Ligation of uterine vessels in total laparoscopic hysterectomy using Hem-o-lok clips

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Abstract

Objective: The Hem-o-lok clip ligation has become the preferred method for vessel ligation. We evaluated the feasibility and safety of uterine vessel ligation using the Hem-o-lok clip during total laparoscopic hysterectomy.

Materials and methods: The clinical outcomes of 58 hysterectomies were compared between the following two groups: Hem-o-lok clip group (n = 29) and bipolar coagulation group (n = 29).

Results: Of the 29 patients in the Hem-o-lok clip group, bilateral application of Hem-o-lok clips was completed in 25 patients (86%); unilateral use of the bipolar coagulator was needed in four patients for rapid control of bleeding from lacerated uterine vessels during dissection and/or because of anatomical difficulty. No complications, such as dislodgement, slippage, or bleeding, were identified in the Hem-o-lok clip group. No difference was identified in surgical outcomes, such as blood loss or operative time, between the two groups. Postoperative pelvic infections occurred in one patient from each group with unilateral and bilateral use of the Hem-o-lok clip; the ligated uterine vessels using the Hem-o-lok clip were intact, but the coagulated uterine vessels were weakened by the pelvic infections, which caused active uterine bleeding requiring emergent reoperation.

Conclusion: The Hem-o-lok clip could be used for ligation of uterine vessels and might be resistant to pelvic infections compared with bipolar coagulation. Prospective randomized trials are needed to confirm the real clinical benefit of this surgical approach.

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Introduction

Total laparoscopic hysterectomy (TLH) is currently accepted as a safe and efficient method to manage benign uterine pathology, and is an acceptable alternative to standard abdominal hysterectomy [1,2]. There are various techniques for TLH which depend on energy sources, the use of uterine manipulators, vaginal tubes, the method of uterine artery ligation, and the method of vault closure [3]. New methods and techniques for ligation of the uterine vessels have been developed, including metal clips, the Hem-o-lok clip, endovascular staples, the sutting technique, bipolar electrocautery, the argon beam coagulator, and laser or ultrasonic dissectors [4].

Vessel ligation using the Hem-o-lok clip has been accepted as a reliable technique to control renal vessels during laparoscopic nephrectomy [5,6]. However, a description of uterine vessel ligation using Hem-o-lok clips during TLH has not yet been published. In this study, we report our experience with the application of Hem-o-lok clips for uterine vessel control. We also evaluate the advantages of using Hem-o-lok clips for uterine vessel control in comparison with bipolar coagulation during TLH.

Materials and methods

This study was approved by the Institutional Review Board of the National Cancer Center (NCCNCS-11-473). We retrospectively...
reviewed TLHs performed at the National Cancer Center-Korea (a tertiary educational and research hospital). Patients with benign disease were included in the current analysis. Between December 2007 and March 2011, 58 patients underwent TLHs. Hem-o-lok clips (WECK EFx; Teleflex, Research Triangle Park, NC, USA) were used to ligate uterine vessels in 29 patients. In the remaining 29 patients, the uterine vessels were ligated using other instruments, such as a bipolar coagulator (Micro-Ring, PM433R; Aesculap, Center Valley, PA, USA), an endoloop, and silk ties. We separated the patients into the following two groups: Group I (ligation using Hem-o-lok) and Group II (ligation by conventional methods). For each patient, the operative time, estimated blood loss, blood transfusion requirements, change in hemoglobin level, post-operative hospital stay, amount of drainage, and complications were recorded and analyzed.

Operative technique

Laparoscopy was performed under general anesthesia. All patients were positioned in the lithotomy position and draped in a sterile fashion. The first 11-mm port was placed through the umbilicus, and a second 5-mm or 11-mm port was placed in the left lower quadrant site. Two 5-mm ports were placed in the supra-pubic and right lower quadrant sites. Both round ligaments were electrocoagulated by bipolar coagulation and cut using a monopolar coagulator. The Fallopian tubes and utero-ovarian ligaments were ligated if the patient desired ovarian preservation and there were no pathologic findings. The vesicouterine peritoneal fold was opened and the bladder was bluntly mobilized using surgical gauze to avoid electrocautery injury to the lower urinary tract. Bipolar coagulation was selectively used for bleeding control.

