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A Comparison of Laparoscopic and Abdominal Radical Parametrectomy for Cervical or Vaginal Apex Carcinoma and Stage II Endometrial Cancer After Hysterectomy

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ABSTRACT

Background and Objective: Radical parametrectomy (RP), performed either abdominally (ARP) or laparoscopically (LRP), is a viable alternative to radiotherapy in treating invasive cervical cancer, vaginal apex cancer, and endometrial cancer that is more advanced than initially suspected after hysterectomy. We carried out a comparative study on intra- and postoperative parameters between the two performed by similarly experienced surgeons.

Methods: Forty consecutive patients indicative for RP were reviewed: 22 and 18 underwent ARP and LRP, respectively. Information was collected on demographics, indications for initial and this surgery, tumor characteristics, intra- and postoperative parameters, and complications. The lengths of resected parametrial and vaginal tissues were measured.

Results: Compared with ARP, LRP resulted in shorter operative time (200 vs 239 min), less blood loss (627.8 vs 929.5 mL), shorter hospital stay (16.8 vs 19.9 days), and removal of more pelvic lymph nodes (27.4 ± 5.9 vs 23.1 ± 7.1). Although it was not attempted in ARP to remove lymph nodes in the deep obturator space, it was attempted in LRP and one positive node was found. In the ARP cohort there was one case of injury to the small intestine during surgery, whereas in LRP there was one instance of lower urologic fistula after surgery.

Conclusion: LRP is superior to ARP in terms of shorter operative time, less blood loss, and shorter hospital stay while still maintaining the completeness of the procedure. It can be safely performed in the hands of experienced surgeons for cervical or vaginal apex carcinoma and stage II endometrial cancer after hysterectomy.

Key Words: Abdominal radical parametrectomy, Complication, Cervical stump carcinoma, Hysterectomy, Laparoscopic radical parametrectomy, Partial colpectomy, Pelvic lymphadenectomy.

INTRODUCTION

An unexpected histopathological finding, after simple hysterectomy or supracervical hysterectomy, of an occult invasive cervical cancer or vaginal apex cancer or of a more advanced (eg, FIGO stage II) endometrial cancer than initially suspected is rare in gynecological surgery.[1] The presence of persistent endometrial cancer in a cervical stump is even rarer.[2] Primarily because of the relative rarity of these cancers, investigating their optimal treatment modality has been difficult. Consequently, the treatment modality is not standardized. Currently, the treatment options include radiotherapy or radical trachelectomy with pelvic lymph node dissection (PLND) for early stages (no later than FIGO stage IIA2) of cervical stump cancer, parametrectomy, partial colpectomy, and PLND for incidental finding of cervical cancer after simple hysterectomy or vaginal apex cancer after total hysterectomy.[3] For ease of nomenclature, we refer in this article to these procedures collectively as "radical parametrectomy with partial colpectomy" and "pelvic lymphadenectomy," or simply "RP."[4–6]

However, radiotherapy, performed in the form of external beam radiation and intracavitary brachytherapy in the

absence of a uterus, often results in damage not only to the bladder and rectum, leading to extensive bleeding and, in severe cases, rectal-vaginal or bladder-vaginal fistula (which is difficult to repair), but also to ovarian tissues, which in turn increases the risk of premature ovarian failure, especially in younger patients.[7] Consequently, RP is more appealing, especially to achieve results comparable with radiation therapy.[1,5,6,8,9] RP not only avoids the complications resulting from radiotherapy performed in the absence of a uterus, but it also minimizes or eliminates by ovarian transposition the damage to ovarian function because of adjuvant radiation. As an added bonus, RP helps to determine whether any risk factors, such as the presence of parametrial and/or lymph node metastasis, are present, facilitating the decision on postoperation adjuvant therapy. A recent retrospective study reports that RP had a therapeutic efficacy similar to that of radiotherapy or concurrent chemoradiotherapy but had a lower rate of late complications, making RP more attractive.[10] For stage Ia2-IIa cervical cancer, the 5-year survival rate in patients who underwent simple hysterectomy is reported to be significantly lower than that in patients who received radical surgery and radiotherapy,[8,11] but the survival rate can be dramatically increased if RP is performed.[5]

First reported in 1961,[12] RP is a technically challenging surgical procedure consisting of resection of the parametrium, upper colpectomy, and pelvic lymphadenectomy to serve as a definite treatment for patients with cervical cancer after simple hysterectomy.[5,6] RP can be performed abdominally[1,6,8,11] or laparoscopically,[2,7,13–17] and, as reported recently, robotically.[18] It is generally viewed that laparoscopic RP (LRP) with pelvic lymphadenectomy and partial colpectomy is a safe and feasible treatment option because of the more enhanced visualization of the operative space and distinct pelvic anatomical structures.[2,7,16,17,19,20] However, data are scanty about whether LRP is superior to abdominal RP (ARP), especially those based on the same hospital and operations performed by similarly skilled and experienced surgeons, and within roughly the same time period. A few studies compared their LRP results using historical data, which were collected in different institutions or even different continents, sometimes >20 years apart.[17] Using data from the same institution and from surgeons of comparable skill levels and experience should provide more accurate and reliable quantification about how LRP compares with ARP with regard to intra- and postoperative parameters, complications, and outcomes.

The aim of this study was to evaluate, for cervical stump carcinoma, the incidental finding of cervical cancer and stage II endometrial cancer and vaginal apex cancer after total or supracervical hysterectomy, and how LRP with pelvic lymphadenectomy and partial colpectomy compares with ARP with regard to intra- and postoperative parameters and complications. Although these 3 types of cancers are etiologically different gynecological cancers, they nonetheless share a commonality: the operation procedures are similar yet technically challenging because of the absence of a uterus. We demonstrate that, compared with ARP, LRP is a safe and feasible treatment option in the case of unexpected histopathological findings of an occult invasive cervical cancer, vaginal apex cancer, or more advanced (eg, FIGO stage II) than the initially diagnosed endometrial cancer after hysterectomy.

