



## Comparison of endoloop and Hem-o-lok clip for stump closure in laparoscopic appendectomy: which one is more cost-effective. A retrospective study

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Received: 14.07.2021

Accepted/Published Online: 05.03.2022

Final Version: 18.03.2022

### Abstract

We aimed to show the effect of closure of the appendix stump with different methods during laparoscopic appendectomy (LA), on postoperative complications, healing process and costs. Patients who underwent LA due to acute appendicitis in the last 5 years in Rize were retrospectively analyzed. Our study includes comparative analysis on two patient groups in which we carried LA. We used endoloop (EL) in Group 1 and hem-o-lok polymeric clip (HC) in Group 2 to close the appendix stump. Patients were compared in terms of demographic characteristics, American Society of Anesthesiologists (ASA) score, preoperative white blood cell and C-reactive protein (CRP) elevation, whether a drain was used, appendix diameter, pathological diagnosis, postoperative complications, duration of surgery and length of stay, and cost. Of 209 patients, 111 (51.2%) were male and 98 (48.8%) were female. The frequency of drain placement was higher in Group 2 (P = 0.005). No stump leakage was observed in either group, but the incidence of other postoperative complications was significantly higher in the EL group (P=0.041). The use of HC is cheaper than the use of EL. There was no significant difference in other parameters. Both EL and HC are used safely in LA. Although both methods do not have obvious advantages over each other, HC stands out one step further due to its more affordable cost and less possibility of postoperative complications.

**Keywords:** appendectomy, complications, stump, laparoscopy

### 1. Introduction

Acute appendicitis (AA) is the most common cause of emergency surgery worldwide. The standard technique is open appendectomy using the Mc-Burney incision. Laparoscopic appendectomy (LA) was first performed in 1983 as an alternative to open appendectomy (1). With advances in laparoscopy and surgical instruments, the laparoscopic approach to appendectomy has gained wide acceptance over the years.

LA is a safe procedure that provides shorter hospital stay, less wound infection, and faster postoperative recovery (2). LA is recommended as the first choice, especially in the elderly, obese patients and women (3, 4). The most important step in avoiding complications such as appendiceal stump leakage, peritonitis, sepsis, and fistula that may develop in the postoperative period during appendectomy is the safe closure of the stump (5). Many different methods have been used to close the stump in LA. Endoloop, non-absorbable polymeric clips, titanium clips, extracorporeal knots, intracorporeal ligatures, staples and ligasure are among these stump closure methods (3). There is no consensus on which of these methods is the gold Standard (6).

The ideal method for appendiceal stump closure should be safe, accessible, simple to use, and cost-effective (7-10). Stapler use is the safest and most expensive closure method, especially in inflamed, enlarged and wide-based stumps (7). The use of the Endoloop (EL) is technically complex and may require short training, but it is less costly than staples (11). Hem-o-lok polymeric clip (HC), stands out in terms of ease of use, reduction in operation time and cost (12).

### 2. Materials and Methods

Our study was carried out retrospectively with the approval of the ethics committee of Recep Tayyip Erdoğan University, Faculty of Medicine (approval date:25/11/2021, number: 2021/205). Two hundred and nine patients who underwent LA between January 2018 and September 2021 at Rize Recep Tayyip Erdoğan University Training and Research Hospital were included in the study. The appendix stump was closed with EL (CovidienTM, SurgitieTM, Ligating Loop with Delivery System, United States) or HC (Hem-o-lok ligation system, Teleflex Medical, North Carolina, United States). Patients whose appendix stump was closed using a single EL were included in Group 1, and patients whose appendiceal

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stump was closed using a single HC were included in Group 2.

Patients who used different stump closure techniques, had two or more ligatures, and were converted to open appendectomy for any reason were not included in the study. Patients' age, gender, American Society of Anesthesiologists (ASA) score, preoperative white blood cell and C-reactive protein (CRP) elevation, whether a drain was used, appendix diameter, pathological diagnosis, postoperative complications, duration of surgery and hospitalization, cost were recorded separately for Group 1 and Group 2. Differences between groups were compared.

### 2.1 Surgical technique

All operations were performed by the same surgical team and a standard protocol was followed in the surgical procedure. In general anesthesia induction, two grams of intravenous cefazolin was administered as antibiotic prophylaxis. A 10 mm trocar was placed above the umbilicus, followed by a 30° scope and examination of the peritoneal cavity. A 5 mm trocar was placed 4-5 cm above the pubis in the midline, and the second trocar (5 mm in Group 1, 10 mm in Group 2) was placed in the left lower quadrant. (Fig. 1).

