Int Surg 2017;**102:**334–339
DOI: 10.9738/INTSURG-D-14-00270.1

Laparoscopic Appendectomy Using Hem-o-lok Polymer Clips: A Single-Center Experience

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Although the surgical technique of laparoscopic appendectomy (LA) stump has been well understood, there are many alternative techniques in relation to torocar positioning and closure of appendicular stump. In recent times, Hem-o-lok polymer clips (HOLP) was implemented in several studies in the closure of appendicular stump because of its lower cost and easy implementation. The purpose of this study to investigate the safety, usefulness, and cost effectiveness of HOLP for the closure appendecular stumps in LA. The study was carried out between December 2011 and December 2013. Patients with acute appendicitis were included in the study. Two groups were defined as patients with the HOLP and patients with endoloop. The prospectively collected data, including age, sex, body mass index, operative time, hospital stay, cost effectiveness, intraoperative, and postoperative complications were retrospectively analyzed. A total of 66 (35 male, 31 female) LA were performed. The endoloop group consisted of 30 patients (16 male, 14 female, and mean age, 30.4 ± 1.8), while the HOLP group consisted of 36 patients (19 male, 17 female, and mean age, 28.6 ± 1.6). The mean operative time was 42.5 ± 1.3 in the HOLP group and 53.8 ± 1.5 in the endoloop group ($P < 0.0001$). The mean hospital stay was 2.1 ± 0.2 days in HOLP group and 2 ± 0.2 in the endoloop group ($P = 0.73$). Both patient groups had no intraoperative complication, and no cases were converted to open procedure. Total hospital cost was 1170.8 ± 6.3 dollars in the HOLP group and 1094 ± 6.9 dollars in the endoloop group ($P < 0.0001$). The use of HOLP for the appendicular stumps in LA is a feasible, safe, and cost-effective procedure in patients with uncomplicated acute appendicitis.

Key words: Acute appendicitis – Hem-o-lok polymer clips – Laparoscopic appendectomy

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Since the laparoscopic appendectomy (LA) was first described in 1983 by Semm,[1] it has become a frequently used alternative in the treatment of acute appendicitis.[2,3] The number of LAs has progressively increased since it has been demonstrated to be a safe procedure, with excellent cosmetic results. Furthermore, LA allows a shorter hospitalization, and a quicker, less painful postoperative recovery.[4,5] However, concerns and controversy exist related to the closure of the appendiceal stump. New materials have been introduced for controlling the appendiceal stump closure, such as the endoloop, ultrasonically activated scalpel, instrument-assisted knotting, metal clip, hem-o-lok polymeric clip (HOLP), and linear endostaplers.[6–14] The base of the appendix is usually closed by an endoloop ligature or linear in LA.[6–8] During this process, although stapler technique is considered to be one of the safest methods, its high cost is a disadvantage.[9] In recent times, HOLP was implemented in several studies in the closure of appendicular stumps because of its lower cost and easy implementation.[10–12] In our center, HOLP and endoloop have been used to close appendicular stumps in more than 95% of cases. The stapler technique or intracorporeal knot-tying suture are rarely used.

Therefore, we aimed to evaluate the safety, technical simplicity, and cost of HOLP for the closure of the appendix base during LA.

Materials and Methods

This study was performed from May 2011 to December 2013 after receiving ethics committee approval. A total of 66 consecutive patients with acute or suspected acute appendicitis underwent laparoscopic appendectomies by 2 surgeons. All patients were informed in detail about the potential risks and benefits of both operations. The patients were nonrandomly divided into 2 groups: in the first group, the base of the appendix was secured by HOLP while in the second group, the appendix base was closed by double endoloop. One surgeon used the HOLP whenever possible. The other surgeon generally preferred to use the endoloop. These 2 methods were applied by the 2 surgeons to more than 20 consecutive LA procedures. One surgeon used the XL size HOLP for the closure of the appendicular stump. The other surgeon used proximal double 2-0 polydioxanone endoloop ligatures.

