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Large hem-o-lok polymeric clips for stump closure in laparoscopic appendectomy

Ismail Alper Tarim, Murat Derebey

Ondokuz Mayis University, Faculty of Medicine, Department of General Surgery, Samsun, Turkey

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Abstract

We aimed to evaluate the results of laparoscopic appendectomies performed with large hem-o-lok polymeric clips (HC) and to discuss the applicability and effectiveness of large HC to close the appendix stump. Medical records of patients who underwent surgery for acute appendicitis by the same team between September 2015 and August 2020 were retrospectively analyzed. 181 patients who underwent laparoscopic appendectomy (LA) were included in this study. LA was performed on 156 (86.2%) of these with a HC and 25 (13.8%) with the other techniques. The mean appendix diameter was 9 ± 2.2 mm for HC and 13 ± 5.4 mm for other techniques. The mean operation time and length of hospital stay were shorter in cases where HC was used for stump closure. The appendiceal stump closure by large HC, including complicated grade acute appendicitis, is a safe, feasible and effective method. However, it may be insufficient in cases of severe acute appendicitis with increased appendix stump diameter or involvement of the cecum.

Keywords: Laparoscopic appendectomy, hem-o-lok clips, stump closure

Introduction

Appendectomy is one of the most common operations in general surgery. The standard technique is an open appendectomy using the Mc-Burney incision. With advances in laparoscopy and surgical instruments, the laparoscopic approach to appendectomy has gained wide acceptance over the years. Laparoscopic appendectomy (LA) is a safe procedure that provides shorter hospital stays, less wound infection, and faster postoperative recovery [1, 2]. The most important step of LA is the closure of the appendix stump. A leakage from the appendiceal stump may lead to life-threatening conditions such as intra-abdominal sepsis and enterocutaneous fistula, and reoperation may be required [3].

Various methods such as stapler, non-absorbable polymer clips, titanium clips, and endoloops are preferred in LA. The ideal method for appendix stump closure should be safe, accessible, simple to use and cost-effective [4−7]. There is no universal agreement on which method is the gold standard [8]. We aimed to evaluate the outcomes of laparoscopic appendectomies performed with large hem-o-lok polymeric clip (HC) and to discuss the feasibility and efficacy of large HC to close the appendiceal stump.

***Coresponding Author:** Murat Derebey, Ondokuz Mayis University, Faculty of Medicine, Department of General Surgery, Samsun, Turkey
E-mail: mderebey@gmail.com

Materials and Methods

This study was carried out in the General Surgery Clinic of Ondokuz Mayıs University Medical Faculty Hospital. Ethical approval was obtained from the local ethics committee for the study (IRB approval number OMU: 361/2020). Medical records of 204 consecutive patients who were operated for acute appendicitis by the same team between September 2015 and August 2020 were retrospectively analyzed. 22 patients who were unsuitable for laparoscopic surgery due to previous multiple abdominal surgeries or additional diseases (such as, COPD, congestive heart failure, etc.) and one patient who were converted to open surgery were not included in this study (Figure 1). It was aimed to perform all laparoscopic appendectomies using large hem-o-lok polymeric clips (Weck, Research Triangle Park, NC, USA). Laparoscopic stapler, endoloop method or HC method with the endoloop were used in cases which large HC were inadequate or difficult to close the appendix stump. In the HC method with the endoloop we developed, after the appendix stump was tied with endoloop, a HC were put under and above this area. The appendix was then cut between clips. The outcomes of patients in which the stump of the appendix was closed using either HC or other techniques (stapler, double endoloop, or HC method with the endoloop) were evaluated separately. Age, sex, body mass index (BMI), white blood cell (WBC) count before the operation, duration of symptoms, appendix diameter, operating time, usage of drain, length of hospital stay (LOS), and postoperative outcomes were recorded as data.

