

Hand-made Extracorporeal Knotting versus Hem-o-Lok Clip for Stump Closure in Laparoscopic Appendectomy

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ABSTRACT

Objective: To compare hand-made extracorporeal knotting and hem-o-lok clip for the closure of appendix stump regarding safety, complications and cost-effectiveness.

Study Design: Descriptive study.

Place and Duration of Study: Baskent University Adana Teaching and Research Center, between January 2010 and December 2016.

Methodology: A total of 287 patients, who underwent laparoscopic appendectomy, were enrolled in this study. Patients were divided into hand-made extracorporeal knotting and hem-o-lok clip groups. Patients were compared according to age, gender, duration of symptoms, serum leukocyte count, American Society of Anesthesiologists (ASA) score, intraoperative findings, operation time, hospital stay, pathology report and complications.

Results: Of 287 patients, 149 (51.9%) were female and 138 (48.1%) were male. The mean age was found 34.9 years. No statistical difference was observed between groups according to age, gender, duration of symptoms, serum leukocyte count, ASA score, operation time and hospital stay. Intraoperative findings were different between groups ($p < 0.05$). Overall postoperative complication rate was 6.6%. No statistical difference was observed regarding complications.

Conclusion: Both hand-made extracorporeal knotting and hem-o-lok clips can be used for stump closure in laparoscopic appendectomy. Hand-made extracorporeal knotting is an effective, safe and cost-effective method alternative to hem-o-lok clips.

Key Words: *Laparoscopic appendectomy, Clip, Stump closure, Knotting, Appendicitis.*

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INTRODUCTION

Appendectomy is the most commonly performed surgical procedure for patients admitted to emergency department. Since laparoscopic appendectomy (LA) was first introduced in 1983, it became popular and an alternative to open appendectomy.¹ LA is now the standard approach for the treatment of acute appendicitis and superior to open appendectomy regarding outcomes. It has the advantage of better visualisation of the abdominal cavity for additional pathologies. However, LA has higher cost rates than open appendectomy because of stump closure technique.

There are different techniques for appendix stump closure in laparoscopic surgery.² Some authors recommend simple tie knotting or endoloop³; whereas, others recommend staplers⁴ and clips.⁵ All these techniques were proven to be safe and effective but stapler and endoloop increase the cost, especially stapler should be preferred only in selected patients.⁶ Metal clips were

found to be effective and safe even in complicated appendicitis.⁷ Simple tie mimics endoloop but decreases cost; and it can be applied by intra- or extra-corporeally. Recently, hem-o-lok (non-absorbable polymeric) clips were introduced and found to be effective for stump closure.⁸ Hand-made extracorporeal knotting was described before⁹ but it was not compared with endoclip.

As described above, all techniques for stump closure can be preferred; however, their cost-effectiveness and applicability should be considered. There are fewer studies in literature comparing hand-made extracorporeal knotting and hem-o-lok clips. In this study, the aim was to compare two different techniques; hand-made extracorporeal knotting and hem-o-lok clip for stump closure in laparoscopic appendectomy regarding operation time, complications and cost-effectiveness; and define which one safer and superior.

METHODOLOGY

A total of 287 patients who underwent laparoscopic appendectomy at Baskent University between January 2010 and December 2016 were included. Patients with the signs of clinical and/or radiological appendicitis, age between 18-90 years, laparoscopic appendectomy with use of hand-made extracorporeal knotting and hem-o-lok clip were included. Patients with plastrone appendicitis, conversion to open appendectomy, single

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incision laparoscopic appendectomy and use of other techniques for stump closure were excluded. Data were collected retrospectively *via* patient software data records. Patients were divided into two groups according to stump closure technique: group 1 was hem-o-lok clip and group 2 was hand-made extracorporeal knotting group. Ethical approval and informed consent were not taken because of the retrospective design of this study, but this study was prepared in accordance with the Declaration of Helsinki ethical principles.