MATERIALS AND METHODS

Patients

Between May 2006 and March 2011, 40 patients admitted to our hospital were indicative for RP. Twenty-two of them underwent ARP, and the other 18 underwent LRP with partial colpectomy and lymphadenectomy. All surgeries were performed by senior gynecological surgeons with >20 years of surgical experience at Shanghai OB/GYN Hospital. Among the ARP group, 10 (45.5%) were operated on by the corresponding author, who also performed all but 1 LRP (94.4%).

Preoperation evaluation with physical and pelvic examination and computed tomography (CT), magnetic resonance imaging (MRI), or positron emission tomography (PET) scan was performed for all patients. Clinical information was collected including demographics, indications for the initial surgery, pathological diagnosis, tumor stage, intra- and postoperative parameters and complications, duration of urinary catheter use, and duration of hospital stay. All patients received perioperative antibiotics and low-molecular-weight heparin postoperatively. A Foley catheter was placed after surgery for all patients. Patients with high or intermediate risk factors for recurrence such as lymph node metastasis, parametrial involvement, tumor size of ≥4 cm, presence of lymph-vascular space invasion, and lymph nodes positivity for cervical cancer; and such as age, lymph-vascular space invasion, tumor size, low uterine involvement, and high grade for endometrial cancer, received radiotherapy or chemoradiotherapy as adjuvant treatment.[21]

Surgical Procedures

ARP. Under general anesthesia and in plain position, the patient's abdominal cavity was opened and explored. In all cases, there was no peritoneal spread. For patients who had a total or supracervical hysterectomy previously, certain parts of the small intestine were found to be adhered to the rectal-vagina peritoneum; hence, the adhesion was surgically separated. ARP with partial colpectomy and pelvic lymphadenectomy was performed as in type III Wertheim radical surgery. In essence, ARP was identical to LRP except that (1) there was no removal of lymph nodes in the deep obturator space and pelvic floor; and (2) after the bladder-peritoneum fold was exposed, the bladder was dissected and then pushed downward, followed by the development of the ureter tunnel and the exposure of the paravesical space. Ovarian transposition was also performed for patients with cervical cancer or vaginal apex cancer who were younger than 50 years. For type II endometrial cancer, such as clear cell cancer, omentectomy was performed.

LRP. Under general anesthesia, the patient was put in a lithotomy-Trendelenburg position. A 10-mm trocar was introduced through the umbilicus, and the abdominal cavity was insufflated with carbon dioxide and explored for evidence of metastatic disease. One pair of 5-mm trocars was placed symmetrically approximately 4 cm away from the umbilicus, slightly below the horizontal line passing through the umbilicus. Another pair of trocars, one 5 mm and the other 10 mm, was inserted bilaterally at the outer one-third of the iliac spine umbilicus line symmetrically. A sponge probe was used to manipulate the vaginal apex or stump of the cervix so the vesical-vagina fold and rectal-vagina fold could be exposed easily.

The pelvic lymphadenectomy was performed as reported previously[22] but with some variations. The peritoneum between the round ligament and the infundibulopelvic ligament was incised bilaterally to expose the common iliac artery, the external iliac artery and veins, and the superior vesical artery. From the bifurcation of the common iliac to the circumflex iliac artery, the nodes were completely removed and all vessels skeletonized. The obturator space between the external iliac vessels and the superior vesical artery was exposed, and the obturator nerve was isolated, followed by the incision of lymph nodes of the inferior and superior obturator nerve and the removal of tissues in the paravesical space and in the pelvic floor (**Figure 1A**). The stump was manipulated to the anterior to expose the rectal-vagina-peritoneum fold, followed by the incision of the fold. The rectum was
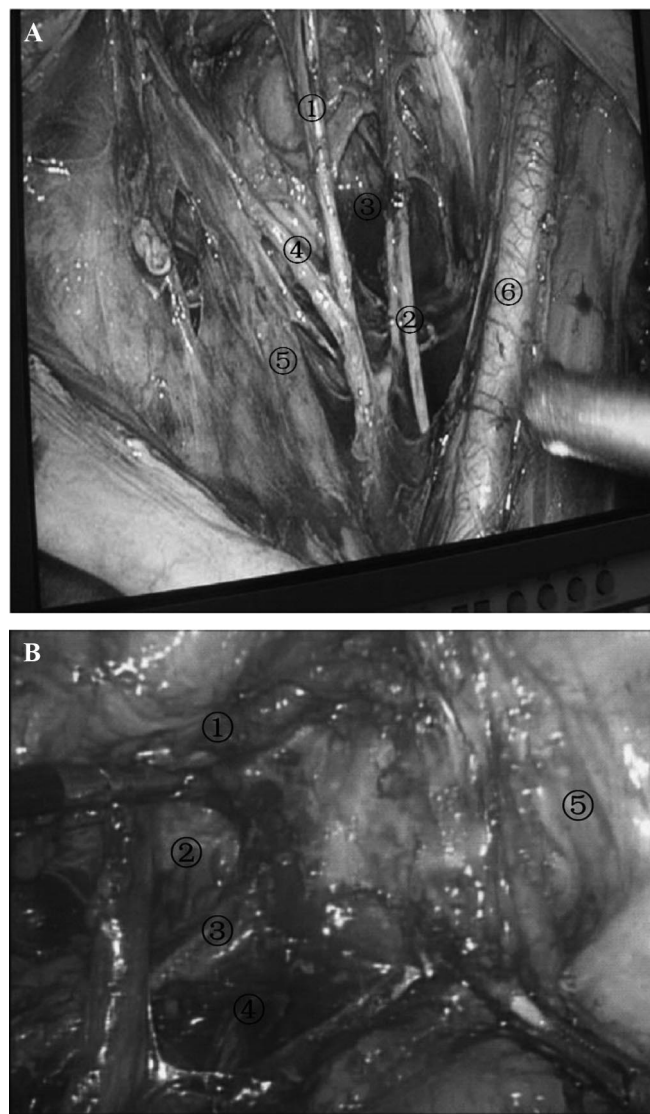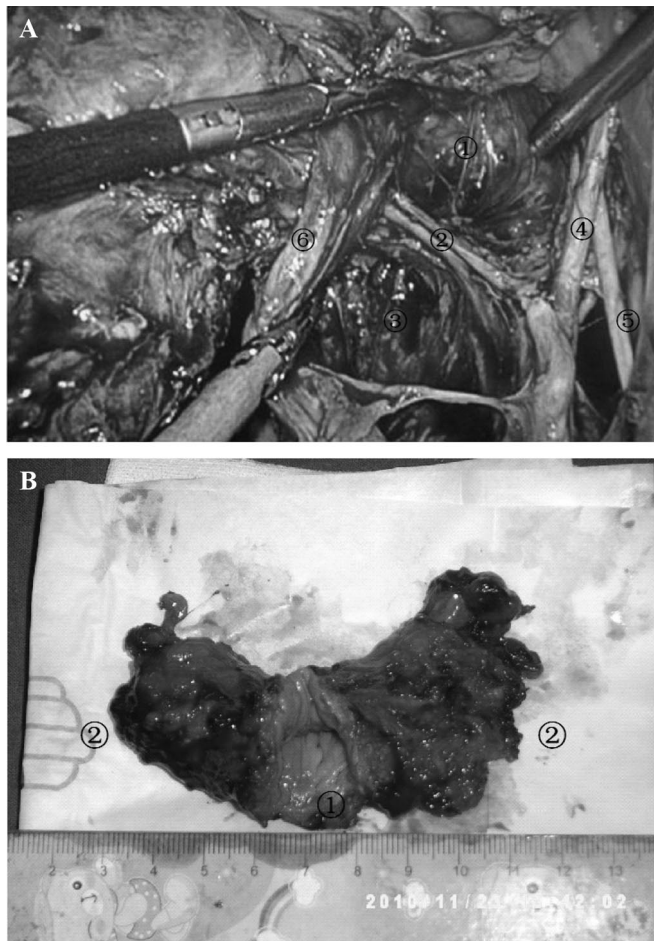