In Group I, the uterine vessels were thoroughly skeletonized to allow for visualization of the tips of the Hem-o-lok clip coming together (Fig. 1A–F). If the uterine vessels were embedded into the soft tissues, the vessels were separated from the surrounding tissues by electrocauterization parallel to the vessels to minimize the risk of vessel trauma. After complete circumferential dissection of the left uterine vessels, an extracorporeal silk was applied to the left uterine vessel for traction of the uterine vessels to apply a 5-mm Hem-o-lok efficiently through the left lower quadrant port. Two Hem-o-lok clips were placed on the left uterine vessels on the resected uterine side and one clip was placed on the vaginal stump side to achieve adequate occlusion. Then, the left uterine vessels were transected directly using a scissors after coagulation of the cutting site using a bipolar coagulator. The uterine vessels on the right side were ligated in a similar fashion through a suprapubic port. The vaginal cuff was first cut for better exposure and isolation of the right uterine vessels. In Group I, Hem-o-lok clips were applied bilaterally in 25 patients. In the other four patients, Hem-o-lok clips were used unilaterally; the contralateral uterine vessels

Fig. 1. (A–F) Ligation of uterine vessels using Hem-o-lok clips during laparoscopic hysterectomy. (A) Dissection of the upper part of embedding uterine vessels from the uterine cervix using a bipolar dissector through the left lower quadrant port while pushing the vessels inferiorly using an atraumatic forceps through the suprapubic port. (B) Complete dissection of uterine vessels from the uterine wall and applying silk ties. (C) Application of Hem-o-lok clips to the left uterine vessels while keeping gentle traction of the vessels with silk ties through the left lower port. (D) Double ligation using Hem-o-lok clips on the resected uterine side. (E) Hem-o-lok clip application to right uterine vessels while keeping gentle traction with silk ties through the suprapubic port after near-complete resection of the vaginal cuff for easy exposure of the right uterine vessels. (F) Hem-o-lok clips that were completely applied to both uterine vessels (white arrows). In a patient with a postoperative pelvic infection, (G) an actively pumping uterine artery on the left side was sutured using PROLENE 4-0, while the integrity of the right-side uterine vessels was maintained with Hem-o-lok clips, as indicated by the white arrow (H). (I) Complete dissection and tying of uterine vessels, an artery on a vein, from the surrounding tissue.
were sealed using extracorporeal silk ties (1-0 black silk, SK 14510; Ailee, Seoul, Korea). ENDOLOOP (Ethicon, Piscataway, NJ, USA) was used in three patients because of uterine tumors, and a bipolar coagulator was used in one patient for rapid control of uterine vessel bleeding during dissection. No complications, such as dislodgement, slippage, or bleeding, were identified in any of the patients in the Hem-o-lok clip group.

In Group II, the bilateral uterine vessels were grasped and electrocoagulated using a bipolar coagulator in 26 patients. Endo-loops and/or silk ties were also used in three patients. The vagina was cut using a monopolar coagulator and the uterus was retrieved through the vagina. The vaginal stump was sutured by an intracorporeal endosuture using VICRYL 1-0 (Ethicon, Inc. Sommerville, NJ, USA). A drain was inserted through the port-insertion site in the right lower quadrant. In both groups, the same techniques were performed through the whole course of the procedure except for ligation of the uterine vessels.

**Statistical analysis**

Statistical analysis was carried out using SPSS (version 12.0; SPSS, Inc., Chicago, IL, USA) for Windows (version 17.0). The results are expressed as the mean and number (%). The difference in means was tested using an independent Student t test. A p value < 0.05 was considered statistically significant.

