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Appendiceal stump closure with hem-o-lok clips in laparoscopic appendectomy

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Abstract

Various appendiceal stump closure techniques are used in laparoscopic appendectomy (LA). The purpose of this study was to investigate the safety and usefulness of the Hemolok clip for the closure of appendicular stumps in LA. From January 2015 to October 2018, a total of 87 consecutive patients underwent LA by three surgeons with planned use of Hemolok clips. In 9 (10.3%) patients, hemolok clips could not be used for the closure of the stump. The remaining 78 patients were included for analysis. The demographics, operation time, hospitalization time and complications were recorded. Of these 78 patients, 39 (50%) were male and 39 (50%) were female. The mean age was 28.55 ± 10.61 (18-73) years and median operation time was 51.3 (30-160) minutes. Twenty-two (28.2%) of the patients had complicated appendicitis (perforated, necrotic). The median time until oral diet allowance was 10.48 (4-36) hours after surgery and median hospitalization time was 22.92 (6-72) hours. Postoperative complications were seen in 4 (5.1%) patients; two had abdominal pain, one had abdominal distention and one had trocar site infection. None of the complications were associated with the use of hemolok clips. None of the patients required reoperation. The appendiceal diameter was found to be greater in patients without hemolok closure compared to patients with hemolok closure ($p = 0.003$). The closure of the appendix stump with hemolok in LA is an appropriate, safe, fast and cost-effective technique. It is important to note that the appendix stump should not be extremely edematous or necrotic in order to be able to apply hemolok clips. Ideally, the stump should have a diameter smaller than 1 cm.

Keywords: acute appendicitis, laparoscopic appendectomy, appendiceal stump, hem-o-lok clip

1. Introduction

The most common acute abdominal pathology requiring emergency surgery is acute appendicitis, with a lifetime risk of 8.6% for men and 6.7% for women (1,2). The curative treatment of acute appendicitis is appendectomy which may be done through an open incision in the abdomen or through laparoscopic techniques (3). Laparoscopic appendectomy (LA) was first described in 1983 by Semm as an alternative to open surgery (4). With this method and advances in techniques, beneficial outcomes such as shorter hospitalization, less postoperative pain, earlier return to work and better cosmetic results emerged as the advantages of LA compared to open appendectomy, indicating that this method was more than an alternative to classical surgery. As such, LA has gained significant popularity and is now recommended as the new 'gold standard' technique for appendectomy (5).

The main concern in LA is the matter of closure of the appendiceal stump because most complications develop as a result of leakage from the stump. Many methods are used to close the stump in LA. The methods of stump closure include intracorporeal knotting, endoloop, titanium clips, endostapler, and more recently, the use of nonabsorbable plastic polymer clips (6-9). Most of these techniques are either time consuming or expensive, or they are not commonly available as their production is often limited (10). Less expensive techniques, such as endoloops or intracorporeal knotting, are used as a standard method in many institutions to close the appendiceal stump in LA.

The aim of this retrospective clinical study was to evaluate the safety and efficacy of the universally available polymer locking ligation system (Hem-o-lok clip) for stump closure in L.

2. Materials and Methods

In this sudy, we retrospectively examined 87 consecutive patients that were successfully treated via laparoscopy after being diagnosed with acute appendicitis between January 2015 and October 2018. In 78 of them, hem-o-lok clips were used to close the appendix stump. The study was performed in accordance with the ethical standards specified in the Declaration of Helsinki and was approved by the Clinical Research Ethics Committee of Ordu University (Date: 15.11.2018, No: 2018-226). Informed consent was obtained from all individual participants included in the study. All operations were done by two surgeons experienced in minimally invasive techniques who routinely perform a variety of laparoscopic general surgery procedures. In some cases, a surgical trainee (first to fifth year of surgical training) was also present and contributed to the surgery under the supervision of the two specialists. hem-o-lok clips were used

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for closure of the stump whenever possible.