Figure 1. (A) The intraoperative situs after a pelvic and deep obturator nerve lymphadenectomy. The tissues marked are 1, right superior vesical artery; 2, right obturator nerve; 3, deep obturator fossa; 4, right uterine artery; 5, right ureter; 6, right iliaca extrema. (B) The intraoperative situs after transection of the left anterior vesicouterine ligament. The tissues marked are 1, left ureter; 2, left fossa paravesicalis; 3, left cardinal ligament; 4, left fossa pararectalis; 5, vesical-vagina fold.

separated from the vagina and pushed to the posterior, exposing the pararectal space.

The uterine artery was isolated and cut at its origin with the uterine vein. The ureter was dissected off the lateral peritoneum down to the ureter tunnel. The tunnel was developed by placing ventral traction on the uterine ves-

sels and freeing the ureter from the adventitial attachments of the vessels medial and ventral.[20] On dissection of vessels over the ureter, the anterior vesicouterine ligament was divided and incised. The posterior vesicouterine ligament was also incised. The same procedure was performed on both sides. Next, the bladder peritoneum fold was incised, and the bladder was moved forward from the anterior vaginal wall (**Figure 1B**).

Both cardinal and sacral ligaments were exposed and dissected as in a type III radical hysterectomy, exposing the paravesical and pararectal space (**Figure 2A**). The paravaginal tissues were incised, followed by the circum-

Figure 2. (A) The intraoperative situs after freeing the right cardinal ligament. The tissues marked are 1, right fossa paravesicalis; 2, right cardinal ligament; 3, right fossa pararectalis; 4, right superior vesical artery; 5 right obturator nerve; 6, right ureter. (B) The surgical specimen after a parametrectomy. The vaginal cuff was closed by continuous suture 1, and the transected parametria; 2, the length of the parametric tissue was 3.0 cm on the left and right sides.

ferential incision of the upper vaginal part with an ~3-cm margin underneath the scar of the vaginal cuff or vagina fornix. Tissue samples were taken from the vagina and measured (**Figure 2B**). The vagina cuff was then closed with a running locking suture. The peritoneum from the surface underneath the bladder was sewn to the surface of the rectum with 0 monocryl sutures. Ovarian transposition was also performed for patients with cervical cancer or vaginal apex cancer who were younger than 50 years. For type II endometrial cancer, such as clear cell cancer, omentectomy was performed.

For both ARP and LRP, the following parameters were collected and analyzed: demographics, indication for initial surgery, time elapsed from the initial surgery, indication for this surgery, tumor stage and grade, operative time, estimated amount of blood loss, surgical findings, decrease in hemoglobin transfusion requirement after surgery (in grams per liter), lymph node count, lymph node positivity, intra- and postoperative complications, if any, and duration of hospital stay. The lengths of resected parametrial (cardinal ligament) tissues and the vaginal tissues were measured by experienced pathologists. The length of the incised vaginal tissues was measured in 4 positions: at 3, 6, 9, and 12 o'clock. The duration of urinary catheter drainage and the time to the return of normal bowel movement were also recorded.