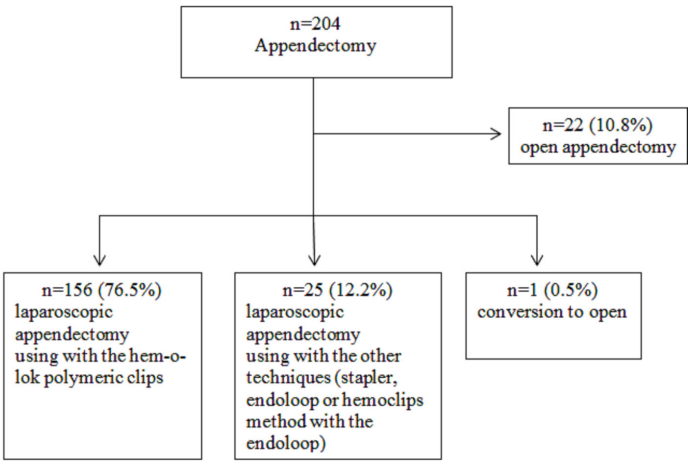

Figure 1. Flow chart of patients who underwent appendectomy between September 2015 and August 2020

Surgical Procedure

The surgical procedure followed a standardized protocol. All of surgeries were performed by the same surgical team. Two grams of intravenous cefazolin was administered as antibiotic prophylaxis at the induction of general anesthesia. Before the trocars were placed into the abdominal cavity, a urinary catheter was routinely inserted to empty the bladder and removed after surgery. A 10-mm trocar was placed in the lower part of the umbilicus followed by the insertion of a 30° scope and inspection of the peritoneal cavity. A 5-mm trocar was placed 4 to 5 cm above the pubis at the midline, and the second 10-mm trocar was inserted in the left lower quadrant (anti-McBurney's point). The mesoappendix was resected with a 5-mm vessel sealing device. After the proximal base of the appendix was closed with double HC, another clip was placed distally and the appendix was cut between clips (Figure 2). Different methods were used in cases where the stump of the appendix could not be closed safely using a large HC under visual control. Laparoscopic stapler, endoloop, or HC method with the endoloop were used in these cases. Drains were not routinely used. A specimen retrieval bag was used for perforated appendicitis.

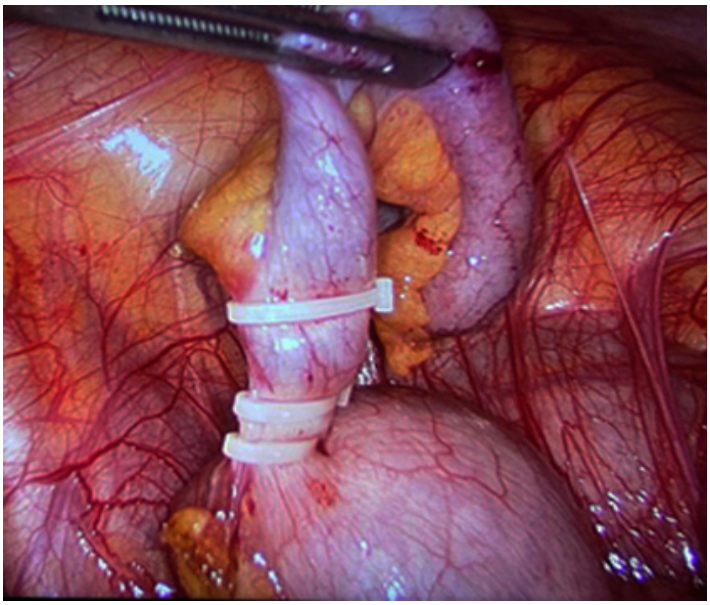

Figure 2. Placement of hem-o-lok polymeric clips on appendiceal base, and distal part

Statistical Analysis

All data were analyzed by using SPSS (Statistical Package for Social Sciences) for Windows 15.0 program. Descriptive statistics were used for demographic and clinical features. Data were presented as mean ± standard deviation. The results were also presented as percentages for continuous variables and the number for categorical variables.

Results

A total of 181 patients who underwent LA were selected for this study. LA was performed on 156 (86.2%) of these with HC and 25 (13.8%) with the other techniques (Table 1). Staplers were used in 10 patients, endoloop in 6, and HC method with the endoloop in 9 patients in whom HC were insufficient (Table 2). The mean appendix diameter was 9 ± 2.2 mm for HC and 13 ± 5.4 mm for other techniques. The operation time was prolonged when other techniques were used instead of hem-o-lok (55 min vs. 46 min, Table 1). The preference for inserting drains into the abdominal cavity was higher when other techniques were used (56% vs 26%, Table 1). Clinical outcomes and postoperative complications were summarized in Table 1, and the most common complication after laparoscopic appendectomy was wound infection (1.1%). One of the patients whose appendix stump was closed with HC was hospitalized again due to acute intestinal obstruction and another due to intraabdominal abscess. In one patient who underwent laparoscopic appendectomy using a stapler, ileocecal resection was performed on the second postoperative day secondary to appendiceal stump leakage. While the LOS was 26 ± 18 hours on the HC side, this time was 51 ± 50 hours in other techniques. In 3 (2%) of all cases, the pathology result was malignant (Table 1). Right hemicolectomy was performed for one of these patients discussed in the oncology council and the other two elderly patients were decided to be followed up.

