SCIENTIFIC PAPER JSLS

Retroperitoneal Approach in Single-Port Laparoscopic Hysterectomy

Tae-Hyun Kim, MD, Chul Jung Kim, MD, Tae-Joong Kim, MD, Yoo-Young Lee, MD, PhD, Chel Hun Choi, MD, PhD, Jeong-Won Lee, MD, PhD, Duk-Soo Bae, MD, PhD, Byoung-Gie Kim, MD, PhD

ABSTRACT

Background and Objectives: In single-port laparoscopic hysterectomy(SP-LH), ligation of the uterine artery is a fundamental step. We analyzed the effectiveness and safety of 2 different surgical approaches to ligate the uterine artery in SP-LH for women with uterine myomas or adenomyosis.

Methods: A single surgeon (TJ Kim) performed 36 retroperitoneal single-port laparoscopic hysterectomies (SP-rH) from September 1st 2012 to April 30th 2013. We compared these cases with 36 cases of conventional single-port laparoscopic abdominal hysterectomy (SP-aH) performed by the same surgeon from November 1st 2011 to July 31th 2012 (historic control). In the SP-rH cases, the retroperitoneal space was developed to identify the uterine artery; then, it was ligated where it originates from the internal iliac artery.

Results: Estimated blood loss (EBL) was decreased in the SP-rH group compared with the SP-aH group (100 mL vs 200 mL; $P = .023$). The median total operative time was shorter in the SP-rH group (75 minutes vs 93 minutes; $P < .05$). The operative time of the Scope I phase, including ligation of the utero-ovarian (or infundibulopelvic) ligament, round ligament, uterine artery, and detachment of the bladder, was longer in the SP-rH group compared with that in the SP-aH group (26.0 minutes vs 24 minutes; $P = .043$). However, the operative time of the Scope II phase, including detachment of the uterosacral-cardinal ligament, vaginal cutting, and uterus removal, was shorter in the SP-rH group (19.5 minutes vs 30 minutes; $P < .05$). Operative complications were not significantly different between the groups ($P = .374$).

Conclusion: Although SP-rH may be considered technically difficult, it can be performed safely and efficiently with surgical outcomes comparable to those of SP-aH.

Key Words: Hysterectomy, Laparoscopy, Myoma, Retroperitoneal space, Single-port.

INTRODUCTION

Laparoscopic hysterectomy (LH) is one of the most commonly performed gynecologic surgeries. The use of single-port laparoscopic surgery has expanded in the management of gynecologic neoplasms. According to the results of recent studies on single-port laparoscopic hysterectomy (SP-H), this technique is a safe and efficient alternative to traditional laparoscopic surgery, with excellent cosmetic outcomes.[1–5] Therefore, SP-H is growing in popularity with both patients and surgeons.

LH can be divided into 2 subcategories, depending on the method used for ligation of the uterine artery: laparoscopically assisted vaginal hysterectomy (LAVH), where ligation of the uterine vessels is performed through a vaginal approach, and total laparoscopic hysterectomy (TLH), where ligation of the uterine vessels is performed laparoscopically.

Generally in TLH, uterine vessels are coagulated or dissected close to the uterus, alongside the cervix, according to the steps of a conventional total abdominal hysterectomy. A uterus enlarged by myomas or adenomyosis has an extensive, tortuous vascular supply. Therefore, vascular branches may not be completely coagulated, which may result in increased risk of intraoperative bleeding and conversion to laparotomy.[6] Several studies of TLH have demonstrated that ligation of the uterine artery where it originates from the internal iliac artery is effective for reducing blood loss.[7–11]

Moreover, a single-port approach has additional limitations on ligation of uterine arteries near the cervix. In the umbilical approach, the clamping angle for the uterine

Department of Obstetrics and Gynecology, Konyang University Hospital, Daejon, Korea (Drs T-H Kim, CJ Kim).

Department of Obstetrics and Gynecology, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea (Drs T-J Kim, Y-Y Lee, CH Choi, J-W Lee, and D-S Bae, and B-G Kim).

