



Stump Closure Techniques in Laparoscopic Appendectomy: Analysis of 511 Patients

Laparoskopik Appendektomide, Appendiks GÜDÜK Kapatma Teknikleri: 511 hastanın Analizi

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ABSTRACT

Aim: Laparoscopic appendectomy has become an accepted method for the management of acute appendicitis. Closing the appendiceal stump is a crucial step in this operation. Although various methods for stump closure have been described, there is no evidence-based consensus in the literature. In our study, we aimed to compare the stump closure techniques used in laparoscopic appendectomy surgeries performed in our clinic.

Material and Method: Laparoscopic appendectomy operations conducted between 2017 and 2021 were retrospectively examined. Demographic information, operation durations, length of hospital stays, Alvarado scores, intraoperative findings, readmissions, reoperations, intra-abdominal abscesses, wound site infections, stump leakage, ileus, and other complications were evaluated for a total of 511 patients.

Results: Of the patients, 193 (37.8%) were female, and 318 (62.2%) were male. The mean age was 37.84 years, with an Alvarado score of 6.89, and an average hospital stay of 1.45 days. Stump closure methods were as follows: 208 (40.7%) patients with Hem-o-lok polymer clips (HLK), 59 (11.5%) patients with endo-stapler (EDS), 111 (21.7%) patients with manually inserted loops (EYL), and 133 (26%) patients with endoloop (EDL). According to the method, the average operation durations were determined as 48.28 minutes in the HLK group, 51.69 minutes in the EDS group, 48.23 minutes in the EYL group, and 48.80 minutes in the EDL group. Hospital stays were observed to be the longest in the EDS group with an average of 1.73 days based on the stump closure method. Complications developed in 2 patients in the HLK group, 2 patients in the EDS group, and 1 patient in both the EYL and EDL groups.

Conclusion: The examined stump closure methods appeared to be similar in terms of application and complications. Although the study included a large series of patients, these findings need to be confirmed through prospective randomized controlled trials.

Keywords : Laparoscopy, appendectomy, stump

ÖZ

Amaç: laparoskopik appendektomi, akut apandisit yönetiminde kabul edilmiş bir yöntemdir. Apendiks güdüğünün kapatılması bu operasyonun en önemli basamağıdır. GÜDÜK kapatma için bir çok yöntem tarif edilse de literatürde kanıta dayalı bir konsensüs yoktur. Çalışmamızda, kliniğimizde gerçekleştirilen laparoskopik appendektomi ameliyatlarını uygulanan güdük kapatma yöntemlerine göre karşılaştırmayı amaçladık.

Gereç ve Yöntem: 2017-2021 yılları arasında, gerçekleştirilen laparoskopik appendektomi operasyonları, retrospektif olarak incelendi. Toplam 511 hastanın demografik bilgileri, ameliyat süreleri, hastanede yatış süresi, alvarado skorları, intraoperatif bulguları, yeniden yatış ve ameliyat, intra abdominal apse yara yeri enfeksiyonu, güdük kaçağı, ileus gibi komplikasyonları değerlendirildi.

Bulgular: Hastaların 193'ü (%37,8) kadın 318'i (%62,2) Erkekti. Ortalama yaş 37.84, Alvarado skoru 6,89 hastanede yatış süresi 1,45 gündü. GÜDÜK kapatma yöntemi, 208 (%40,7) hastada hem-o-lok polimer klip(HLK)* ile, 59(%11.5) hastada endo-stapler(EDS)* ile, 111(%21.7) hastada el yapımı loop'un(EYL)* batına itilmesi ile, 133(%26) hasta endoloop(EDL)* ile kapatıldı. Yönteme göre, ortalama ameliyat süreleri, HLK grubunda 48,28 dk, EDS grubunda 51,69 dk., EYL grubunda 48,23dk., EDS grubunda 48,80 dk. olarak tespit edildi. GÜDÜK kapatma yöntemine göre hastanede yatış süreleri, EDS grubunda 1,73 ortalama ile en uzun yatış süresi olarak gözlenmiştir. Gelişen Komplikasyonlar HLK grubunda 2 hastada, EDS grubunda 2 hasta, EYL grubunda ve EDL grubunda 1'er hasta saptanmıştır.

