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Original Research

Non-Electrical Ligation of Vessels Using Hem-o-lok Clips Ensures No Electrical Ureteral Injury during Total Laparoscopic Hysterectomy

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Abstract

Background: Ureteral injury is one of the most common anatomical complications during total laparoscopic hysterectomy (TLH). And most ureteral injuries resulted from electrosurgery and were recognized postoperatively. To avoid thermal damage to the ureter during TLH, we evaluated the feasibility and safety of vessel ligation using the Hem-o-lok clip. **Methods**: A retrospective analysis of 480 patients who underwent TLH. Hem-o-lok clips were used to ligate both uterine vessels. If the patient underwent unilateral or bilateral salpingo-oophorectomy, the gonadal vessels were also ligated by using Hem-o-lok clips. Clinical outcomes including perioperative and postoperative complications were evaluated. **Results**: Perioperative complications were reported in six patients, with four cases of stump dehiscence and two cases of bladder injury. All bladder injuries were found during the operation and repaired. None of the patients experienced ureter injury or vessel rebleeding. **Conclusions**: Vessel ligation by Hem-o-lok clips in TLH is a safe method for ligating vessels and avoiding unexpected ureteral injury. Prospective studies are needed to confirm the real clinical benefit of this surgical approach.

Keywords: total laparoscopic hysterectomy; TLH; Hem-o-lok clip; ureteral injury

1. Introduction

Hysterectomy is one of the most common surgeries performed worldwide. More than 600,000 patients underwent a hysterectomy in the United States, even though the number of hysterectomies has declined over the years [1]. Laparoscopic hysterectomy is accepted as an alternative method to abdominal hysterectomy [2] and is available in two approaches: laparoscopic-assisted vaginal hysterectomy (LAVH) and total laparoscopic hysterectomy (TLH). Moreover, laparoscopic coagulation of the uterine vessels is associated with reduced bleeding compared to the transvaginal route [3]. During TLH, various methods and techniques are used to ligate the uterine vessels. The most popular ligation method is bipolar coagulation, although alternative methods include staples, vascular clips, ultrasonic energy, and manual suturing [4–8].

Complications of hysterectomy include infectious, anatomical, and pathological complications. Ureteral injury is one of the most common anatomical complications [9]. The laparoscopic route showed the highest rate of ureteral injury. A common site of injury is the pelvic side wall, which is injured when dissecting along the infundibulo-pelvic (IP) ligament and the lower uterine segment during ligation of the uterine vessels [10]. The rate of ureteral injury varies from 0.16% to 0.78% in previous reports [11–14]. Wong *et al.* [15] reported that most ureteral injuries resulted from electrosurgery and were recognized postoperatively. They are usually repaired by open ureteral anastomosis [15]. Across the United States, ureteral injuries are one of the most common reasons for minimally invasive gynecologic surgeries (MIGS)-related litigations [16]. Thus, avoiding thermal damage to the ureter during TLH is paramount.

Hem-o-lok clips are locking polymer clip for vessel ligation. Using 5 mm trocars, Hem-o-lok clips allow surgeons to ligate 3 to 10 mm vessels. Unlike other energy-based device, Hem-o-lok clips are cold ligation system. Thus, there's no chance of thermal damage. We designed this study to introduce our experience using Hem-o-lok clips instead of the bipolar coagulator for vessel control.

2. Materials and Methods

We retrospectively reviewed the medical records of patients who underwent TLH at our institution between December 2015 and December 2019. Patients with benign diseases were included. To control for variations in technique, expertise, and outcomes among surgeons, only a single surgeon's experiences were included. We excluded patients who underwent single port surgery. Precancerous lesions, such as carcinoma in situ of the cervix (CIS) and endometrial intraepithelial neoplasia (EIN), were also excluded.

Hem-o-lok clips (#544990; WECK EFx; Teleflex, Re-

search Triangle Park, NC, USA) were used to ligate both uterine vessels. If the patient underwent unilateral or bilateral salpingo-oophorectomy, the gonadal vessels were also ligated by using Hem-o-lok clips.

We recorded and analyzed changes in hemoglobin level, operating time, postoperative hospital stay days, perioperative and postoperative complications, along with any additional operations undergone by each patient.