Statistical Analysis

The statistical significance of changes in continuous variables between ARP and LRP was found using the Wilcoxon rank sum test. The Fisher exact test was used when analyzing the difference in rates between the 2 groups. The Pearson correlation coefficient was used when evaluating correlations between 2 variables when both variables were continuous. P values of $<.05$ were considered statistically significant. All computations were made with R 2.14.1 (www.r-project.org).[23]

RESULTS

Patient Characteristics

All 40 patients in the ARP and LRP groups combined underwent RP with partial colpectomy and pelvic lymphadenectomy. The patients' characteristics in these 2 groups were comparable and are listed in **Table 1**. The indications for the initial surgery and for RP are also listed in **Table 1** separately for the 2 groups. Among the 40 cases, 13 (32.5%) ARPs or LRPs were performed immedi-

Table 1.
Patient Characteristics in the ARP and LRP Groups

Variable	Abdominal Surgery Group (n = 22)	Laparoscopy Group (n = 18)	P Value
Age (y), mean ± SD (range)	50.5 ± 5.8 (39–61)	48.6 ± 7.9 (34–64)	.57
Indications for initial surgery			
CIN III or microinvasive squamous cervical carcinoma	2 (9.1%)	5 (27.8%)	
Endometrial cancer Ia or endometrial atypical hyperplasia	7 (31.8%)	6 (33.3%)	.28
Leiomyomas and/or adenomyosis	13 (59.1%)	7 (38.9%)	
History of previous surgery			
Cesarean delivery	6 (27.3%)	7 (38.9%)	.51
Myomectomy	2 (9.1%)	0 (0.0%)	.49
Types of initial operation			
LAVH (+BSO/MSO)	3	9	
TAH (+BSO/MSO)	6	4	NA
Supracervical hysterectomy	13	5	
Time elapsed from initial procedure			
Frozen pathologic verification of inadequate surgery, supplement surgery done immediately	7	6	
Occult invasive cancer after simple (supracervical) hysterectomy, days (n)	2 (14–30)	5 (14–77)	NA
Invasive cancer in residual cervix or vaginal, years (n)	13 (1.5–19)	7 (9–22)	
Indications for this surgery (FIGO staging)			
Cervical cancer Ia2	1	0	
Cervical cancer Ib1	11	8	.64
Cervical cancer Ib2	3	2	
Stump vaginal cancer (invasive, adeno)	0	2	
Endometrial cancer II	7	6	

CIN = carcinoma in situ; TAH = total abdominal hysterectomy; LAVH = laparoscopy-assisted vaginal hysterectomy; MSO = monolateral salpingo-oophorectomy; BSO = bilateral salpingo-oophorectomy; NA = not applicable.

ately after hysterectomy; 7 (17.5%) were done between 2 and 11 weeks after the initial surgery when invasive cervical cancer was found unexpectedly, and 20 (50.0%) were carried out between 1.5 and 22 years after the initial surgery.

Among the 13 patients with endometrial cancer, 11 (84.6%) had at least 1 high-risk factor for recurrence (**Table 2**), including 4 (30.8%) who had poorly differentiated and clear cell carcinoma, 5 (38.5%) with deep muscular invasion, 5 (38.5%) with lymph-vascular invasion, and 2 (16.7%) with positive lymph nodes. In 27 patients with cervical cancer and vaginal cancer of the apex, 17 (63.0%) had 1 or more high risk factors (**Table 2**), including 5 (18.5%) with tumor size >4 cm in diameter, 9

(33.3%) with deep muscular invasion, 8 (29.6%) with lymph-vascular invasion, and 8 (29.6%) with lymph node positivity. For both ARP and LRP groups, all specimens had negative margins with no evidence of metastasis in the parametrium. In all, 28 of 40 patients (70.0%) had at least 1 high-risk factor for recurrence. Accordingly, 9 (22.5%), 4 (10.0%), and 15 (37.5%) patients received postoperative chemotherapy, radiotherapy, and chemoradiotherapy, respectively, and the remaining 12 (30.0%) did not receive any adjuvant therapy.

Intraoperative Parameters

The operative time for ARP ranged from 167 to 347 minutes, with an average of 239 minutes. In contrast, LRP had

Table 2.
Intra and Postoperative Characteristics in the ARP and LRP Groups

Variable	ARP Group (n = 22)	LRP Group (n = 18)	Statistical Significance
Mean operative time, min (range)	239.0 ± 45.8 (167–347)	200.1 ± 54.0 (117–327)	.009
Amount of blood loss (mL), mean ± SD (range)	929.5 ± 448.2 (250–1900)	627.8 ± 356.2 (200–1800)	.021
Number (%) of patients needed blood transfusion	13 (59.1)	5 (27.8)	.062
Difference between pre- vs postoperative Hb (g/L)	–30.1 ± 13.8	–20.2 ± 7.5	.009
Length of resected cardinal ligament			
Left (cm)	2.6 ± 0.8	2.7 ± 0.5	.49
Right (cm)	2.7 ± 0.8	2.9 ± 0.9	.45
Length of the resected vaginal cuff tissue			
12 o'clock (cm)	2.5 ± 0.7	3.3 ± 2.8	.29
3 o'clock (cm)	2.6 ± 0.7	2.6 ± 0.7	.59
6 o'clock (cm)	2.8 ± 0.6	2.9 ± 1.0	.64
9 o'clock (cm)	2.6 ± 0.7	2.9 ± 0.8	.23
Pathological factors			
Mean number of nodes (range)	23.1 ± 7.1 (10–43)	27.4 ± 5.9 (18–39)	.022
Positivity rate (%)	11/508 (2.2)	12/493 (2.4)	.84
Mean number of lymph nodes in the obturator space	3.73 ± 1.03(2–6)	8.11 ± 1.13 (5–10)	<.001
Positivity rate (%)	4 (4.8)	5 (3.4)	NA
Number (%) of positive lymph nodes below the obturator nerve	0	1 (0.7)	NA
Cervical cancer, case (%)			
Tumor size >4 cm	3 (20)	2 (16.7)	NA
Deep muscle invasion	6 (40)	3 (25)	NA
Lymph-vascular space invasion	5 (33)	3 (25)	NA
Positive nodes	5 (33)	3 (25)	NA
Endometrial cancer, case (%)			
Poor differentiation and clear cell carcinoma	3 (42.8)	1 (16.7)	NA
Deep muscle invasion	3 (42.8)	2 (33)	NA
Lymph-vascular space invasion	3 (42.8)	2 (33)	NA
Positive nodes	1(14.2)	1 (16.6)	NA
Margin	All negative	All negative	
Residual disease (%)	None	None	
Operative complication			
Intestine laceration during surgery	1 (4.5)	0 (0.0)	1.0
Postoperation complications			
Embolism in lower left limb	1	0	.20
Wound infection	1	0	
Prolonged wound healing	3	0	
Lower urological fistula	0	1	
Total (%)	5 (22.7)	1 (5.6)	