Sonuç: İncelenen güdük kapatma yöntemlerinin, uygulanması ve komplikasyonları açısından benzer oldukları görülmüştür. Her ne kadar geniş bir seri olsa da bu bulguların prospektif randomize kontrollü çalışmalar ile denetlenmesi gerekmektedir.

Anahtar Kelimeler: Laparoskopi, appendektomi, güdük

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INTRODUCTION

Appendectomy is an important procedure in emergency surgical practice. There are two methods for performing an appendectomy: open and laparoscopic. Laparoscopic appendectomy (LA) was first performed by Semm and colleagues in 1983 (1). Over the past 40 years, the advantages of laparoscopic appendectomy over open appendectomy, such as shorter hospital stays, less pain, and earlier return to postoperative work, have been demonstrated, and it has gained general acceptance (2-4). In laparoscopic appendectomy, the most crucial step of the surgery is the secure closure of the appendiceal stump. As LA has become more widespread, many different methods for closing the appendiceal stump have been defined and applied (5-10). However, it has been reported that the rate of postoperative intra-abdominal abscess is higher in LA compared to open appendectomy (11). Postoperative intra-abdominal abscess, peritonitis, fistula, and other infectious complications are believed to be associated with the appendiceal stump closure methods. Nevertheless, none of these methods have shown superiority over the others in terms of postoperative complications and perioperative outcomes (12-14). In this study, we aimed to analyze the intraoperative and postoperative results of four different stump closure methods (Hem-o-lok clips, endostapler, endo-loop, and handmade-loop).

MATERIAL AND METHOD

Approval was obtained from the Health Sciences University Dışkapı Yıldırım Beyazıt Training and Research Hospital Clinical Research Ethics Committee (Date: 18.04.2022, Decision No: 135/16). This study was conducted in accordance with the ethical guidelines of the 1975 Declaration of Helsinki and its later amendments. Informed consent form was obtained from all participants included in the study.

Study design

Between January 2017 and December 2021, cases of laparoscopic appendectomy were retrospectively examined. Patients who were completed laparoscopically and used hem-o-lok polymer clip, endo stapler, handmade loop or commercially available endo loop as stump closure method were included in the study. Cases where laparoscopy was initiated but converted to open surgery, involving routine non-appendectomy surgeries (such as colectomy, ileocecal resection, etc.), where a different method was used for stump closure other than the mentioned four methods, and of elective interval appendectomy were excluded from the study. Patients with missing data were excluded from the study. In total, 511 cases, were analyzed. Patients were divided into four groups based on the stump closure method used. The primary outcome of the study was compared among these four groups as postoperative intra-abdominal abscess. As

secondary outcomes, the study analyzed variables including length of hospital stay (days), duration of surgery (minutes), hospital readmission, reoperation, incision site (trocar entry site) infection, postoperative bleeding, postoperative ileus, and stump leak. Postoperative intra-abdominal abscess was defined as a postoperative intra-abdominal collection diagnosed clinically with fever, leukocytosis, and abdominal pain, confirmed by cross-sectional imaging (computed tomography), and requiring antibiotic administration or radiological or surgical intervention. Incision site infection was defined as a superficial surgical site infection at any trocar entry site requiring antibiotic administration, incision opening, or both. Stump leak was determined by the demonstration of leakage from the appendiceal stump through contrast-enhanced cross-sectional imaging or reoperation, or both. The study design incorporated The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (15)

Statistical analysis

IBM SPSS Statistics for Windows, Version 21 (IBM Corp., Armonk, NY, USA) was used for all analyses. Categorical variables were characterized using frequencies and percentages across the corresponding subset of the sample. Shapiro-Wilk and Kolmogorov-Smirnov (K-S) tests were used to check the data for normality. The differences between the subgroups were tested using the Chi-square or Fisher's exact test for categorical variables, ANOVA, and the Kruskal-Wallis rank sum test for continuous variables (relative frequencies). Statistical significance was set at $p < 0.05$.