The mesoappendix was resected with a 5 mm vessel closure device ligasure (Covidien™ LigaSure™ Maryland Jaw Laparoscopic Sealer/Divider, Unites States). In Group 1, a single EL was placed on the base of the appendix, and in Group 2, a single HC was placed on the base of the appendix and cut using a ligasure (Fig. 2). Different methods were used when the stump of the appendix could not be closed safely using a single EL or a single HC. Laparoscopic stapler, double EL or double HC were used in these cases, but these cases were excluded from the study. The use of a drain was not standard, this was decided during the procedure. A sampling bag was used for perforated appendicitis.



Fig. 1. Locations of the trocars

### 2.2 Statistical analysis

Statistical analyzes were performed with IBM SPSS V22

(Chicago, Unites States). Categorical data were presented with numbers and percentages, and continuous variables with mean and standard deviation. The distribution properties of continuous variables were evaluated with the Kolmogorov-Smirnov test and the Shapiro-Wilk test. Chi-square test was used to evaluate the relationship between stump closure technique and categorical variables, and Mann Whitney-U test was used to evaluate its relationship with continuous variables. The statistical significance level was accepted as  $P < 0.05$  in all statistical analyses.

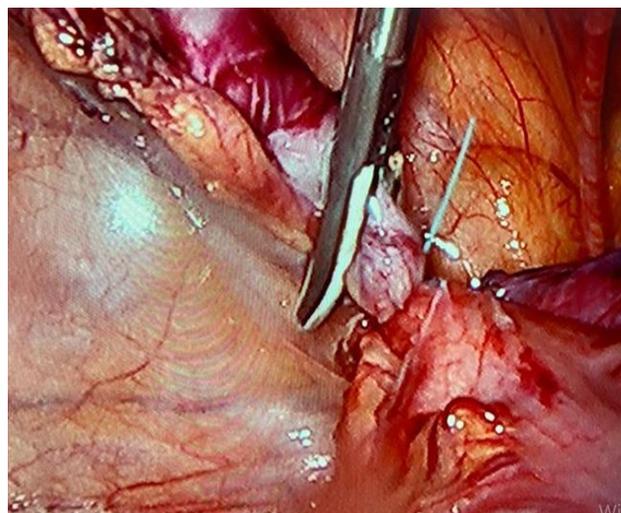


Fig. 2. Closing of the appendicular stump with application of one endoloop and cut off with ligasure

### 3. Results

There were 107 (51.2%) patients in Group 1 and 102 (48.8%) patients in Group 2. Of 209 patients, 111 (53.1%) were male and 98 (46.9%) were female. The mean age was 39.8 (minimum 18, maximum 90 years). Demographic data of the patients are defined in Table 1. There was no difference in terms of comorbid diseases in both groups according to ASA scores ( $P = 0.659$ , Table 1). There was no difference between the groups in terms of preoperative white blood cell and CRP elevation ( $P = 0.842$ ,  $P = 0.498$ , respectively Table 1). Mean operative times were 54 and 55 minutes for Group 1 and Group 2, respectively ( $P = 0.321$ , Table 2).

The use of drains was significantly higher in Group 2 ( $P = 0.005$ , Table 2). On macroscopic examination, appendix diameter was similar between both groups ( $P = 0.865$ , Table 2). There was no difference between the two groups in terms of pathological diagnosis ( $P = 0.830$ , Table 2). No stump leakage was observed in any patient in either group. Other postoperative complications were significantly higher in Group 1 ( $P = 0.041$ , Table 2). Mean length of hospital stay was similar in both groups ( $P = 0.436$ , Table 2). While the cost of one EL used in Group 1 is approximately \$43, the cost of one HC used in Group 2 is approximately \$6. The cost of EL associated with cost effectiveness is approximately 7 times higher (Table 2).

**Table 1.**Demographic characteristics of patients and preoperative findings

	Group 1 (Endoloop) n:107	Group 2 (Hem-o-lok) n:102	P
<b>Gender,n(%)</b>			
Male	57(53.3)	54(52.9)	0.962
Female	50(46.7)	48(47.1)	0.450
<b>Age,years (min-max),(SD)</b>	40.4 (18-81)(±15.94)	39.2	0.450
A1	30	34	0.659
A2	62	53	
A3	15	15	
<b>WBC height,n(%)</b>			
Yes	81(75.7)	76(14.5)	0.842
No	26(24.3)	26(25.5)	
<b>CRP Height,n(%)</b>			
Yes	79(73.8)	71(69.6)	0,498
No	28(26.2)	31.(30.3)	

min = minimum, max = maximum;SD = standard deviation;ASA= American society of anesthesiologists;WBC = white blood cell;CRP= C-reactive protein.