	Table 2. (continued)		
Variable	Abdominal Surgery Group (n = 22)	Laparoscopy Group (n = 18)	P Value
Late complication	0	0	ND
Duration of hospital stay (days)	19.9 ± 5.2	16.8 ± 3.8	.049
Adjuvant therapy			
Chemotherapy alone	8	1	
Radiotherapy alone	4	0	
Chemoradiotherapy	5	10	
No treatment (%)	5 (22.7)	7 (38.9)	.32
Duration of urinary catheter use (days)	Median 25.5 (10–30)	Median 35.0 (30–90)	.0003
Duration of bowel function recovery (days)	Mean 2.5 ± 0.6	Mean 1.7 ± 0.6	<.0001

a significantly shorter operative time, averaging 200.1 minutes or about 16.9% shorter (**Table 2** and **Figure 3**). The amount of blood loss in the ARP group averaged 929.5 mL, whereas in the LRP group the loss was significantly less, averaging 627.8 mL, or an average of 32.5% reduction (**Table 2** and **Figure 3**).

On further review of the data, we found that the 3 operations with the heaviest blood loss were the very first 3 LRPs performed by the senior author, suggesting that the heavier blood loss was likely a result of less experience. In fact, after the first 3 LRPs, the amount of blood loss during LRP appeared to stabilize **(Figure 4A)**. Removing these 3 cases yielded a mean blood loss of 513.3 mL—a reduction of almost half (44.8%) compared with that in ARP. Consistent with this notion, the corresponding operative times for the 3 surgeries were 327, 257, and 157 minutes, corresponding to the first, third, and fifteenth longest LRP operation, respectively (**Figure 4B**). Discarding these 3 cases resulted in a mean operative time of 190 minutes, an average reduction of 20.5% compared with ARP.

The decrease in postoperative hemoglobin levels in patients receiving LRP was significantly lower than in those who underwent ARP (**Table 2** and **Figure 3**). Consequently, 5 of 18 patients (27.8%) in the LRP group received a blood transfusion compared with 13 of 22 patients (59.1%) in the ARP group, a reduction of 52.9% (**Table 2**). The first 3 LRPs accounted for 3 of 5 (60%) blood transfusions in the LRP group. In all 40 patients, the amount of blood loss during surgery was positively correlated with the surgical time ($r = 0.36$, $P = .02$).

LRP removed significantly more pelvic lymph nodes (27.4 ± 5.9) than ARP (23.1 ± 7.1) ($P = .02$; **Table 2**). However, no statistically significant difference in lymph node positivity rate between the 2 groups was found (2.2% vs 2.4%; $P = .84$; **Table 2**). The mean number of removed lymph nodes in the obturator space was 8.1 (±1.1) and 3.7 (±1.0), respectively, in the LRP and ARP groups, a statistically significant difference ($P < .0001$). One positive lymph node in the deep obturator space was found in the LRP group, but none was found in the ARP group because lymph node removal was not attempted in that area.

In the LRP group, the mean length of the resected left and right parametrial tissues was 2.7 cm and 2.9 cm, respectively, slightly longer than, but statistically no different from, that in the ARP group (2.6 cm and 2.7 cm, respectively; $P = .49$ and $P = .45$, respectively). The vaginal lengths in all 4 positions removed in the LRP group were similar to those in the ARP group (**Table 2**), and the difference was not statistically significant. No major intraoperative complication occurred in the LRP group, but one case of injury to the small intestine occurred in the ARP group.

Postoperative Outcomes

In the ARP group, postoperative complications occurred in 5 patients, including 1 embolism in the lower left limb and 4 wound infections. All were treated without difficulty. In the LRP group, 1 patient, operated on by a senior surgeon who was performing his first LRP, was found to have a ureterovaginal fistula and subsequently underwent open surgery to plant the ureter into her bladder after a failed attempt to insert an intraureteral cannula by cystoscopy.

Although the rate of postoperative complications in the ARP group was higher than that in the LRP group (22.7%
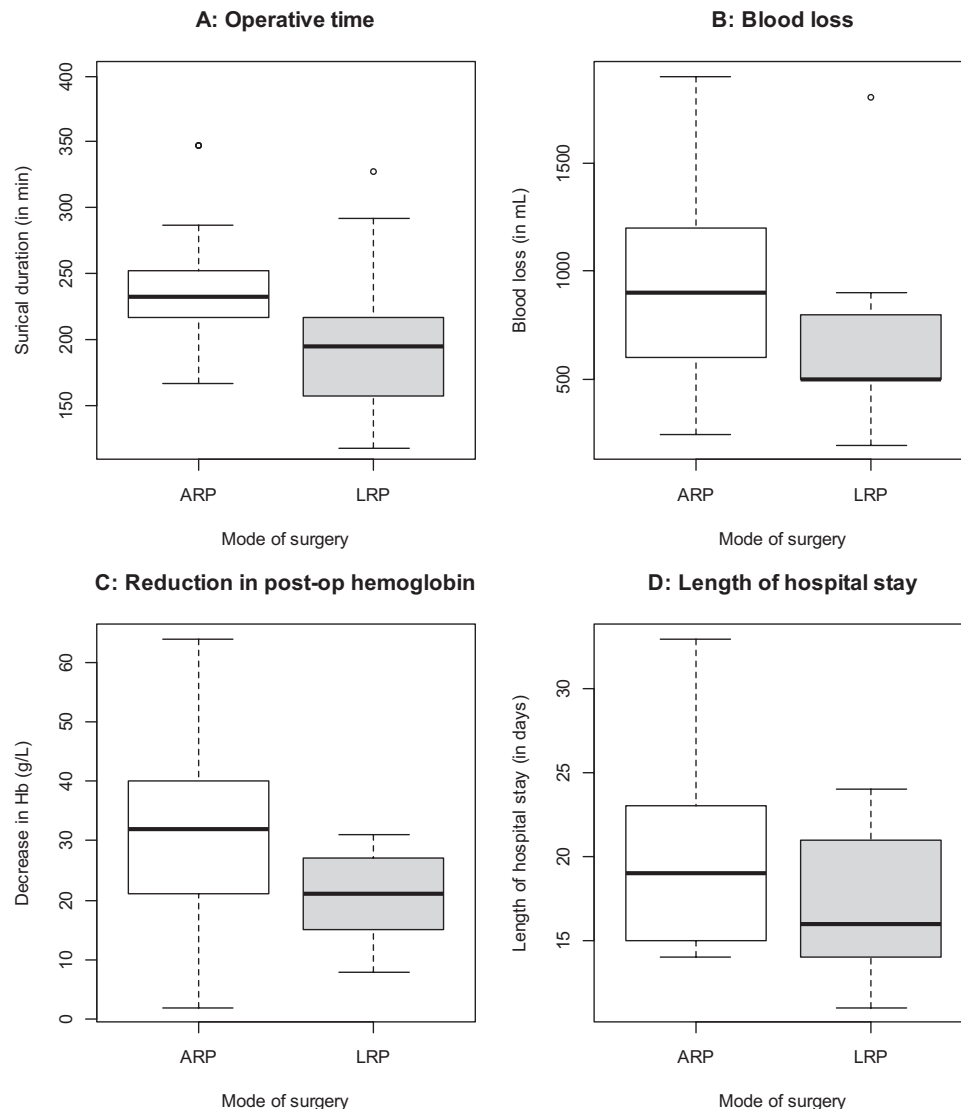
Figure 3. Box plots of operative time (A), blood loss (B), postoperation reduction in hemoglobin (C), and length of hospital stay (D) between the ARP (white box) and LRP (gray box) groups.