RESULTS

A total of 511 patients were included in this study. The appendiceal stump was closed with a Hem-o-lok clip in 208 patients (40.7 %), endo-stapler in 59 patients (11.5 %), endo-loop in 133 patients (26.0 %), and a handmade loop in 111 patients (21.7 %). The mean age of the patients was 37.84 ± 13.15 years. 193 of patients (37.8%) were female and 318 (62.2%) were male. There was no difference in the mean age and sex distribution among the four groups according to the stump closure method applied. There were ASA1 120 (23.4%), ASA2 351 (68.6%), ASA 3 and ≥ 40 (8%) patients, respectively. A total of 191 (37.3%) patients had an Alvarado score of six or less and 320 (62.7%) patients had an Alvarado score of seven or more. There was no significant difference between the four stump closure methods applied according to the patients' Alvarado scores. ($p=0.328$) According to histopathological results, no significant difference was observed between the groups ($p=0.448$).

The average operation time of the patients was 48.80 ± 15.32 minutes and the average hospital stay was 1.40 ± 0.49 days. There was no difference between the groups in terms of operation time and length of hospital



stay. None of the patients underwent reoperation. The number of patients readmitted to the hospital was 12 (2.3%) and there was no difference in readmission among the four groups. Nine (1.8%) patients had wound infections. There were no statistically significant differences between the groups in terms of wound infection. ($p = 783$) Postoperative ileus was observed in 6 (1,2%) patients and no difference was observed according to stump closure methods. Among the 511 patients included in the analysis, there were no cases of postoperative intra-abdominal abscess, stump leak, or bleeding. **Table 1** summarizes the study results

DISCUSSION

Unfortunately, despite the passage of 30 years since Semm and colleagues' description of LA, there is still no established consensus on the most crucial step of the surgery, which is stump closure (1). In this study, we evaluated four different methods, and we believe that the choice of selected methods is related to the surgical team's experience and familiarity with the technique.

In our study, the primary outcome we aimed to assess was the difference in the development of intra-abdominal abscess among the groups, but no intra-

abdominal abscesses were observed in any group. Gomes and colleagues reported intra-abdominal abscess rates of up to 5% in their study of 131 cases of complicated appendicitis (16). While Sham and colleagues observed abscess rates of up to 4.2% in their study of 1790 patients comparing endo-loop and endo-stapler closure, there was no significant difference in abscess rates based on the closure technique used (17). The absence of abscess development in our patient group may be attributed to our low rate of complicated appendicitis.

When evaluating the demographic characteristics of patients in terms of age and gender, there were no significant differences among the groups. When assessed in terms of physical condition using ASA scores, we found that it was not a determining factor in choosing the method. In a Cochrane review, Manu and colleagues reported that while classical ligature provided a nine-minute reduction in surgical time compared to other mechanical closure methods, there was insufficient evidence to favor other mechanical closure methods over classical ligature (12). This suggests that if a method is chosen to shorten the surgical time based on the patient's physical condition, it should be a method familiar to the surgical team.

Table 1: The comparison of laparoscopic appendicitis cases was conducted based on groups categorized by age, gender, and certain clinical and laboratory values