Discussion

The most important step of the LA procedure is closure of the appendix stump. Stump leakage is likely to occur when using unsafe techniques [9, 10]. The use of HC to close the appendix stump in LA has been started in the last decade [5, 11]. After this period, discussions about the most appropriate method to close the appendix stump have gradually increased. The ideal method should be safe, accessible, simple to use, cost-effective and has acceptable complication rates. It should not prolong the operation time and LOS, and should be used in all cases whether complicated appendicitis or not. No one technique has yet been shown to be superior to each other [12].

Knight et al [13] evaluated 10 studies involving 702 patients, 7 prospective and 1 randomized controlled, between 2000 and 2017. As a result of this study was determined that HC method had the lowest complication rate compared to other techniques. On the other hand, while Kliuchanok and colleagues [14] compared a single polymeric clip with endostapler, Lucchi and colleagues [15] compared the HC with the endoloop. No difference was found in terms of complications in these two studies. In our series, HC were sufficient to close the appendix stump in 86.2% of LA cases. Complication rates of surgeries using HC or other techniques were similar.

Table 1. Demographics features and surgical outcomes of patients undergoing laparoscopic appendectomy with hem-o-lok polymeric clips or other techniques

Parameter	Value
Number of procedures, (n, %)	
Hem-o-lok	156 (86.2)
Other techniques	25 (13.8)
Total	181 (100)
Gender (F/M), (n, %)	
Hem-o-lok	68 (44) / 88 (56)
Other techniques	10 (40) / 15 (60)
Total	78 (43) / 103 (57)
Age (years ± SD)	
Hem-o-lok	29 ± 12
Other techniques	34 ± 15
Total	30 ± 13
BMI (≥30 kg/m^2), (n, %)	
Hem-o-lok	7 (4.5)
Other techniques	2 (8)
ASA class (II – III), (n, %)	
Hem-o-lok	14 (9)
Other techniques	3 (12)
Preoperative WBC count (mean ± SD, 10^9/L)	
Hem-o-lok	13.4 ± 4.3
Other techniques	12.1 ± 3.3
Total	13.3 ± 4.3
Duration of symptoms (≥48h), (n, %)	
Hem-o-lok	34 (22)
Other techniques	7 (28)
Appendix diameter (mm, mean ± SD)	
Hem-o-lok	9 ± 2.2
Other techniques	13 ± 5.4
Total	9.6 ± 3.2
Operation time (minutes, mean ± SD)	
Hem-o-lok	46 ± 17
Other techniques	55 ± 23
Total	47 ± 16
Drainage, (n, %)	
Hem-o-lok	41 (26)
Other techniques	14 (56)
Length of hospital stay (hours, mean ± SD)	
Hem-o-lok	26 ± 18
Other techniques	51 ± 50
Total	30 ± 27
Follow-up time (months, mean ± SD)	
Hem-o-lok	23 ± 15
Other techniques	20 ± 13
Total	22 ± 15
Complications, (n, %)	
Ileus	1 (0.5)
Stump leakage	1 (0.5)
Intra-abdominal abscess	1 (0.5)
Wound infection	2 (1.1)
Total	5 (2.7)
Reoperation, (n, %)	2 (1.1)
Readmission, (n, %)	2 (1.1)
Histopathologic diagnosis, (n, %)	
Phlegmonous appendicitis	106 (58.5)
Gangrenous or necrotizing appendicitis	58 (32)
Perforated appendicitis	1 (0.5)
Lymphoid hyperplasia	13 (7)
Malignant	3 (2)

Table 2. Application of different methods in cases where appendix stumps cannot be closed securely using large hem-o-lok polymeric clips