Address correspondence to: Tae-Joong Kim, MD, Department of Obstetrics and Gynecology, Samsung Medical Center, Sungkyunkwan University School of Medicine, 81 Irwon-ro, Gangnam-gu, Seoul 135-710, Korea. Telephone: 82-2-3410-3547; Fax: 82-2-3410-0630. E-mail: tj28.kim@gmail.com

DOI: 10.4293/JSLS.2016.00001

vessels is not perpendicular, and the vessels are stretched by uterine mobilization. These diagonal and stretched uterine vessels are susceptible to bleeding after vessel sealing. Therefore, we attempted a retroperitoneal approach for ligation of the uterine artery in SP-TLH. In single-port retroperitoneal hysterectomy (SP-rH), the retroperitoneal spaces are developed to identify the ureter and internal iliac artery, followed by ligation of the uterine artery where it originates from the internal iliac artery. SP-rH can result in less intraoperative bleeding and a decreased risk of ureteral damage.[12,13] We subdivided SP-TLH cases depending on the approach to ligation of the uterine artery: alongside the cervix (aH) or a retroperitoneal approach (rH). The purpose of this study was to evaluate the efficacy of SP-rH through comparison of surgical outcomes to those of SP-aH.

MATERIALS AND METHODS

Starting in September 1st 2012, one surgeon (TJ Kim of Samsung Medical Center) has routinely performed ligation of the uterine artery by retroperitoneal space development in SP-TLH. Thirty-six SP-rH cases were performed consecutively from September 1st 2012 to April 30th 2013, and operative times for each stage of the procedures were recorded. Data were collected through retrospective chart review. Thirty-six SP-aH cases that were performed by the same surgeon before the introduction of SP-rH (from November 1st 2011 to July 31st 2012) served as a historical control group. We obtained informed consent from the patients, and the institutional review board (IRB) approved the study.

Demographic information, uterine size, operative indication, final pathology, and additional procedures were recorded. The uterine diameter was measured before surgery by transvaginal ultrasonography. For both types of surgery, the operative time was measured for each step. We also recorded estimated blood loss (EBL), uterine weight, change in hemoglobin level, transfusion rate, failed operations, postoperative pain, length of postoperative hospital stay, and intraoperative and postoperative complications.

Total operating time was defined as the time from the beginning of the skin incision to the completion of skin closure. The operative procedure was divided into 6 steps. Step 1 was the opening of the umbilicus. Step 2 (defined as Scope I) included ligation of the utero-ovarian ligament [or infundibulopelvic (IP) ligament], round ligament, and uterine artery (alongside the cervix or retroperitoneal access), as well as detachment of the bladder. Step 3 (defined as Scope II) included detachment of the uterosacral-cardinal ligaments, vaginal cutting, and uterus removal. Step 4 was closure of the vaginal cuff. Step 5 was hemostasis, and Step 6 was closure of the umbilical opening. Blood loss was estimated by subtracting the irrigation fluid volume from the total amount of fluid in the suction apparatus. The change in hemoglobin level was evaluated by comparing the hemoglobin level on postoperative day 1 to that before the surgery.

Postoperative pain management for laparoscopic hysterectomy at Samsung Medical Center was consistent throughout the entire study period. The degree of postoperative pain was assessed and recorded by a nurse using a visual analog scale (VAS) at 1, 6, 12, and 24 h after surgery. The VAS consisted of a nongraduated 10-cm line ranging from "no pain" to "worst possible pain." Oral NSAIDs (zaltoprofen, 80 mg 3 times daily) were routinely administered after surgery with patient-controlled analgesia (PCA). When patients needed additional pain control, the pain scale was assessed and recorded, followed by administration of parenteral NSAIDs (ketoprofen 1 ampule; 100 mg, intramuscular injection). Pethidine was administered if the pain was intolerable after injection of parenteral NSAIDs.

Continuous variables were compared by using the Mann-Whitney U test or Student's t test. Fisher's exact test and the χ^2 test were used for categorical variables. All probabilities refer to 2-tailed tests, and effects were considered statistically significant at $P < .05$. Statistical analyses were performed with SPSS software, version 18.0 (SPSS, Chicago, IL, USA).