Surgery was described briefly, as follows: pneumoperitoneum was obtained by the use of a Veress needle. Three laparoscopic ports were placed: A 10-mm at the umbilicus, a 5-mm at the midline just cephalic to the pubic bone, and a 10-mm trocar at the left iliac fossae. After the initial laparoscopic evaluation of the abdominal cavity, a Harmonic scalpel was used (Ultracision, Ethicon Endosurgery, Cincinnati, OH) for the sectioning and hemostasis of the appendicular mesentery. Occlusion of the appendicular base was performed by using two nonabsorbable hem-o-lok XL polymeric clips (Weck Closure Systems, Triangle Park, NC) (Image 1). The size of the XL clip was 17.33 mm in the outer arch and 13.58 mm in the inner arch. Results were analyzed statistically using the SPSS 15.0 program (SPSS Inc., Chicago, IL, USA). Variables expressed as mean, standard deviation, median, minimum and maximum values, and count and percentage. The Student's t-test was used for the comparison of quantitative values, and the chi-square test was used for the comparison of categorical values.

3. Results

Of the 78 patients who received hem-o-lok clips, 39 (50%) were male and 39 (50%) were female. The mean age of the patients was 28.55 ± 10.61 (18-73) years. Operation time was between 30 min and 160 min and the median time was 51.3 min. In one patient, the abscess around the cecum was drained. There were no complications such as bleeding and perforation. The median time until allowance of oral diet was 10.48 (4-36) hours and median hospital stay was 22.92 (6-72) hours. Twenty-two (28.2%) patients had complicated appendicitis (perforated/necrotic). Postoperatively, two of the patients had abdominal pain, one had abdominal distention and another had trocar site infection. The abdominal pain and distention resolved within 3-4 hours without any additional treatment. The patient who developed a trocar site infection completely recovered with dressing and antibiotics. In addition, no major complications, such as intraabdominal abscess, stump opening or gastrointestinal tract perforations, were observed in this study. We did not have any patients who required re-hospitalization or re-operation (Table 1).

During the study period, the appendix stump could not be closed with the hem-o-lok clip in 9 (10.3%) of the patients who underwent LA. The reasons were either necrotic appendix root or the size of the appendix (extremely large due to edema etc.). Four of these patients received endoscopic stapling and five underwent the endoloop closure. The median appendix diameter of the patients in which hem-o-lok clips could be applied was 9.35 (4-15) mm. The median appendix diameter in the 9 patients without hem-o-lok application was 13.33 (8-34) mm. There was a statistically significant difference between the two groups in terms of appendix diameter ($p = 0.003$). In patients who could not receive hem-o-lok clips, the operation time was between 45 min and 90 min, with a median of 51.6 min. There was no statistically significant difference between the hem-o-lok and non-hem-o-lok groupsin terms of operation time ($p > 0.05$).

Table 1. The data of patients whose appendiceal stumps were closed with Hem-o-lok clips during laparoscopic appendectomy

Gender	
Male	39 (50%)
Female	39 (50%)
Mean age (year)	28.55 ± 10.61 (18-73)
Mean operation time (min)	51.3 (30-160)
Mean diameter of the Appendix (mm)	9.35 (4-15)
Number of complicated appendix	22 (28.2%)
Mean time of oral diet (hrs)	10.48 (4-36)
Mean time of hospitalization (hrs)	22.92 (6-72)
Postoperative Complications	
Major Complication	0 (0.0%)
Minor Complication	4 (5.1%)
Trocar site infection	1 (1.3%)
Postoperative abdominal distention	1 (1.3%)
Postoperative abdominal pain	2 (2.6%)

4. Discussion

LA is currently the preferred technique for the treatment of acute appendicitis. In recent studies, it has been estimated that >50% of appendectomies are performed by laparoscopic approach (11). The most important step in LA is the appropriate closure of the appendicular stump which enables avoidance of serious complications such as postoperative fistula, peritonitis, abscess and sepsis (12).

There is no unanimously accepted suggestion regarding the closure of the appendicular stump in LA. However, it is widely accepted that the ideal method for appendix stump closure should be safe, accessible, technically simple and cost effective. Various appendiceal stump closure techniques have been described in the literature, including endoloop, intracorporeal knotting, metal titanium clips, endostaplers and polymer plastic clips. Every technique has its own benefits and disadvantages (6-9).

The current literature most commonly describes using either a suture ligature 'endoloop' or an endoscopic stapler to close the appendix (13,14). Endoloops are one of the first methods used to close the appendiceal stump. Endoloop is a laparoscopic knot lasso made of silk or polyglactine. Closure of the appendix stump with endoloop is a common procedure and has lower cost compared to staplers (15,16). The main problem with this method is that the knot may be loose and this could lead to leaks from the appendiceal stump. The use of endoloop for the closure of appendiceal stump in some cases may prolong surgery time due to the need for experience in the application (15). On the other hand, the endoscopic stapler method is a safe and widely-accepted method, but at the same time it is the most expensive method when compared with other techniques (17). Staplers allow simultaneous sealing and division of both the mesentery of the appendix and the appendix base. One of the major

advantages is that it is safe even when the appendix base is inflamed and its diameter is too large (18).