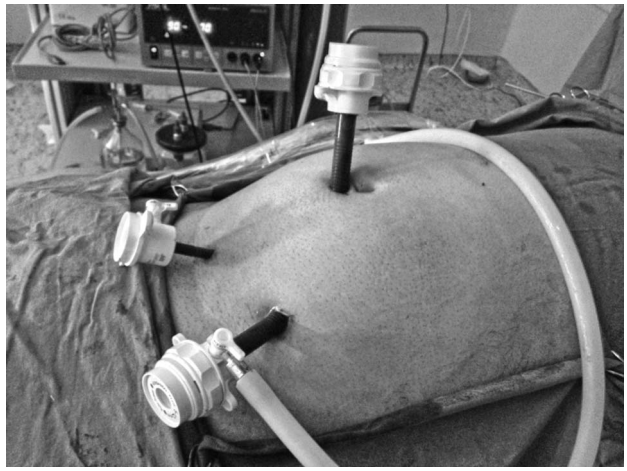

Fig. 1 Port placement.

We obtained informed consent preoperatively from all patients for the use of HOLP or endoloop ligature for appendicular stump closure during LA.

The indications for surgery were based on physical examination; clinical signs and symptoms; imaging techniques (abdominal ultrasonography and computed tomography); and laboratory findings. According to clinic presentation and scanning, cases with acute or suspected acute appandicitis who were accompanied by common intra-abdominal abscess and sepsis were excluded from this study and were treated via open. Additionally, patients with previous major abdominal surgery or pregnant patients were excluded from this study.

Patients were divided into 2 groups: the hem-o-lok polymeric clips group consisted of 36 patients while the endoloop group had 30 patients. The prospectively collected data including age, sex, body mass index, operative time, hospital stay, cost effectiveness, intraoperative, and postoperative complications were analyzed retrospectively.

Statistical analysis

Statistical analysis was performed using statistical software (SPSS version 15.0, SPSS Inc, Chicago, Illinois). Results are expressed as mean ± SD. Comparisons between groups were made using Pearson's χ^2 test or Fisher's exact test. A value of $P < 0.05$ was accepted significant.

Operative procedure

The patient was positioned in the supine position with the head down and right side up. The surgeon and an assistant stood on the left side, and the

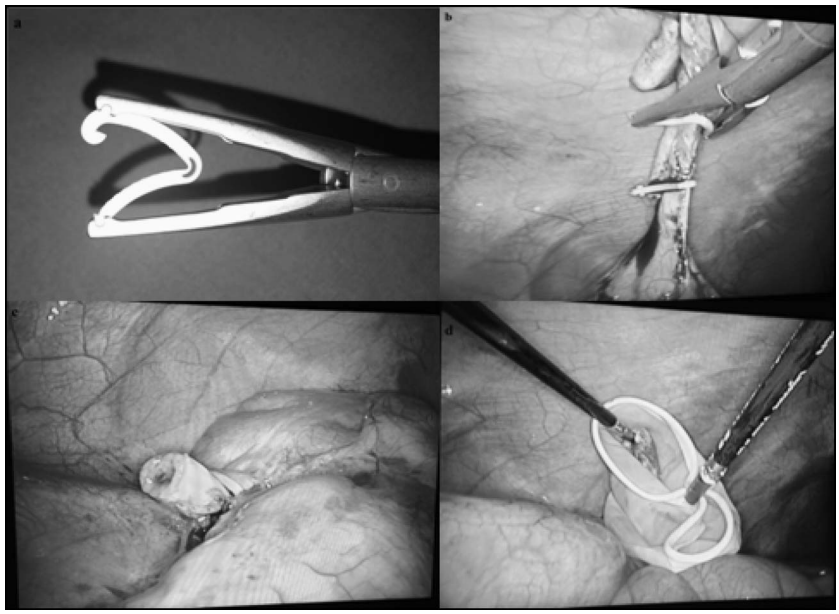

Fig. 2 (Top left) Hem-o-lok polymer clips (HOLP). (Top right, bottom left) Application of HOLP. (Bottom right) Removing of specimen.