The SP-rH Procedure

The details of the surgical technique for SP-aH are described elsewhere.[14] In SP-rH, the first surgical step was to develop the retroperitoneal space and ligate the uterine artery where it originates from the internal iliac artery. With an articulating instrument (Roticulator; Covidien, Norwalk, CT, USA), the IP ligament was pulled medially, maintaining proper tension at the peritoneum. The peritoneum was incised parallel to the IP ligament, and advanced energy devices, including LigaSure (Covidien/ValleyLab, Boulder, CO, USA) or EnSeal (Ethicon Endo-Surgery, Blue Ash, OH, USA), were used to develop the retroperitoneal space. After identifying the ureter at the level of the pelvic brim where it crosses the common or external iliac artery, further dissection lateral to the ureter was needed to identify the internal iliac artery. Development of the paravesical and pararectal spaces enabled the

surgeon to skeletonize the uterine artery where it originated from the internal iliac artery. Finally, the uterine artery was coagulated or transected at its origin.

After ligation of the uterine arteries through the retroperitoneal approach, the remaining procedure was the same as that of conventional SP-TLH. To expose the lateral side of the uterus with more powerful traction, we used a 5-mm endoscopic myoma screw and a vaginal manipulator (**Figure 1**). The fallopian tubes, ovarian ligament, and round ligament were transected. The anterior and posterior leaves of the broad ligament were separated. Next, the vesicouterine peritoneal fold was identified, and the bladder was mobilized by blunt dissection with advanced energy devices until the anterior vagina was identified. After the uterine vessels were sealed and transected, the cardinal and uterosacral ligaments were transected. A Colpo-Pneumo Occluder (CooperSurgical, Inc., Trumbull, CT, USA) balloon was insufflated with 50 mL of air to preserve an adequate pneumoperitoneum before the colpotomy. The cervix was circumscribed along the colpot-