vs 5.6%), the difference did not reach statistical significance, likely because of the lack of statistical power **(Table 2)**. The duration of urinary catheter drainage in the LRP group was significantly longer than that in the ARP group **(Table 2)**. The elapsed time from surgery to the return of bowel movement, however, was significantly shorter in the LRP group than in the ARP group (1.7 ± 0.6 days vs 2.5 ± 0.6 days; $P < .0001$). The duration of hospital stay for the LRP group was also significantly shorter than that of the ARP group, averaging 16.8 days in the former versus 19.9 days in the latter, or a reduction of 15.6% **(Table 2** and **Figure 3)**.

No patient was found to have residual disease. Seventeen patients in the ARP group (77.3%) and 11 in the LRP group (61.1%) received adjuvant radiotherapy or chemoradiotherapy (**Table 2**). All 40 patients were followed up from 3 to 60 months, and as of this writing, no patients have died or had recurrence. The follow-up included gynecological examination, ultrasonography, and pelvic CT if necessary.

Comparison with Other Published Studies

We compared the intra- and postoperative features of this study with other published studies reporting either ARP or

A: Amount of blood loss vs. time sequence

B: Operation time vs. time sequence
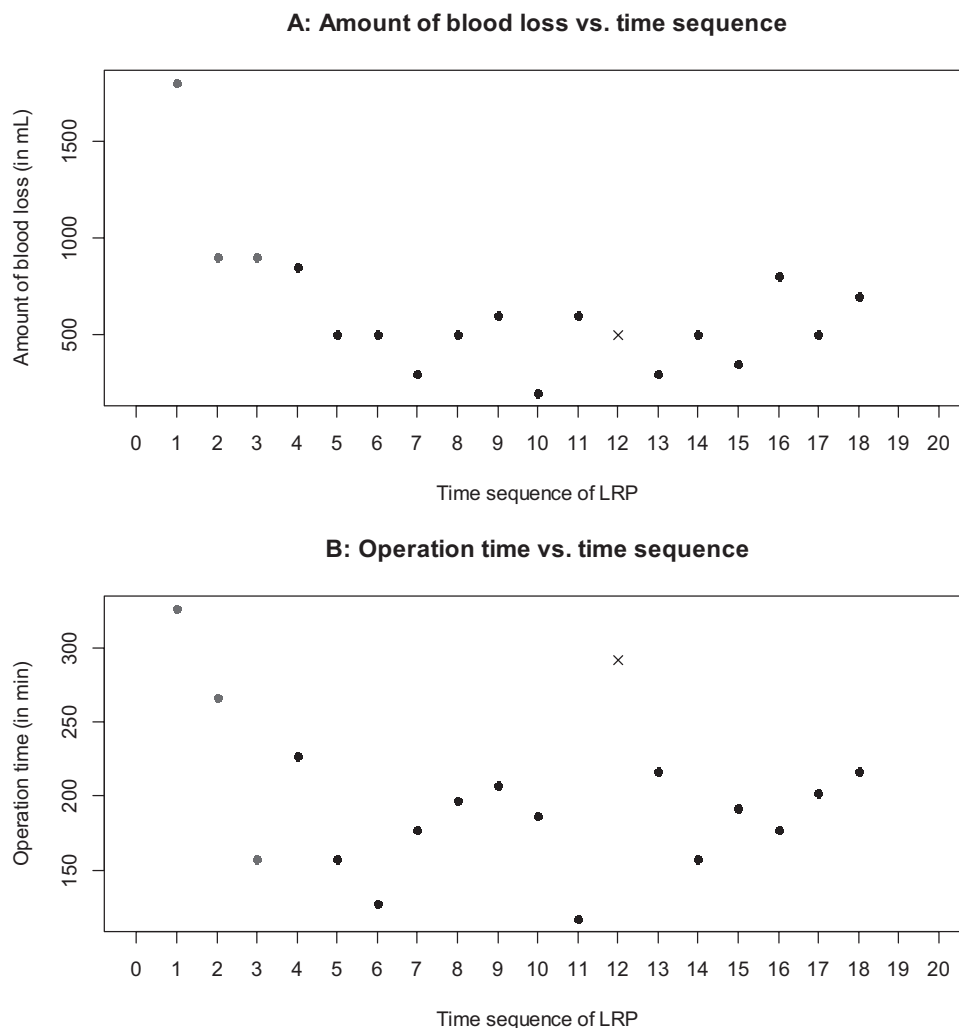
Figure 4. Time sequence of LRPs and the amount of blood loss (A) and the operative time (B). The first 3 data points are the first 3 LRPs performed by the senior author and her team. The dot marked with an "x" is the first LRP performed by another senior surgeon but with less experience.