**Results**

Table 1 shows the characteristics of the patients who underwent TLH. Both groups were similar with respect to baseline patient characteristics, such as age, body mass index, parities, menopause, or history of laparotomy or laparoscopy. The weight of the uterus was significantly heavier in Group I than in Group II. The indications for TLH were uterine myomas, adenomyosis, carcinoma in situ of the cervix, endometriosis, and simple hyperplasia of the endometrium. Eleven patients in Group I and 13 patients in Group II had prior abdominal surgery, such as cesarean section, ovarian cystectomy, appendectomy, myomectomy, salpingectomy, gastrectomy, laparoscopic tubal ligation, or laparoscopic salpingectomy.

Table 2 shows the comparison of surgical outcomes between the two groups of patients. Complications requiring additional surgery were reported in two patients in Group I. The first patient underwent a TLH, bilateral salpingo-oophorectomy, and adhesiolysis for myoma uteri. In the 2nd postoperative day, the patient had a fever with abdominal pain. A sigmoid colon perforation was suspected based on a pelvic computed tomography (CT) scan and the patient underwent emergency surgery, including a laparoscopic rectal repair and a temporary ileostomy. This complication was not thought to be related to the uterine vessel dissection and Hem-o-lok application. Despite diffuse abdominal inflammation, the vessels that had been ligated using Hem-o-lok clips were not affected and remained well sealed. The ileostomy was revised 3 months later. The second complication occurred in a patient in whom the uterine vessels were ligated using Hem-o-lok clips on the right side and a bipolar coagulator on the left side. The patient had been discharged without specific complications on the 3rd postoperative day. On the 10th postoperative day, the patient sought evaluation in the emergency room for massive vaginal bleeding. During urgent laparoscopy, the severe adhesions between the vaginal stump and the bowel from postoperative pelvic infections, and active bleeding from the left uterine artery were identified. The left uterine vessels, which had been electrocoagulated using a bipolar coagulator, were damaged secondary to postoperative pelvic infection and inflammation. The integrity of the ligated right uterine vessels, which had been ligated using Hem-o-lok clips, was maintained (Fig. 1G and H). The left uterine artery was sutured using PROLENE 4-0 (Ethicon, Inc. Sommerville, NJ, USA) for hemostasis.

**Discussion**

This is the first report in which Hem-o-lok clips were used for ligation of uterine vessels during TLH. In our study, the application of a Hem-o-lok clip was similar to conventional surgical methods in the surgical outcomes and more resistant to the pelvic

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<th>Table 1</th>
<th>Characteristics of patients undergoing total laparoscopic hysterectomy.</th>
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<tr>
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<td>Group I (n = 29)</td>
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<tr>
<td>Age, median (y)</td>
<td>46.5</td>
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<tr>
<td>Body mass index (kg/m²)</td>
<td>23.9</td>
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<tr>
<td>Parity (n)</td>
<td>1.7</td>
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<tr>
<td>Menopause, n (%)</td>
<td>4 (13.8%)</td>
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<tr>
<td>Weight of the uterus (g)</td>
<td>235.5</td>
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**Table 2**

Comparison of surgical outcomes.

- **Additional procedures, n (%)**
  - Group I (n = 29): 22 (75.9%)
  - Group II (n = 29): 24 (82.7%)
  - p: 0.52

- **Adhesiolysis, n (%)**
  - Group I (n = 29): 16 (55.2%)
  - Group II (n = 29): 16 (55.2%)

- **Prophylactic adenexectomy, n (%)**
  - Group I (n = 29): 15 (51.7%)
  - Group II (n = 29): 18 (62.1%)

- **Ovarian cystectomy, n (%)**
  - Group I (n = 29): 3 (10.3%)
  - Group II (n = 29): 3 (13.8%)

- **Peritonectomy, n (%)**
  - Group I (n = 29): 2 (6.9%)
  - Group II (n = 29): 2 (6.9%)