monitor was on the right side of patient. General anesthesia was applied to all patients. All patients received cefazolin 1 g intravenously during the operation, and the skin was prepared with a 10% povidone iodine solution. After a pneumoperitoneum pressure of 14 mmHg was established by CO_2 with an insufflation needle placed just under the umbilicus, a 10-mm trocar was inserted in the umbilicus to introduce a 30-degree laparoscope. The peritoneal cavity was then inspected by a 30° scope. An additional 10-mm trocar at the midline just 3 fingers above the pubic bone and a 5-mm trocar at the left lower quadrant were inserted. All trocar positions can be seen in Fig. 1. A 5-mm vessel-sealing instrument (LigaSure Valleylab, Covidien, Minneapolis, Minnesota) was used for the meso-appendix dissection. The proximal base of the appendix was closed using single HOLP or endoloop (Fig. 2a, 2b, 2c). The specimen was removed with a bag made of powder-free sterile gloves (Fig. 2d).

Results

A total of 66 laparoscopic appendectomies were performed. The endoloop group consisted of 30 patients (mean age, 30.4 ± 1.8; range, 16–72 years), while the hem-o lok group had 36 patients (mean age, 28.6 ± 1.6; range, 16–65 years). The clinic outcomes and demographic data of each group are explained in Table 1. Body mass index was similar in both study groups ($P = 0.06$). The mean postoperative hospital stay was 2.1 ± 0.2 days in the hem-o-lok group and 2 ± 0.2 days in the endoloop group, which is not statistically significant ($P = 0.73$). Mean operation time was 42.5 ± 1.3 minutes (range, 30–90) in the HOLP group and 53.8 ± 1.5 minutes (range, 35–100) in the endoloop group, which is statistically significant ($P < 0.0001$). There were no intraoperative complications and conversion to open procedures in either patient group. The negative appendectomy rate was 6%. There was a different pathology in patients with negative appendectomy. These cases were discharged

Table 1 Clinic outcomes and demographic data of each group

Patients, n	Hem-o-lok polymer clips group	Endoloop group	*P*
n (male/female)	36 (19/17)	30 (16/14)	0.96
Age	28.6 ± 1.6	30.4 ± 1.8	0.47
Body mass index, kg/m^2	26.6 ± 0.5	25 ± 0.6	0.06
Operation time, min	42.5 ± 1.3	53.8 ± 1.5	**<0.0001**
Hospital stay, d	2.1 ± 0.2	2 ± 0.2	0.73
Intraoperative complications, n	0	0	
Postoperative complications (wound infection), n	2	2	0.85
Total cost, dollars	1170.8 ± 6.3	1094 ± 6.9	**<0.0001**

Table 2 Histological characteristics of total appendectomy specimens in each group

	Hem-o-lok polymer clips	Endoloop	*P* value
Suppurative	30	24	>0.05
Gangrenous	2	2	
Perforated	2	2	
Normal	2	2	

with healing. Histopathological data were normally appendicitis, suppurative, gangrenous and perforated appendicitis, and described as shown in Table 2 according to groups. There was no significant difference in histological characteristics between the 2 groups ($P > 0.05$). The port site infection occurred in 2 patients in the HOLP group and 2 patients in the endoloop group ($P = 0.85$). These patients were those with perforation appendicitis and treated with drainage or oral antibiotic. There were no surgery-related postoperative complications requiring hospital stay after discharge. The per-cost of HOLP for LA was \$30, while that of endoloop for LA was \$60. Total cost was 1170.8 ± \$6.3 in the HOLP group and 1094 ± \$6.9 in endoloop group. There was statistical significance between the groups ($P < 0.0001$).

Discussion

Our results show that the use of the HOLP for the closure of the appendix base in LA is a feasible, safe approach and a cost-effective procedure in patients with nonsevere acute appendicitis, as an alternative to the use of endoloop.