Under general anesthesia, three-puncture laparoscopy was performed. The first 11-mm port was placed through the umbilicus, and two 5-mm ports were placed in the right and left lower quadrant sites. After informed consent, the ovaries and salpinx were removed in post-menopausal women. If the patient desired ovarian preservation and there were no pathologic findings, the ovarian ligaments were resected to preserve the ovary. The anterior and posterior leaves of the broad ligament were dissected to identify the uterine vessels. After uterine vessels were identified, the right-angled clamp was passed beneath the vessels from the anterior to the posterior side. Uterine vessels were completely separated from the surrounding tissues. Then, the vessels were thoroughly skeletonized for ligation by Hem-o-lok clips. One or two Hem-o-lok clips were placed on the vaginal stump side for adequate occlusion, and one clip was placed on the uterine side. Then, the uterine vessels were transected using scissors without connection of monopolar diathermy (Fig. 1A–D). In patients who underwent unilateral or bilateral salpingo-oophorectomy, we dissected the peritoneum surrounding the IP ligament using scissors without connection of monopolar diathermy. Then, the ovarian vessels were thoroughly skeletonized, and ligation using Hem-o-lok clips was performed. One or two Hem-o-lok clips were placed on the proximal side for adequate occlusion, and one clip was placed on the distal (ovarian) side (Fig. 2A–D). The vagina was cut using scissors with the connection of monopolar diathermy and the uterus was retrieved through the vagina. The vaginal stump was sutured using a laparoscopic approach. A drain was inserted in the left lower quadrant through the 5-mm port insertion site.

The results are expressed as mean $\pm$ standard deviation and statistical analysis was carried out using SPSS statistical software (version 21.0; SPSS Inc., Chicago, IL, USA). The statistical significance was set at $p < 0.05$.

3. Results

A total of 715 patients underwent TLH. A total of 131 patients who underwent single port TLH were excluded, as well as 72 patients who had precancerous lesions. Thirty-three patients were excluded, whose vessels we failed to ligate by Hem-o-lok clips. Failure rate was 6.4%. The main cause of failure was vessel tearing and bleeding during dissection of uterine vessels. Finally, a total of 480 patients met the inclusion and exclusion criteria.

The clinicopathologic characteristics of the patients are presented in Table 1.

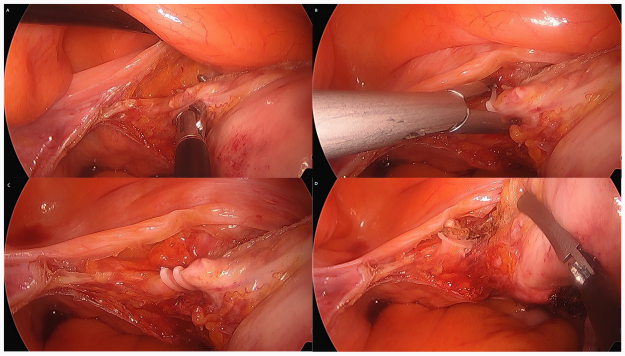

Fig. 1. Ligation of uterine vessels using Hem-o-lok clips. (A) Uterine vessels are completely separated from the surrounding tissues. (B) One Hem-o-lok clip is placed. (C) Two Hem-o-lok clips are placed. (D) Uterine vessels are transected using scissors.

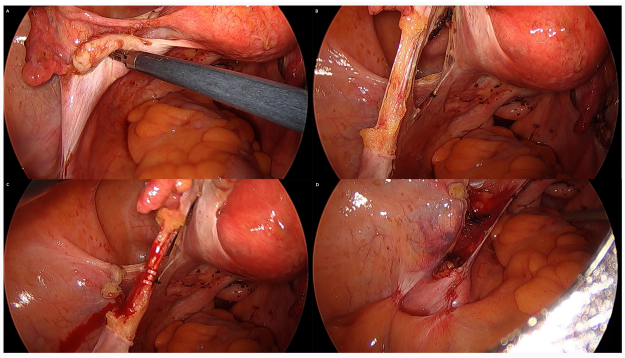

Fig. 2. Ligation of ovarian vessels using Hem-o-lok clips. (A) Ovarian vessels are identified. (B) Ovarian vessels are completely separated from the surrounding tissues. (C) Two Hem-o-lok clips are placed. (D) Ovarian vessels are transected using scissors.

The most common indication for TLH was uterine myoma. Other indications included adenomyosis, endometriosis, endometrial hyperplasia, and uterine prolapse.

Prior abdominal surgeries were present in the history of 172 of the 480 patients (35.8%), with cesarean section being the most common procedure.

Table 2 shows the surgical outcomes. Perioperative complications were reported in six patients, with four cases of stump dehiscence and two cases of bladder injury. All bladder injuries were found during the operation and repaired using VICRYL 3-0 (Ethicon, Inc. Sommerville, NJ, USA). None of the patients experienced ureter injury or vessel rebleeding.

4. Discussion

Lee *et al.* [8] first reported the ligation of uterine vessels using Hem-o-lok clips during TLH. However, the number of patients was small, with only 58 patients included in their study. In our study, a total of 480 patients were included. Our study shows that the application of Hem-o-lok

Table 1. Clinicopathological characteristics of patients.