- **Operative time, min**
  - Group I (n = 29): 169.6
  - Group II (n = 29): 155.9

- **Blood loss (mL)**
  - Group I (n = 29): 139.0
  - Group II (n = 29): 129.7

- **Blood transfusion, pack**
  - Group I (n = 29): 0.1
  - Group II (n = 29): 0

- **Hemoglobin change (g/dL)**
  - Group I (n = 29): 4.6
  - Group II (n = 29): 4.8

- **Complication (%)**
  - Group I (n = 29): 6.9
  - Group II (n = 29): 0

- **Amount of drain (mL)**
  - Group I (n = 29): 120.2
  - Group II (n = 29): 96.5

- **Complications on the 3rd postoperative day**
  - Group I (n = 29): 2 (6.9%)
  - Group II (n = 29): 2 (6.9%)

- **Postoperative hospital stay (d) (standard deviation)**
  - Group I (n = 29): 4.6 ± 0.52
  - Group II (n = 29): 4.5 ± 0.52

- **Amount of drainage on the 1st postoperative day**
  - Group I (n = 29): 120.2
  - Group II (n = 29): 96.5

- **Complication (%)**
  - Group I (n = 29): 6.9
  - Group II (n = 29): 0

- **Excluding the case of sigmoid colon perforation.
- Amount of drainage on the first postoperative day.
- Two cases: sigmoid colon perforation and left uterine arterial bleeding (however, these complications were not associated with Hem-o-lok clip application).
inflammation. Thus, ligation using Hem-o-lok clips could be considered as a method for the ligation of uterine vessels.

Adequate hemostasis is essential for advanced laparoscopic procedures because uncontrolled bleeding may cause significant complications and even require conversion to laparotomy to obtain sufficient hemostasis [4]. Therefore, the development of new energy sources for hemostasis has facilitated advanced laparoscopic procedures [7]. Although unexpected sudden death after TLH occurs very rarely and might be mainly related to disruption of vessel ligation, this event is critical to patients and gynecologists and might be underreported. Bipolar coagulation during TLH is a weak method for sealing the uterine arteries compared with ties during open surgery [8,9]. Surgical techniques and instruments to ligate uterine vessels should be improved in terms of feasibility and safety. However, few studies have documented the method of ligating the uterine vessels during TLH [3]. At present, some new instruments and techniques were introduced for hemostasis in accordance with the developments achieved in laparoscopic surgery in recent years. These instruments and techniques include metal clips, Hem-o-lok clips, endovascular staples, the suturing technique, bipolar electrocautery, LigaSure (Valleylab, Boulder, CO, USA), argon beam coagulator, and laser or ultrasonic dissectors [3,4]. In our study, Hem-o-lok clips were successfully applied to ligate uterine vessels bilaterally and unilaterally in 25 and four patients, respectively.

The characteristics of devices used in this study are presented in Table 3. Bipolar instruments have been widely used in ligating the uterine vessels. The introduction of bipolar instruments during laparoscopy improved dissection and hemostasis simultaneously, thus allowing for early control of vascular bleeding [4]. Bipolar instruments may be efficient when severe adhesions are found because such procedures do not critically require meticulous dissection [10]. A theoretical advantage of bipolar energy is the more controlled spread of energy because bipolar energy is only transmitted within a small space [4,7]. However, increasing vessel size is associated with increased thermal injury. As reported in a recent study, the actual thermal spread of bipolar coagulation is up to 3.2 mm in 6–7-mm vessels [7].

Endoloop has been used for vascular control during laparoscopic surgery. This technique does not require advanced laparoscopic skills and may be of help, particularly for surgeons unfamiliar with endoscopic techniques. The disadvantage of endoloop is that a significant amount of healthy tissue needs to be killed, and loops may slip off due to tissue ischemia with secondary loosening of the fixed loops [4]. In the current study, endoloops were applied for reinforcement of uterine vessels. Complete dissection of uterine vessel is a prerequisite for using endoloops or Hem-o-lok clips.