LRP results (**Table 3**). **Table 3** shows that overall the operative time was similar between ARP and LRP ($P = .49$; **Figure 5A**), but the estimated amount of blood loss was significantly reduced (69.6%) for LRP compared with ARP ($P = .008$; **Figure 5B**). In addition, our operative time, blood transfusion rate, and intra- and postoperation complication rates for either ARP or LRP appeared to be similar to other published results; the amount of blood loss was also comparable for ARP. For our LRP case series, the estimated blood loss (**Figure 5C**), the duration of hospital stay (**Figure 5D**), and the duration of urinary catheter drainage seemed to lag because of reasons elaborated in the Discussion section. However, because only 3 of 7 studies on LRP reported measurements of surgical com-

pleteness and extensiveness, the comparison can be difficult because of different circumstances, as discussed next.

We also found that the amount of blood loss during RP has decreased substantially over the years ($r = -0.63$, $P = .028$; **Figure 5C**). In addition, the reported mean duration of hospital stay appeared to be associated with the sample size of the study ($r = 0.57$, $P = .033$; **Figure 5D**).

DISCUSSION

Traditionally performed abdominally, RP with pelvic lymphadenectomy and partial colpectomy after simple hysterectomy is a technically challenging procedure. The

Table 3.
Comparison with Other Published ARP and LRP Results Relevant to This Study

Author (Year of Publication)	Mean Age of Patients (y)	Indications for Surgery	Mode of Surgery	No. Cases Reported	Operation Time (min)	Estimated Blood Loss (mL)	% Transfusion	% Intraop Complication	% Postop Complication	Length of Hospital Stay (days)	Reported Mean Vaginal Length and Parametrium Depth (cm)
Orr et al. (1986)[1]	38.3	ICC	ARP	23	198	1750	100	33.3	69.6	9.1	NR
Chapman et al. (1992)[11]	39 (med.)	ICC	ARP	18	210 (med.)	900	NR	5.6	NR	8 (med.)	NR
Kinney et al. (1992)[8]	60 (med.)	ICC	ARP	27	185 (med.)	NR	89	7.4	29.6	13 (med.)	NR
Leath et al. (2004)[5]	40.8	OCC	ARP	23	NR	900	17	8.7	4	3.6	NR
Ayhan et al. (2006)[6]	49.9	ICC, EC, AC	ARP	27	163	880	NR	NR	18.5	17.3	NR
This study	50.5	OCC, SCC, VC, EC	ARP	22	239	929.5	59.1	4.5	22.7	19.9	VL: 2.5–2.6- 2.8- 2.6 PD(L): 2.6 PD(R): 2.7
Lee et al. (2003)[19]	48	MCC, REC	LRP	3	278.3	210	NR	66.7	NR	7.3	VL: NR PD(L): 2–2.5 PD(R): 3–2.1
Kohler et al. (2003)[2]	53.3	OCC, SEC, REC	LRP	6	424	NR	0	0	83.3	NR	VL: NP PD: 4.5
Fleisch and Hatch (2005)[20]	40.5	MCC	LRP	6	207	300	NR	33.3	16.7	3.5	NR
Liang et al. (2006)[16]	46.7	VSC, CSC	LRP	6	180	220	NR, presumably 0	0	0	11.5	NR
Liang et al. (2007)[17]	47.6	VSC, CSC	LRP	21	176	220	9.5	NR, presumably 0	9.5	10.2	NR
Vignancour et al. (2007)[24]								20	25		
Buda et al. (2009)[7]	48.7	OCC	LRP	12	300	158.3	0	0	16.7	3.7	VL: NR PD(L): 2.7 PD(R): 3.1
Park et al. (2010)[10]	49	ICC	ARP & LRP	29	297	538	59	10.3	6.9	17	NR
This study	48.6	OCC, CSC, VC, EC	LRP	18	200	627.8	27.8	0	5.6	16.8	VL: 3.3–2.6- 2.9- 2.9 PD(L):2.7 PD(R): 2.9

NR = not reported; C = cervical; V = vaginal; CC = cervical cancer; VC = vaginal cancer; EC = endometrial cancer; ICC = invasive CC; OCC = occult CC; MCC = metastatic CC; CSC = cervical stump cancer; VSC = vaginal stump cancer; REC = recurrent EC; AC = anaplastic carcinoma; VL = vaginal length; PD = parametrial depth; PD(L) = parametrial depth, left side; PD(R) = parametrial depth, right side; med. = median.

Figure 5. (A) Box plot of operative time by mode of RP. (B) Box plot of estimated blood loss by mode of RP. (C) Scatter plot of reported mean blood loss during surgery and the year of publication. The solid dots represent the results of ARPs, and the open dots represent those of LRPs. The dots marked with "x" or a cross were data reported in this study representing results from ARP and LRP, respectively. (D) Scatter plot of reported mean duration of hospital stay and the sample size of the published study. All data were taken from **Table 3**. In a few cases, medians were used instead of means because of data unavailability. One study by Park et al.[10] had mixed cases of ARP and LRP, but most were ARP. Therefore, it was treated as ARP for convenience.

absence of the uterus and the altered anatomical structure, along with considerable pelvic adhesion, and fibronetic and contracted parametrial tissues resulting from the previous surgery, pose a great challenge in visualizing tissue space and in separating bladder and rectal space, which often cause more blood loss during surgery, increased difficulty in complete removal of parametrial tissues, and more complications. This is seen from the average amount of blood loss during ARP (**Table 3** and **Figure 5**), even though it was reduced over the years (**Table 3**). In contrast, the amount of blood loss is much less during LRP

(**Figure 5**). In our case, LRP reduces blood loss by 300 mL, or 32.5%, compared with ARP. In fact, the reduction in blood loss would amount to 44.8% if inexperience with the first few cases of LRP is factored in.