	Total (n = 480, %)
Age (y), mean ± SD	46.6 ± 5.8
BMI (kg/m^2), mean ± SD	22.8 ± 2.9
Parity (n), mean ± SD	1.8 ± 0.6
Menopause (%)	80 (16.7)
Weight of the uterus (g), mean ± SD	208.2 ± 95.8
Indication for TLH, n (%)	
Myoma	316 (65.8)
Adenomyosis	115 (24.0)
Endometriosis	24 (5.0)
Endometrial hyperplasia	18 (3.7)
Uterine prolapse	7 (1.5)
Previous surgery, n (%)	172 (35.8)
Cesarean section	89 (18.5)
Appendectomy	45 (9.4)
Adnexal operation	32 (6.7)
Myomectomy	6 (1.3)

SD, standard deviation; BMI, body mass index; TLH, total laparoscopic hysterectomy.

Table 2. Surgical outcomes.

	Total (n = 480, %)
Operation time (min), mean ± SD	135.2 ± 30.1
EBL (mL)	128.5 ± 71.4
Hemoglobin change (g/dL), mean ± SD	1.6 ± 0.7
Postoperative hospital stay (days), mean ± SD	2.9 ± 0.8
Complications, n (%)	6 (1.2)
Stump dehiscence	4 (0.8)
Bladder injury	2 (0.4)
Ureter injury	0
Vessel rebleeding	0

SD, standard deviation; EBL, estimated blood loss.

clips was safe and feasible. Thus, ligation using Hem-o-lok clips could be considered a method for the ligation of uterine and gonadal vessels to avoid unexpected thermal damage.

There are various methods and techniques for the ligation of the uterine vessels, with bipolar instruments being the most popular method. Although bipolar coagulation is convenient, it is a weak method for sealing the uterine arteries compared with ties during open surgery and can cause thermal damage to the surrounding tissues [17]. The higher power of bipolar coagulation translates into a wider thermal damage width and repeated electrocoagulation leads to heat accumulation, with the range of thermal damage bound to increase [18]. In addition, increasing vessel size is associated with increased thermal injury [5].

The uterine artery crosses the ureter from the lateral border of the uterus at approximately 2 cm lateral to the cervix [19]. Bipolar coagulation can result in ureter damage at the site of uterine artery coagulation. Such damage is hard to localize during surgery, and symptoms such as ureteral leaks usually present postoperatively, adversely affecting both the surgeon and patient [20]. Considering the incidence of MIGS-related litigations due to ureteral injuries, avoiding thermal damage during uterine vessel ligation is critical [16].

There are several advantages of the Hem-o-lok clips. First, they represent a cold ligation system, which avoids the problem of the electrical thermal spread associated with electrical devices. Second, the Hem-o-lok clips have better holding power by locking and can withstand a higher arterial pressure compared to other instruments. Third, the Hem-o-lok clips have a *locking* mechanism and ensure distinct tactile feedback; thus, surgeons know whether they have securely locked onto the patient vessel or not. In our study, Hem-o-lok clips were successfully used for uterine and ovarian vessel ligation, and none of our patients experienced ureteral damage or vessel leakage. Moreover, there were no intra- or postoperative complications related to the Hem-o-lok clips.

The disadvantage of using Hem-o-lok clips resides in the technical difficulties in applying them. First, a complete dissection of the vessels is essential for an appropriate application. The dissection of ovarian vessels is relatively easy. If, the varicosities of ovarian vessels are found, we ligate artery and vein separately. However, uterine vessels show plenty of anatomic variation, mainly in their origin, raising a challenge for surgeons [21]. Second, complete dissection is always accompanied with the risk of vessel tearing. In turn, vessel tearing, mainly of uterine veins, forces surgeons to use energy devices. Consequently, the dissection of uterine vessels is complex and requires time, concentration, and experience. Nevertheless, after the dissection is completed, applying the Hem-o-lok clips only takes a few seconds. And when Hem-o-lok clips are applied appropriately, patients do not incur in ureter injury or rebleeding. Also, this technique can be used in case of advanced laparoscopic surgery, such as for laparoscopic radical hysterectomy or deep infiltrating endometriosis.

This study has several limitations. The primary limitation is the lack of a comparison arm. Second, this study is retrospective. Third, the number of patients enrolled is relatively small, though greater than that used in existing studies. Finally, the learning curve to dissect vessels and apply the Hem-o-lok clips was not considered.

5. Conclusions

In conclusion, ligation by Hem-o-lok clips in TLH is a safe method for ligating vessels and avoiding unexpected ureteral injury. Prospective studies are needed to confirm the real clinical benefit of this surgical approach.

Availability of Data and Materials

The data that support the findings of this study are available on request from the corresponding author.

Author Contributions

The design of study and Responsible Surgeon was done by JHY. The reference collection and manuscript preparation was done by SJL, SIK. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

Ethics Approval and Consent to Participate

This retrospective study was approved by the Institutional Review Board of the Catholic University of Korea (VC22RASI0311). The requirement for informed consent was waived owing to the retrospective nature of the study. The study was conducted in accordance with the principles of the Declaration of Helsinki.

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Conflict of Interest

The authors declare no conflict of interest.

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