The Hem-o-lok clip is made of a nonabsorbable polymer and applied using a 5-mm laparoscopic applicator. The Hem-o-lok clip has teeth within its jaws to ensure tissue security with locking firmly in place. The use of the Hem-o-lok clip is facilitated by the narrow profile and ability to partially close the jaws without locking, allowing for complete visualization of the tips of the clip before final development [11].

The Hem-o-lok clip has several advantages. First, the Hem-o-lok clip has fewer tendencies to slip off and better tissue-holding power, as the teeth ensure tissue security [4,6,11]. The Hem-o-lok clips can resist higher arterial pressure than other instruments, such as ultrasonic coagulating shears, electrothermal bipolar vessel sealers, and titanium laparoscopic clips [12]. Hem-o-lok clips tolerate a pressure of 800 mmHg on the arterial segment with no evidence of leakage [13]. Moreover, Hem-o-lok clips can be safely used for vascular control, especially in hypertensive patients with no concern regarding slippage. Second, Hem-o-lok clips provide excellent tactile feedback with locking. Therefore, the surgeon can detect whether or not the clips were placed well [6]. Third, Hem-o-lok clips are reported to be resistant to microbial growth [11]. In our study, the uterine vessels ligated using Hem-o-lok clips were intact, whereas the vessel coagulated using a bipolar electrocautery was necrotic, which required an emergent surgical procedure to control active bleeding. Finally, these clips are not metal based and have no scattering effect on CT or magnetic resonance imaging scans [11,14].

In our study, Hem-o-lok clips were successfully used for uterine vessel ligation. The surgical outcomes, such as operative time, blood loss, or postoperative hospital stay, were not significantly different between the two groups. There were no intraoperative or postoperative complications related to the Hem-o-lok clip, such as clip slippage, in any of the cases. Nevertheless, we had a few definitive challenges to overcome while using Hem-o-lok clips for ligation of uterine vessels. Technical difficulties in applying Hem-o-lok clips on the unilateral side occurred in four patients for the following reasons. Complete dissection of the uterine vessels (Fig. 11) to apply Hem-o-lok clips is difficult and requires time, concentration, and experience due to anatomical variations of the uterine vessels and uterine tumors around the vessels. Frequently, embedding uterine vessels appears to be a difficult condition. In addition, tearing of uterine vessels, primarily uterine veins, is another indication to use a bipolar coagulator immediately. Although complete dissection of uterine vessels and applying Hem-o-lok clips appear to be a safer approach for uterine vessel ligation, this approach might be challenging for some gynecologists, especially for those with limited experience because of the associated technical difficulties. Complete dissection always accompanies the risk of vessel tearing. We believe that development of an adequate holding and ligating system suitable for partially embedding uterine vessels without complete dissection makes ligation of uterine vessels easier and safer (Fig. 2).

The potential limitations of this study were the small number of cases and patient selection bias due to retrospective design. The current report included surgeons’ initial experience with uterine vessel ligation using Hem-o-lok clips. The learning curve to dissect uterine vessels and apply the Hem-o-lok clip might be one of the potential biases. A trial period for Hem-o-lok clips has not been described in the operative record. The additional cost for a single use of Hem-o-lok is approximately 11,940 Korean Won (10.70 US$). The cost effectiveness should thus be evaluated in future clinical trials.

In conclusion, Hem-o-lok clip ligation could be used as one of the methods for ligating uterine vessels and might be a stronger method in the inflammatory environment; in addition, the method is not susceptible to infections. Therefore, prospective randomized

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<td>Characteristics of various hemostatic devices.</td>
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<td>Polymer clip</td>
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<td>Mechanical</td>
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<td>Bipolar electrocautery</td>
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<td>Endoloop</td>
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trials are needed to confirm the real clinical benefit of this surgical approach.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

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