All operations were performed using 3 conventional laparoscopic trocars (two 10-mm and one 5-mm ports). One 10-mm trocar for the camera (30 degree) was placed *via* infraumbilical incision, other 10-mm trocar *via* suprapubic incision and 5-mm trocar *via* right lower quadrant mid-clavicular incision. After positioning the patient in 20° Trendelenburg position and 15° tilting to the left, dissection of the mesoappendix was done gently by Ultracision® harmonic scalpel (Ethicon Endosurgery, Cincinnati, USA). Then appendix stump was closed by modified Tayside knot, hand-made extracorporeal knotting described by Mayir *et al.*¹⁰ Stump was closed by two knots in group 2 (Figure 1). One non-absorbable polyester braided suture or absorbable polyglactin braided suture was tied outside the abdomen and then pushed forward by the knot applier on the appendix stump. Nearly 2-3 mm above the former knot, another one was placed. Non-absorbable polymeric clip (Hem-o-lok® ligation system, Teleflex Medical, NC, (USA) was used for patients in group 1. One clip was placed on the appendix stump by clip applier. The other clip was placed 2-3 mm above the former one (Figure 2).

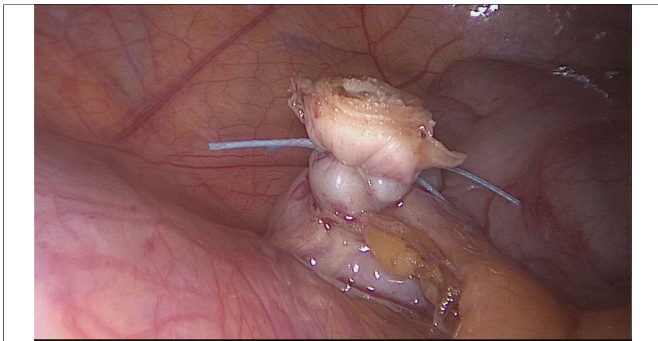


Figure 1: Hand-made extracorporeal knotting on appendix stump.

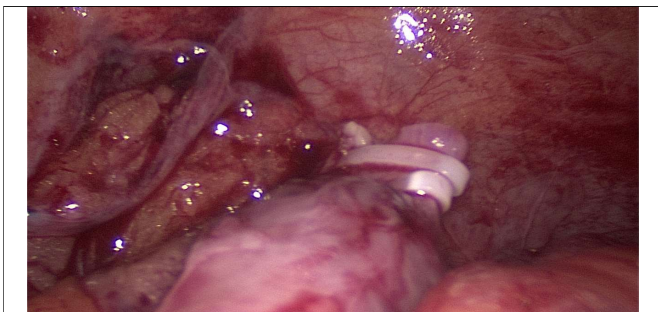


Figure 2: Hem-o-lok clips on appendix stump.

Patients in the two groups were compared according to age, gender, duration of symptoms, serum leukocyte count, American Society of Anesthesiologists (ASA) score, intraoperative findings, operation time, hospital stay, pathology report and complications.

Statistical analyses were performed with Statistical Package for the Social Sciences Software (version 17.0; SPSS, Inc., Chicago, IL). For continuous variables, Kolmogorov-Smirnov test was applied to test normal distribution. The two groups were compared using the independent samples t-test for normally distributed continuous variables and the Mann-Whitney U-test for non-normally distributed continuous variables. For continuous variables, those with normal distribution were expressed as mean \pm SD, median values without normal distribution. The Chi-square test was used for comparison of categorical variables. A p-value less than 0.05 was considered statistically significant.