In recent years, laparoscopic clips have been proposed as an alternative method for the closure of the appendiceal stump during laparoscopic appendectomy. Rickert et al. offered evidence that the use of titanium clips had significant success in the closure of appendiceal stumps. The most important feature of titanium clips in comparison to other commercially available clips is the size; appendiceal stumps up to 20 mm in diameter can be securely closed with these clips (19). The disadvantage of titanium clips is reported to be the risk of displacement during manipulations required for the laparoscopic procedure (20).

The safety of hem-o-lok clips has been demonstrated in various areas of surgery, including the in ligation procedures of the ureter, cystic duct or vessels up to 16 mm in diameter (21). In recent years, several articles have described the use of non absorbable hem-o-lok clips which agree that these are safe, easy-to-use and relatively inexpensive (8,15,22). Al-Temimi et al. found that hem-o-lok clips could be used safely with no increase in intraoperative bleeding, stump dehiscence or postoperative complications in comparison to endoscopic staplers (23). Parteke et al. found that there were no differences in postoperative complications between hem-o-lok clips (3.9%) and endoscopic stapling (5.4%) (8). In our study, the results are similar to the literature in terms of risks, as there were no major complications in the 78 hem-o-lok clip recipients.

Intra-abdominal abscess is the most common surgical complication following LA procedures (14,24). Studies on the endoloop procedure demonstrate a relatively high rate of intra-abdominal abscess (up to 5%) (25). In a large retrospective study, Soll et al. found that complications (including intraabdominal abscess) developed less frequently after the use of hem-o-lok clips compared to the endoloop method (1% vs. 4%, $p = 0.012$) (26). In our study, none of our patients developed intraabdominal abscess.

Hem-o-lok clips are available in a range of sizes including M (medium), ML (medium-large), L (large) to XL (extra-large) that are suggested to be able to ligate tissue bundle sizes up to 16 mm. Although their marketing statements suggest that hem-o-lok clips may be used for closures up to 16 mm diameter, the reliability is decreased in cases where the appendix base diameter is over 1 cm. For instance, Hue et al. suggested the use of hem-o-lok clips when the diameter of the appendiceal stump was less than 10 mm and only in the presence of mild inflammation (27). Our experience is also similar, and the fact that there was a significant difference in stump diameter between the two groups (with and without hem-o-lok) indicates that their use in the severely inflamed appendix may not be reliable, or even possible, in some situations. The main advantages of using of hem-o-lok clips for appendiceal stump closure are the lack of a learning curve for application, the ease of application, and low cost (28). In addition, Hem-o-lok clips are reported to cause a milder reaction from the host tissue compared to endoloops (29).

The Hem-o-lokclip offers significant reduction in costs when compared to endoscopic staplers, and provides a simpler application when compared to suture ligature techniques (30). However, in the presence of necrosis or severe edema, other methods should be considered for the closure of the appendiceal stump. The decision to apply Hem-o-lok on patients with thick appendiceal base and/or acute inflamed tissue should be made with respect to intraoperative status and surgical judgment on a patient-by-patient basis.

There are several limitations in this retrospective study. First of all, our study was not a prospective randomized study and, as mentioned before, the use of hem-o-lok clips was planned in all patients. Thus, comparisons could only be performed in a limited number of subjects in which hem-o-lok application was unfeasible. Secondly, the study population can be considered to be limited for the assessment of outcomes in a widely-used and popular technique such as LA.

In conclusion, the use of nonabsorbable polymeric hem-o-lok clips are feasible and cost-effective for the closure of appendiceal stumps of up to 10 mm in diameter. The results of our study have encouraged us to continue to use this technique. Further randomized controlled trials are needed to compare the hem-o-lok technique to different methods of appendiceal stump closure.

Conflict of interest

None to declare.

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The study was performed in accordance with the ethical standards specified in the Declaration of Helsinki and was approved by the Clinical Research Ethics Committee of Ordu University (Date: 15.11.2018, No: 2018-226).

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