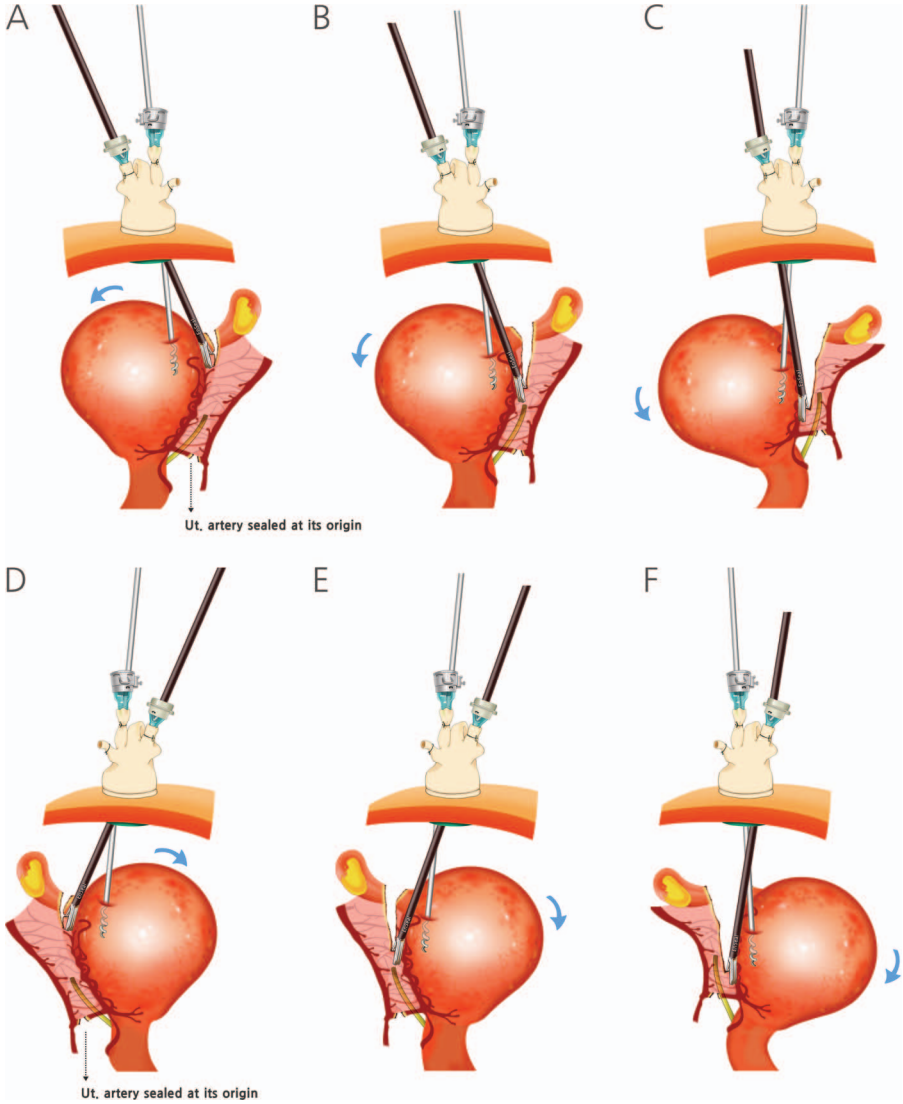

Figure 1. Ligation of uterine vascular pedicles using a myoma screw and Enseal. After ligation of the uterine artery at its origin through the retroperitoneal approach, we used a 5-mm endoscopic myoma screw to get more powerful traction. (A) The fallopian tubes, ovarian ligament, and round ligaments were transected with Enseal. (B) The broad ligament was separated. (C) Uterine vessels were transected and coagulated. (D–F) The same procedures were performed contralaterally, without changing the surgical instrument.

omy cup and, once disconnected, the uterus was delivered vaginally. Vaginal morcellation was performed with a knife to facilitate delivery when the uterus was large. The vaginal cuff was sutured vaginally or laparoscopically with a running suture. After hemostasis was achieved, the single-port system was removed. The transumbilical fascia was approximated with a 2-0 Polysorb suture (Covidien 'PLC, Dublin, Ireland), and the subcutaneous tissue was closed with a 4-0 Monosyn interrupted suture (B. Braun Melsungen, Pfieffewiesen, Germany). Finally, the skin was closed with a skin adhesive (Dermabond; Ethicon).

RESULTS

We compared perioperative outcomes of the SP-aH and SP-rH groups, each of which included 36 cases. The baseline characteristics of the study population were summarized in **Table 1**. There was no statistically significant difference in age, parity, or body mass index between the 2 groups. Preoperative characteristics, such as the history of vaginal delivery, abdominal surgery, and uterine size measured by ultrasonography, were comparable between the groups. The most common symptoms before surgery in both groups were menorrhagia and dysmenorrhoea. Additional procedures performed were different between the 2 groups, with the proportion of prophylactic salpingectomy being higher in the SP-rH group (80.6% vs 55.6%) than in the SP-aH group.

The surgical outcomes are compared in **Table 2**. No patients required an additional port or conversion to laparotomy in the SP-aH group. In the SP-rH group, 3 cases involved failure to develop the retroperitoneal space. The key to failure was the location of the myoma. Large myomas located at the lateral wall of the uterus pushed the medial leaf of the broad ligament laterally. The broad

Table 1.
Patient Characteristics

Characteristic	SP-aH (n = 36)	SP-rH (n = 36)	*P*[a]
Age (years)	46.5 (34–58)	46.0 (36–56)	0.46
Parity	2.0 (0–3)	2.0 (0–3)	0.69
History of vaginal delivery	22 (61.1)	21 (58.3)	0.81
History of abdominal surgery	16 (44.4)	10 (27.8)	0.22
Body mass index (kg/m^2)	22.7 (18–27)	21.8 (17–33)	0.35
Uterine long axis (cm)[a]	8.7 (5–13)	9.4 (6–15)	0.15
Uterine short axis (cm)[a]	5.9 (4–10)	6.0 (3–11)	0.38
Main symptoms for surgery			0.70
Menorrhagia	18 (50.0)	17 (47.2)	
Dysmenorrhea	11 (30.6)	15 (41.7)	
Pelvic pressure/discomfort	4 (11.1)	1 (2.8)	
Others	3 (8.4)	3 (8.4)	
Main pathology			0.33
Leiomyoma	36 (75)	23 (63.9)	
Adenomyosis	12 (25.0)	13 (36.1)	
Additional procedures			0.04
None	12 (33.3)	2 (5.6)	
Adnexal surgery	2 (5.6)	5 (13.9)	
Prophylactic salpingectomy	20 (55.6)	29 (80.6)	
Posterior colporrhaphy	1 (2.8)	0	
Transobturator tape operation	1 (2.8)	0	

Data are expressed as number (% of total group), unless otherwise specified.