RESULTS

Of 287 patients, 149 (51.9%) were females and 138 (48.1%) were males. The mean age was found 34.9 years (min. 18 max. 79 years). Demographic data of the patients were described on Table I. One hundred and eight patients were in group 1 and 179 patients in group 2. Mean duration of symptoms was 1.79 and 1.73 days for group 1 and 2, respectively. Average serum leukocyte count of patients in two groups were similar ($p=0.790$). There was no statistical difference between groups regarding ASA score ($p=0.081$). Perforated appendicitis was found intraoperatively in 11 (6.1%) patients that were in group 2 and intraabdominal abscess was found in 2 (1.1%) patients that were also in group 2. None of the patients in group 1 were found to have perforated appendicitis or abscess intraoperatively, which was statistically different ($p=0.016$). The average operation time was found to be 55 and 45 minutes for group 1 and 2, respectively (Table II). The average hospital stay for group 1 was 1 day and for group 2 was 1 day ($p=0.038$). The permanent pathology of 12 (11.1%) patients in group 1 and 8 (4.5%) patients in group 2 were reported as perforated appendicitis ($p=0.053$). Superficial incisional surgical site infection (4.5%) was the most common complication which was observed in 13 patients. Overall postoperative complication rate was 6.6% ($n=19$). No patients received surgical re-intervention. Percutaneous intraabdominal abscess drainage was done in 4 (1.4%) patients. No intra-operative complication and postoperative mortality was observed. Two hem-o-lok clips used for each patient in group 1, accounts for \$20 and 1 suture used for each patient in group 2 accounts for \$0.63, except from the operation cost. Regarding cost-effectiveness, hem-o-lok clip cost is 31.7 times suture material.

DISCUSSION

Laparoscopic appendectomy is gaining popularity than open procedure and has the advantages such as shorter

Table I: Demographic data of patients.

	Hem-o-lok group (n=108)	Hand-made extracorporeal knotting group (n=179)	p-value
Female/Male	55/53	94/85	0.808 ($\chi^2 = 0.068$)
Age* (years), median (IQR)	31.5 (18-79)	32 (18-78)	0.522 (Z=-0.64)
Duration of symptoms* (Days), median (IQR)	1 (1-10)	1 (1-10)	0.858 (Z=-0.179)
Serum leukocyte count* (x10 ³ /μL)	13.63 ±5.16	13.48 ±3.88	0.790 (t=0.267)
ASA score			0.081 ($\chi^2 = 5.028$)
1	76 (70.4%)	106 (59.2%)	
2	25 (23.1%)	64 (35.8%)	
3	7 (6.5%)	9 (5%)	
Intraoperative finding			0.016 ($\chi^2 = 8.216$)
Appendicitis	108 (100%)	166 (92.7%)	
Perf. appendicitis	0 (0%)	11 (6.1%)	
Abscess	0 (0%)	2 (1.1%)	
Pathology report			0.053 ($\chi^2 = 4.583$)
Appendicitis	96 (88.9%)	171 (95.5%)	
Perf. appendicitis	12 (11.1%)	8 (4.5%)	

* Values are mean ± standard deviation.
ASA = American society of anesthesiologists.

Table II: Per- and post-operative findings of the patients.

	Hem-o-lok group (n=108)	Hand-made extracorporeal knotting group (n=179)	p-value
Operation time (minutes), median (IQR)	55 (15-120)	45 (20-120)	0.317 (Z=1)
Hospital stay (days), median (IQR)	1 (1-12)	1 (1-8)	0.038 (Z=2.075)
Complication			0.111 ($\chi^2 = 6.010$)
None	102 (94.4%)	166 (92.7%)	
SISSI	4 (3.7%)	9 (5%)	
Intraabdominal abscess	0 (0%)	4 (2.2%)	
Seroma	2 (1.9%)	0 (0%)	

SISSI: Superficial incisional surgical site infection.

hospital stay, fast recovery, less pain, and better quality of life. Stump closure of the appendix is the crucial step of this procedure. Although some authors use only coagulation devices for stump closure, most of the surgeons do not dare that much yet. Stump leakage may result in complications such as intraabdominal abscess. In open appendectomy stump can be easily secured with simple tie or in complicated cases with purse string suture. For safe closure of the stump in LA, there are several techniques that are: intra- or extra-corporeal simple tie, endoloop, metal or polymeric clips and endostaplers.⁷ There are studies comparing these techniques although comparison of hand-made extracorporeal knotting and polymeric clips has not been done yet. Strzalka *et al.* conducted a study comparing metal clip, suture and endostaplers in 307 laparoscopic appendectomy patients; and found no statistical difference regarding complications between these three techniques.¹¹ Matyja *et al.* also compared these three methods, found no differences between these techniques,

and states that endoscopic stapler increases cost and should be applied in cases of failure of stump closure with other techniques.¹²