Technique	Appendix stump diameter increased	Severely inflamed appendix with involvement of the cecum
Endoloop	6	-
Hemoclips with the endoloop	9	-
Stapler	2	8

Table 3. Study design, operative time, length of hospital stay, cost from and outcomes different ways of appendiceal stump closure during laparoscopic appendectomy

Author Year Country	Study Design	N	Operative Time (min)	Length of Hospital Stay (day)	Cost Analysis	Outcomes
Our Study 2020 Turkey	Retrospective	156 Double PC 25 Others	46 (average) 55 (average)	1.1 days 2.1 days	NA	PC; safe, accessible, technically simple to use and costeffective No major complications
Kliuchanok 2019 Germany [14]	Retrospective	410 Endostapler 208 Single PC	55.3 (11–77) 51.0 (8–146)		348.70€ 19.94€	PC safe and effective. No difference in the complications.
Reinke 2016 USA [16]	Prospective	25 Double PC	45 (average)		32$	PC safe, efficient, and effective. No major complications.
Lasek 2020 Poland / Germany [8]	Retrospective	152 Endostapler 623 Clipping 243 Endoloop	45 (35–56) 55 (40–75) 70 (55–90)	3 (3-4) days 4 (3-6) days 4 (3-6) days		Usage of staplers for complicated AA may be associated with some clinical advantages.
Lucchi 2017 Italy [15]	Retrospective	121 Hem-o-lock 158 Endoloop	36.4 (15–110) 40.5 (10–120)	1.23 days 1.20 days	48€ 184€	The hem-o-lok appears to be superior than endoloop in terms of easiness of use and cheapness, maintaining the same safety. No difference in the complications.
Rickert 2015 Germany / USA [17]	Prospective	398 Titanium DS-Clip	45 (average)	3.77 days		Suitable as a standard tool for LA. Morbidity did not differ.
Hue 2013 Korea [18]	Retrospective	39 Hem-o-lok 66 Endoloop		5.3 days 5.2 days	29.2$ 68.2$	Hem-o-lok is feasible, safe and cost-effective. No difference in the complications.

Makaram et al [10] did not show any difference between techniques in terms of hospital stay in their current meta-analysis by examining 190 studies involving appendix stump closure methods. Reinke et al [16] showed that the operation time was shortened in laparoscopic appendectomies which were performed using HC. Conversely, Lasek et al [8] compared endostapler, clips and endoloop in terms of operation time and found the shortest operation time in the stapler group. In our study, it was observed that both the operation time and LOS were shorter in HC cases.

The ease of use of the stump closure technique both shortens the operation time and relieves the surgeon. It is an accepted opinion that the best method should also be cost effective. It has been demonstrated in many meta-analysis that the use of HC is cheaper than all other methods except the intracorporeal suturing technique [17, 18]. In Table 3, the results of the different methods are compared with our study. Most of these studies support our results, accepting that the HC method is safe for closing the appendix stump.

According to our results, the surgery was completed in 156 of 181 patients using large HC. Stapler was used in 8 patients with severe inflammatory acute appendicitis with cecum involvement, and endoloop method or HC method with the endoloop was used in 17 patients with increased diameter of the appendix stump (Table 2). If XL size HC were available in our operations, approximately 95 percent of laparoscopic appendectomies would have been completed using HC. We could not use XL size HC because it is not available at our center. The increasing diameter of the appendix stump was the most important factor leading to the preference of other techniques.

The limitations of study were associated with retrospective nature. Another limitation of this single center study was that there was no randomized control group with an alternative method for stump closure. However, the main purpose of this study was to demonstrate that most of the laparoscopic appendectomies can be performed with large HC. We would like to emphasize that the increase in the diameter of the appendix stump is the most

important factor limiting the use of large HC, although most laparoscopic appendectomies can be performed in experienced hands using large HC.

Conclusion

The appendiceal stump closure by large HC is a safe, feasible and effective technique. It significantly shortens the operation time and hospital stay. Other techniques may be preferred in cases of severe inflammatory acute appendicitis with cecum involvement or in cases where the diameter of the appendix stump is increased.

Conflict of interests
The authors declare that they have no competing interests.

Financial Disclosure
All authors declare no financial support.

Ethical approval
Ethical approval for this study was obtained from the local ethics committee (IRB approval number 361/2020).

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