Laparoscopy provides enhanced operative visual field and clarity and resolution unmatchable by abdominal surgery, and it exposes much deeper anatomical structure of the cardinal and sacral ligaments and paravesical and pararectal space. This is particularly helpful when pelvic adhesion is present. Indeed, several studies based on small

case series have demonstrated the promising potential of LRP.[2,7,16,19,20,24,25] One study, based on a moderate-sized case series,[17] suggests that LRP is superior to ARP in terms of operative time and the amount of blood loss, but unfortunately the study made the comparison using older historical data reported by different teams.

Capitalizing on our experience of >300 laparoscopy-assisted radical hysterectomies since 2009, we embarked on LRP and decided to compare it with ARP that was performed also in our hospital around the same time or just a few years earlier on similar patients by similarly experienced senior surgeons with similar educational background and comparable surgical skill levels. This choice of head-to-head comparison minimizes various heterogeneities that invariably exist among different hospitals (often in different regions or even continents), different surgeons, and different patient cohorts, making the results more accurate and credible. The comparison also yields credible quantitative information on how much gain or loss LRP would have compared with ARP.

Our data clearly demonstrate that LRP is superior to ARP in terms of significantly shorter hospital stay, decreased blood loss, fewer blood transfusions, fewer complications, and quicker recovery in bowel movement without any sacrifice in completeness and extensiveness of the procedure, as evidenced by the significantly higher number of removed lymph nodes in the pelvic and obturator space and the measures of removed tissues. More remarkably, these gains in quality of care are achieved with significantly less operative time.

The length of the parametrial tissues removed in the LRP group was comparable with, if not better than, that in the ARP group, and so were the average removed vaginal tissue lengths, indicating that LRP is more likely to meet the requirements for type III radical hysterectomy than ARP. In fact, LRP removed 18.6% more lymph nodes than ARP. In the obturator space, the number of lymph nodes removed by LRP was more than twofold that removed by ARP, mainly because the inferior lymph nodes of the obturator nerve were dissected thoroughly by LRP, whereas they were not by ARP. These data taken together demonstrate that LRP can be successfully and safely performed for cervical stump carcinoma, incidental finding of cervical cancer and stage II endometrial cancer, and vaginal cancer of the apex after hysterectomy.

After ARP or LRP, nearly half (19/40) of our case series still received radiotherapy or combined chemoradiotherapy. This may seem to be at odds with the original intention of RP. However, we note that without RP, the irradiation dos-

ages typically range from 7000 to 8000 cGy,[26] whereas for patients who received RP but happened to have high-risk factors, the dosage is much lower, typically in the range of 4000 to 4500 cGy.[3] In addition, a bilateral ovarian suspension procedure can be performed during either ARP or LRP, which would further minimize the negative impact of adjuvant radiotherapy on ovarian function. Therefore, the much reduced irradiation dosage, without intracavitary radiation and coupled with added protection afforded by bilateral ovarian suspension, effectively reduced or mitigated the risk of damage to ovarian function caused by radiotherapy. This may explain why we had a much lower complication rate, even after radiotherapy (**Table 2**).

We found that the duration of urinary catheter drainage in the LRP group is significantly longer than that in the ARP group. This is likely because of the more extensive parametrectomy than ARP. Even though the difference did not reach statistical difference, possibly because of the limited sample size, it can be seen from **Table 2** that LRP seemed to resect more parametrial tissues than ARP. Several studies on the morbidity after radical hysterectomy have demonstrated that the duration of postoperative bladder dysfunction is associated with the extent of section of the cardinal ligament.[27–30] The pathophysiology of lower urinary tract dysfunction has not yet been clearly elucidated, but it could result from iatrogenic denervation at the time of parametrial dissection, direct surgical trauma, subsequent perivesical fibrosis, loss of support from the vaginal wall, interruption of afferent sensory, parasympathetic and sympathetic autonomic motor nerves, and impaired detrusor reflex.[31]

The longer hospital stay as reported in both of our ARP and LRP series, compared with those published (**Table 3**), may be attributable to several reasons. They include (1) the higher percentage (70%) of postoperative adjuvant therapy; (2) the longer duration of urinary catheter drainage; and (3) the current health insurance policies (provided by the same government-sponsored plan) that provide substantially more coverage for in-patient medication than out-patient, which practically provides a powerful inducement for longer hospital stay.

The amount of blood loss in both LRP and ARP groups in this study is higher than in many published studies (**Table 3**). Although the surgeon's inexperience in performing the first 3 LRPs resulted in an average blood loss of 1200 mL (vs 513.3 mL for the remaining 15 LRPs), the more extensive radical parametrectomy, as evidenced by the extent of resected parametrial and vaginal tissues, may also be responsible. The other important factor that definitely contributes to increased blood loss is that 38.9% of

patients in the LRP group and 36.4% in the ARP group had a history of cesarean delivery or myomectomy (**Table 1**). This high rate of previous history of gynecological surgery reflects an alarmingly high cesarean delivery rate (50–70%) in many regions in China.[32,33] This certainly complicates RP and likely contributes to increased blood loss.

In summary, using surgical data collected in the same hospital and based on RP performed on comparable patients by similarly experienced surgeons with comparable skill levels, we have shown that LRP is superior to ARP in terms of shorter surgical time, decreased blood loss, fewer blood transfusions, shorter hospital stay, and quicker recovery of bowel movement, without any compromise in completeness and extensiveness of the procedure. We conclude that LRP with pelvic lymphadenectomy for cervical stump carcinoma, incidental finding of cervical cancer and stage II endometrial cancer, and vaginal cancer of the apex after hysterectomy can be successfully and safely performed in the hands of experienced gynecological surgeons.

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