Both of these studies are retrospective, which is also one of the limitations of our study. However, endostaplers are proven to be safe even in complicated cases, they increase the cost a lot.^{13,14} Application of the endostapler may increase operation time. Some authors observed increased operation time in endostapler group;⁶ whereas, Kazemier *et al.* found the opposite.¹³ Together with increasing the cost and operation time, we believe that the application of endostapler *via* 15 mm trocar also increases risk of trocar site hernia. Therefore, endostapler should be used in cases when other techniques fail to secure the appendix stump.

Endoloop and intracorporeal knotting have been compared by Bali *et al.* and no statistical difference between groups other than operation time was observed.¹⁵ The mean operation time increases nearly 5.6 minutes when intracorporeal knotting was applied (p=0.01). Kiudelis *et al.* conducted a prospective study on 152 patients comparing intracorporeal knotting with invaginating suture *versus* endoloop and found that endoloop decreases operation time (p>0.05), but increases cost approximately 80€ for each patient.¹⁶ Therefore, endoloop has the advantage of less operation time but increase in cost.

Hem-o-lok clips made of non-absorbable polymeric material can also be used for stump closure. Hue *et al.* compared hem-o-lok clips and endoloop in 105 patients and found hem-o-lok clips to be safe, fast and cost-effective in patients with a mildly to moderately inflamed appendix base of less than 10 mm in diameter.¹⁷ Hem-o-lok clips are \$39 cheaper than endoloop.¹⁷ They are also easily applied and do not increase operation time. In our opinion, hem-o-lok clips are safer than metal clips because they have locking mechanism. Rickert *et al.* used titanium double shanked clips for stump closure, which have the similar design with hem-o-lok clips and found it to be safe and cost-effective.¹⁸ Unfortunately, these titanium clips are applied *via* 12.5 mm trocar; whereas, hem-o-lok clips *via* 11 mm trocar. Ates *et al.* compared titanium endoclip and intracorporeal knot tying in a prospective randomised study, including 61 patients, and found titanium endoclips to be a useful alternative to intracorporeal knot-tying and titanium endoclip application significantly decreases operation time (p=0.01).¹⁵

In a study including 49 pediatric patients, hem-o-lok clips were found to be easily applicable (the mean duration of application for hem-o-lok is 1 minute and endoloop is 5 minutes, p<0.05) and more economical (by \$81.5) than endoloops.¹⁹ Colak *et al.* also found hem-o-lok group to have shorter operation time and cheaper than endoloop group.²⁰ Lucchi *et al.* stated that endoloop and hem-o-lok clips are safe for appendicular stump closure although hem-o-lok clips are superior in case of ease-

ness of use and cheapness.²¹ Wilson *et al.* found hem-o-lok clips to be safe as endoloop with the advantages of low cost and less operation time.²² However, there are cheaper endoloops that costs between \$15-32 and equal to hem-o-lok clip cost.⁶

Mayir *et al.* described hand-made loop for stump closure which is an effective, safe and cheap (only \$1) method.¹⁰ Although hem-o-lok clip application makes additional cost \$19.37 to the patient, it is also inexpensive compared to other techniques.²³ Hand-made loops do not increase operation time and can even be applied *via* 5-mm trocar.

CONCLUSION

Hand-made loop and hem-o-lok clips are both used for stump closure in laparoscopic appendectomy. But, hand-made loop is an effective, safe and cost-effective alternative method to hem-o-lok clips.

CONFLICT OF INTEREST:

Authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:

IMA: Conception or design of the work, analysis, interpretation of data, final approval of the version to be published, critical review.

TA: Interpretation of data, drafting the work, final approval of the version to be published.

HY: Conception or design of the work, conception or design of the work, drafting the work, final approval of the version to be published, critical review.

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