Although the surgical technique of LA stump has been well understood, there are many alternative techniques in relation to trocar positioning and closure of the appendicular stump. Despite these differences, the most important concern in laparoscopic appendectomy is the safety of the method used for the closure of the appendicular stump.[2] Therefore, new techniques such as endoloop, ultrasonic dissection tool, intracorporeal suture, metal clips, bipolar coagulation and linear endostapler have been applied for the best way to control the closure of the appendix stump.[13–16] However, debate about the safety and effectiveness of new applications continues and the best technique has not yet been determined.[17,18] The new applications may extend the duration of the operation or increase cost of LA.[11,13,19] Many surgeons have either used a stapler or endoloop for the closure of the appendicular stump.[6,10,20] The use of a stapler is safe and fast but expensive, while the endoloop is less expensive but requires laparoscopic training. Otherwise, clips spilled into the abdominal cavity have been shown to give rise to peritoneal adhesion and may be the cause of intestinal obstruction.[21] The use of metal clips was first described by Cristalli *et al*.[16] However, it has not gained general acceptance. Recently, a randomized clinical trial reported that the metal clip technique is reliable and shortens the duration of the operation.[22] Additionally, the reliability of using HOLP for the ligation of vessels, ureters, and bile ducts has been reported in over 1000 surgical procedures.[23,24]

Our study shows no significant difference in the length of hospital stay, postoperative, and intraoperative complications between the groups, whereas the HOLP group had a shorter operative time.

In several studies, the operative time and the mean duration of hospital stay when HOLP was used for the closure of the appendix base in LA was between 45 to 60 minutes and 1 to 7 days, respectively.[7,10,11,25,26] Our data correlate well with these studies.

There are several studies that compare HOLP with endoloop for LA in the literature. The length of hospital stay and postoperative complications did not differ significantly between the groups.[2,26,27] Our results correlate well with those studies. Delibegović and Matović[26] and Hue *et al*[2] reported that operative time is significantly lower in the HOLP group compared with the endoloop group. Similarly, we found that operative time in the HOLP group is significantly lower than in the endoloop group. Colak *et al*[25] found operative time is lower in the HOLP group; however, the difference was not significant. In our study, considering per-operation cost for LA, use of endoloop was \$60 while use of HOLP was \$30 and a lower cost than other techniques, which is similar to findings in other studies.[2,23] Also, unlike the above studies, cost analysis in our study was made by calculating the total cost of hospitalization. Total cost was significantly lower in the HOLP group than in the endoloop group.

Several studies reported that double HOLP was used in the closure of the base of the appendix.[2,11,28] However, we used a single HOLP and did not need a second HOLP in the closure of the appendix base. Recently, the use of single HOLP for the closure of the appendix base also has been suggested by several studies.[10,19] In addition, it has been suggested in the closure of cystic duct in laparoscopic cholecystectomies.[29,30]

We think that the use of double HOLP in the closure of the appendix stump causes local abscesses because of its long stump and may cause adhesions in the future. Several studies comparing LA with open appendectomy showed a significant increase in the cost of laparoscopic operation.[31–34] Use of an endobag and endoscopic stapler in the laparoscopic approach significantly increases the cost.[6,8] So, we used sterile powder-free in place of endobag for removal of the specimen during LA.

Hue *et al*,[2] who compared HOLP with endoloop, reported that if the appendix base diameter is less than 10 mm and the inflammation of the appendix base is mild, HOLP should be recommended first. They also suggested that if the appendix base diameter is too large (>10 mm) and the inflammation is not severe, the endoloop could be recommended in place of HOLP during LA. Similarly, a study comparing HOLP to endostapler concluded that if the appendix base diameter is >10 mm and the inflammation is severe during LA, the endostapler should be recommended for the closure of the appendix base during LA. In our study, the appendix base was closed successfully with both HOLP and endoloop. We think the one of the reasons is that most of our cases were admitted to the emergency clinic in the early period of acute appendicitis and there was no necrosis or intense edema in the appendix base. In the literature, there were several reports showing higher incidence of intra-abdominal abscess formation following LA, especially for complicated acute appendicitis cases.[35–37] In our series, intra-abdominal abscess following LA and conversion to open surgery were not observed. So, we excluded accurate or suspected acute appendicitis cases associated with common intra-abdominal abscess or evidence of sepsis.

Conclusion

The use of the HOLP for the closure of the appendix base in LA is a feasible, safe, and cost-effective procedure in patients with a minimal to moderately inflamed appendix base without necrosis. Large-prospective studies will be more helpful to decision making for this approach.

Acknowledgments

The authors declare that there are no potential conflicts of interest.

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