[a]Mann-Whitney U test or Fisher's exact test.

Table 2.
Operative Outcomes

Outcome	SP-aH (n = 36)	SP-rH (n = 36)	*P*[a]
Operative time (min)	93 (53–160)	75(35–153)	0.001
Uterine weight (g)	308 (59–1054)	328 (102–1200)	0.74
EBL (mL)	200 (30–700)	100 (50–800)	0.023
Change in hemoglobin (g/dL)	2.3 (−0.1–+4.9)	1.7 (−0.5–+4.5)	0.088
Transfusion, n (%)	3 (8.3)	1 (2.8)	0.614
Fail			0.239
Conversion to laparotomy	0	0	
Cessation of retroperitoneal space development (SP-rH cases), n (%)		3 (8.3)	
Additional port or conversion to LAVH, n (%)	0	1 (2.7)	0.23
Postoperative pain score (range)			
1 h	3.5 (2–8)	4 (2–8)	0.36
6 h	3 (0–6)	3 (1–6)	0.46
12 h	3 (1–6)	2.5 (1–7)	0.39
24 h	2 (0–6)	2 (1–8)	0.49
Time to VAS score 3 (hr)	2 (0–6)	6 (1–28)	0.44
Postoperative hospital stay, days (range)	3 (2–4)	3 (2–13)	0.70
Operative complications			0.49
Bladder injury, n (%)	0	2 (5.6)	
Ureter injury, n	0	0	

[a]Mann-Whitney U test or Fisher's exact test.

ligament was therefore obstructed by the myoma, and we could not make a sufficient retroperitoneal space and failed to identify the anatomic structures such as the internal iliac artery and the ureter. One case (3.8%) in the SP-rH group needed an additional 5-mm port and was converted to a multiport-assisted laparoscopic vaginal hysterectomy because of severe pelvic adhesion resulting from pelvic endometriosis. The uterine weight, change in hemoglobin level, transfusion rate, and postoperative hospital stay were similar between the 2 groups. EBL was decreased in the SP-rH group compared with the SP-aH group (100 mL vs 200 mL; $P = .023$). Furthermore, the median total operative time was shorter in the SP-rH group (75 minutes vs 93 minutes; $P < .05$). The postoperative VAS pain scores at 1, 6, 12, and 24 h were not different between the 2 groups.

With regard to perioperative complications, there were 2 patients (5.2%) with intraoperative bladder injury in the SP-rH group. One case was identified during surgery and recovered after primary repair. The other patient developed a vesicovaginal fistula 3 weeks after the surgery, despite the primary repair for bladder rupture she had undergone 6 days after the operation. She was treated with open fistulectomy by a urologic surgeon. In the SP-aH group, there were no operative complications. Overall, operative complications were not significantly different between the groups ($P = .49$).

The operative times of each of the 6 steps are described in **Table 3**. The operative time for Scope I was longer (26 minutes vs 24 minutes; $P < .05$) in the SP-rH group than in the SP-aH group. However, the operative time for Scope II was shorter in the SP-rH group (19.5 minutes vs 30 minutes; $P < .05$). Moreover, the SP-rH group had a significantly shorter operative time for umbilical opening, hemostasis, and umbilical closure.

DISCUSSION

In the present study, we compared surgical outcomes of SP-rH cases with those of SP-aH cases performed by the same surgeon. SP-rH was associated with less blood loss and shorter operative time, and there was no significant

Table 3.
Stepwise Operative Times

Time	SP-aH (n = 36)	SP-rH (n = 32)[d]	*P*[c]
Open time (min)			
Median (range)	4.5 (2–10)	3.0 (1–9)	0.000
Scope I[a]			
Median (range)	24.0 (10–35)	27.5 (15–51)	0.043
Scope II[b]			
Median (range)	30 (12–80)	19.0 (8–53)	0.001
Cuff closure			
Median (range)	14.0 (3–20)	7.0 (2–49)	0.33
Hemostasis			
Median (range)	10.0 (3–30)	5.0 (1–13)	0.00
Closure time			
Median (range)	11.39 (5–20)	8.56 (3–15)	0.008

[a]Scope I includes ligation of the utero-ovarian ligament (or IFP ligament), round ligament, and uterine artery, as well as detachment of the bladder.

