. Gynecol Oncol 2015;136:512–5.
16. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform 2009;42:377–81.
17. Park HK, Helenowski IB, Berry E, Lurain JR, Neubauer NL. A comparison of survival and recurrence outcomes in patients with endometrial cancer undergoing robotic versus open surgery. J Minim Invasive Gynecol 2015;22:961–7.
18. Kilgore JE, Jackson AL, Ko EM, et al. Recurrence-free and 5-year survival following robotic-assisted surgical staging for endometrial carcinoma. Gynecol Oncol 2013;129:49–53.
19. Brudie LA, Backes FJ, Ahmad S, et al. Analysis of disease recurrence and survival for women with uterine malignancies undergoing robotic surgery. Gynecol Oncol 2013;128:309–15.
20. Corrado G, Cutillo G, Pomati G, et al. Surgical and oncological outcome of robotic surgery compared to laparoscopic and abdominal surgery in the management of endometrial cancer. Eur J Surg Oncol 2015;41:1074–81.
21. Fader AN, Escobar PF. Laparoendoscopic single-site surgery (LESS) in gynecologic oncology: technique and initial report. Gynecol Oncol 2009;114:157–61.
22. Escobar PF, Frumovitz M, Soliman PT, et al. Comparison of single-port laparoscopy, standard laparoscopy, and robotic surgery in patients with endometrial cancer. Ann Surg Oncol 2012;19:1583–8.
23. Park JY, Kim DY, Suh DS, Kim JH, Nam JH. Laparoendoscopic single-site versus conventional laparoscopic surgical staging for early-stage endometrial cancer. Int J Gynecol Cancer 2014;24:358–63.
24. Barnes H, Harrison R, Huffman L, Medlin E, Spencer R, Al-Niaimi A. The adoption of single-port laparoscopy for full staging of endometrial cancer: surgical and oncology outcomes and evaluation of the learning curve. J Minim Invasive Gynecol 2017;24:1029–36.
25. Fagotti A, Corrado G, Fanfani F, et al. Robotic single-site hysterectomy (RSS-H) vs.

laparoendoscopic single-site hysterectomy (LESS-H) in early endometrial cancer: a double-institution case-control study. Gynecol Oncol 2013;130:219–23.

26. Zapardiel I, Moreno E, Pinera A, De Santiago J. Novel technique for the complete staging of endometrial cancer by single-port laparoscopy. Gynecol Oncol 2016;140:369–71.

27. Cardenas-Goicoechea J, Shepherd A, Momeni M, et al. Survival analysis of robotic versus traditional laparoscopic surgical staging for endometrial cancer. Am J Obstet Gynecol 2014;210:160.e1–11.

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Received Jan. 4, 2019; revised April 26, 2019; accepted April 30, 2019.

The authors report no conflict of interest.

Presented as an abstract at the 49th annual meeting on Women's Cancer for the Society of Gynecologic Oncology, New Orleans, LA, Mar. 24-27, 2018.

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