**Table 2.**Peroperative and postoperative findings

	Group 1 (Endoloop) n:107	Group 2 (Hem-o-lok) n:102	P
<b>Operation time, minutes (min-max),(SD)</b>	54.1 (25-120)(±25.3)	55.5 (20-120)(±22.6)	0.321
<b>Drain use,n(%)</b>			
Yes	23(21.5)	40(39.2)	<b>0.005</b>
No	84(78.5)	62(60.8)	
<b>Appendix diameter,mm (min-max), (SD)</b>	11.07 (4-28)(±4.65)	11.58 (5-40)(±5.98)	0.865
<b>Pathology,n(%)</b>			
Kataral	79(73.8)	69(67.6)	0.830
Perforated	6(5.6)	5(4.9)	
Gangrenous/phlegmon	14(13.1)	18(17.6)	
Lymphoid hyperplasia	5(4.7)	7(6.9)	
Incidental tumor	3(2.8)	3(2.9)	
<b>Postoperative complication,n(%)</b>			
Yes	17(15.9)	7(6.9)	<b>0.041</b>
No	90(84.1)	95(93.1)	
<b>Postoperative complications,n(%)</b>			
Wound infection	3(2.8)	1(0.9)	
Intra-abdominal abscess	3(2.8)	2(1.9)	
Hematoma/bleeding	3(2.8)	1(0.9)	
Brid	4(3.7)	4(3.9)	
Other (pulmonary, cardiac etc.)	5(4.7)	3(2.9)	
<b>Length of stay, days (min-max), (SD)</b>	2.82 (1-13)(±2.69)	2.29 (1-13)(±1.86)	0.436
<b>Cost,Turkish Liras(\$)</b>	395(43)	58(6)	

min = minimum; max = maximum; SD = standard deviation.

#### 4. Discussion

Today, with the widespread use of laparoscopy in every field and the development of technological surgical instruments, LA has become a preferred method by many surgeons in the treatment of acute appendicitis. LA has advantages such as shorter hospital stay, less wound infection, shorter return to daily life, less postoperative ileus, less postoperative pain, and better cosmetic results (13,14). In addition, it is one of the advantages of the laparoscopic approach to distinguish other gastrointestinal pathologies or gynecological pathologies that can mimic appendicitis clinically, and to evaluate the abdomen completely (15,16). The most important step to avoid serious complications such as stump leakage, peritonitis, and sepsis after appendectomy is the safe closure of the appendix stump. Stump leakage may occur when unsafe techniques are used (17,18). No technique has yet been

shown to be superior to the other in closure of the appendix stump (19). The ideal method should be safe, accessible, simple to use, cost-effective, and have acceptable complication rates. Intracorporeal or extracorporeal simple ligation, EL, metal or polymeric clips, and endostaps have been described for safe stump closure in LA (20). Bali et al. compared EL and intracorporeal knotting in their study, and they found no difference between the groups, except that the operation time was shorter in patients using EL (21). In a study comparing HC and metal clips, metal clips were found to be more cost-effective (22). Arer et al. reported in their study that extracorporeal knotting is an effective, safe and cost-effective alternative to HCs (23). There are multiple studies comparing HC and EL. In all of these studies, it was reported that HC can be applied more easily, in a short time, and is cheaper (24,25). In our study, no significant difference

was observed in terms of operation times in both groups. This does not mean that HC is not feasible in a shorter time. In our study, more drains were used in the HC group. Patients in the HC group were more complicated cases, and therefore, the operation time may have been prolonged, making them similar to the EL group (Table 2). Knight et al. He evaluated 10 studies involving 7 prospective and 1 randomized controlled 702 patients on appendiceal stump closure methods between 2000 and 2017 (26). As a result of this study, it was determined that the HC method had the lowest complication rate compared to other techniques. In our study, various complications were experienced in 26 patients, and postoperative complications were significantly less common in the HC group, consistent with the literature (Table 2). HCs are used safely in cystic duct ligation, ureter ligation and vessel ligation (27). HC may have caused fewer complications due to its robust structure and secure locking mechanism. It has been reported that the safest method is endoscopic stapler in cases where the appendix stump cannot be closed safely with other techniques (28). However, this method has disadvantages such as long working time, high cost and trocar site hernia. In our study, a 10 mm trocar was used in the left lower quadrant of the HC group, and the risk for trocar site hernia may have increased, but we could not have detected it correctly due to the short postoperative follow-up period. In terms of cost, the use of HC in our study is approximately 7 times cheaper than the use of EL and is compatible with the literature.

This study has several limitations. Our study is a retrospective study and it is impossible to randomize patients. Most of the patients who underwent LA are discharged within a day or two. Complications following supportive treatment may not have been detected in some of the patients included in the study due to the short follow-up period.

Both EL and HC are suitable surgical options for safe closure of the appendix stump in LA. HC appears to be slightly superior to EL due to its ease of administration, fewer postoperative complications, and lower costs.

#### Conflict of interest

The authors declared no conflict of interest.

#### Funding

No funding was used for the study.

#### Acknowledgments

This research was performed in accordance with, Departments of General Surgery, Recep Tayyip Erdoğan University Medical Faculty, Rize, Turkey

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