[b]Scope II includes detachment of the uterosacral-cardinal ligament, vaginal cutting, and uterus removal.

[c]Mann-Whitney U test or Fisher's exact test.

[d]Four patients in the SP-rH group were excluded because they did not have complete data for all steps.

increase in complications compared to SP-aH. We observed an unexpectedly shorter operative time for SP-rH, in which developing the retroperitoneal space is generally considered to consume more time. To our knowledge, this is the first report to compare the surgical outcome by the 2 different methods of uterine artery sealing in SP-TLH for surgical treatment of patients with symptomatic uterine myomas or adenomyosis.

In LH, the main step is to ligate the uterine vascular pedicles.[7] In SP-aH, the angle from the umbilical approach is diagonal across the uterine arteries, which results in increased risk of incomplete vascular sealing and intraoperative bleeding. Furthermore, in cases with an enlarged uterus with well-developed vascular supply, the coagulation performed extensively to control bleeding may result in ureteral injury. However, in SP-rH, the retroperitoneal approach provides the right angle for ligation of the uterine artery to support the complete sealing and decreases the risk of ureteral injury, because the surgeon can identify the position of the ureter. In previous studies, ligation of the uterine artery at its origin before hysterectomy has been reported to have advantages, such as decreased risk of intraoperative bleeding and ureteral injury.[7–10]

Ureteral injury is one of the most problematic complications in simple hysterectomies. Many studies assessing the incidence of ureteral injuries in gynecologic procedures have reported ureteral injury rates ranging from 0.1 to 2.5%.[15,16] When performing SP-H on a large uterus, insufficient traction of the uterus can result in ureteral injury during lateral transection of uterine vessels, even though there are no risk factors, including endometriosis, intraligamentary myoma, or infection sequelae. Ureteral injuries that are not diagnosed during the operation may result in delayed diagnosis, additional hospital stays with additional interventions or operations, and medicolegal litigation. The retroperitoneal approach is a good option for the prevention of ureteral damage because the surgeon completely visualizes the ureter during the operation.[8] Although the visualization itself does not equate to decreased damage to the ureter, it is imperative to identify and drop the ureter posteriorly off the medial leaf of the broad ligament to protect it.

The clinical advantages of SP-rH can be summarized as less intraoperative bleeding, reduced time for hemostasis, and less risk of ureteral injury. Development of the retroperitoneal space and dissection of the uterine artery and the ureter in single-port laparoscopic surgery may be a technical challenge for some surgeons. However, based on our experience with SP-rH since September 2012, SP-rH can be performed safely and efficiently. The time for retroperitoneal uterine artery ligation was 5 minutes per side on average and the risk of intraoperative complications was not increased.

Unexpectedly, we observed a significantly shorter operative time for SP-rH cases compared with SP-aH cases. Given that the study design was retrospective, there are several potential sources of bias. The patients in the 2 groups underwent the operation during different periods; therefore, the surgeon and the first assistant residents were maturing in their experience with the technique. Although retroperitoneal uterine artery ligation requires a longer amount of time (Scope I phase time was longer in SP-rH), the increase in the surgeon's experience in the later period of the study likely contributed to the reduced total operating time in SP-rH compared with SP-aH. Stepwise analysis of the operative time revealed shorter time for umbilical opening and closure, which might be explained by the increased proficiency of surgical assistants. The durations of Scope II and hemostasis were significantly shorter in the SP-rH cases. This indicates that ligation of the uterine artery at its origin resulted in less intraoperative bleeding, a clearer operative field, and a shorter time to achieve bleeding control.

In conclusion, we found that SP-rH was associated with a shorter operative time and less blood loss than conventional SP-aH. Moreover, this technique should be considered in patients in whom minimal blood loss is important. A prospective trial comparing operative times of each procedure would be optimal to clarify the advantages of SP-rH compared with SP-aH.

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