Parameter	Hem-o-lok n=208 40,7%	Stapler (n=59) 11,5%	Endo-loop (n=133) 26,0%	Handmadeloop (n=111) 21,7%	P	Total n=511(100,0%)
Age(years)	37.52±13.407	41.05±12.670	37.51±12.592	37.11±13.495	0.255*	37.84±13.15
Sex						
Male	72 (37.3%)	28 (14.5%)	51 (26.4%)	42 (21.8%)	0.357**	193 (100%)
Female	136 (42.8)	31 (9.7%)	82 (25.8%)	69 (21.7%)		318 (100%)
ASA						
1	55(45.8%)	15(12.5%)	19(15.8%)	31(25.8%)		120 (100%)
2	139(39.6%)	38(10.8%)	105(29.9%)	69(19.7%)	0.062**	351(100%)
≥3	14(35.0%)	6(15.0%)	11(27.5%)	9(22.5%)		40 (100%)
Alvarado						
≤6	82(42.9%)	16(8.4%)	53(27.7%)	40(20.9%)	0.328**	191(100%)
≥7	126(39.4%)	43(13.4%)	80(25.0%)	71(22.2%)		320(100%)
Histopatoloji						
Acute appendicitis	173	48	113	94		428 (83.75%)
Lymphoid hyperplasia	19	3	9	5		36(7.10%)
Perforated	4	3	6	1	0.448**	14(2.75)
Malign	2	2	3	0		7 (1.30%)
Apendiks vermiformis	10	3	2	11		26(5.10%)
Operation time (minutes)	48.28±15.252	51.69±13.882	48.80±16.018	48.23±15.486	0.477*	48.80±15.32
Hospital Stay (day)	1.43±0.45	1.68±0.59	1.36±0.37	1.28±0.33	0.089*	1.40±0.49
Readmission	5	1	3	3	0.628**	12(2.3%)
Reoperation	0	0	0	0		
Ileus	2	2	1	1	0.447***	6 (1.2%)
Port Site Infection	5	1	1	2	0.783***	9 (1.8%)
Intra abdominal abscess	0	0	0	0		0
Stump Leak	0	0	0	0		0
Bleeding	0	0	0	0		0

*ANOVA ** Chi-square ***Fisher's Exact test

The Alvarado Score is a scoring system indicating the compatibility of a possible acute abdominal condition with appendicitis. In our patients, the score was found to be similar among the groups.

No differences were observed in terms of operation time and length of hospital stay among the stump closure methods in our study, which is in line with the literature (18).

Our study showed no significant difference in postoperative complications (reoperation, readmission, wound infection, postoperative ileus) among stump closure methods, indicating that different stump closure methods are equally safe. The literature supports our findings.

We acknowledged the limitations of our study, which included its retrospective nature and an insufficient number of patients.

In conclusion, this study compared the clinical outcomes of different stump closure methods in appendectomy operations and found no significant difference among these methods. Surgeons can choose one of these methods based on patient characteristics and preferences. These results shed light on the decision-making process in surgical practice.

CONCLUSION

None of the four methods investigated for closing the appendix stump demonstrate any clinical superiority over the others. Surgeons should review all available methods preoperatively and be prepared to apply alternative techniques when necessary. We believe that the intraoperative decision made by the surgeon, taking into account safety and cost considerations, is the most appropriate stump closure method in laparoscopic appendectomy."

ETHICAL DECLARATIONS

Ethics Committee Approval: Approval was obtained from the Health Sciences University Dışkapı Yıldırım Beyazıt Training and Research Hospital Clinical Research Ethics Committee (Date: 18.04.2022, Decision No: 135/16).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

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REFERENCES

1. Semm K. Endoscopic appendectomy. *Endoscopy* 1983;15(2):59–64.
2. Li X, Zhang J, Sang L, et al. Laparoscopic versus conventional appendectomy--a meta-analysis of randomized controlled trials. *BMC Gastroenterol* 2010 (3);10:129.
3. Athanasiou C, Lockwood S, Markides GA. Systematic Review and Meta-Analysis of Laparoscopic Versus Open Appendectomy in Adults with Complicated Appendicitis: an Update of the Literature. *World J Surg.* 2017;41(12):3083–99.
4. Yu MC, Feng YJ, Wang W, et al. Is laparoscopic appendectomy feasible for complicated appendicitis? A systematic review and meta-analysis. *Int J Surg* 2017 ;40:187–97.
5. Ureyen O, Tan S, Dadalı E, et al. Hem-o-lok clips versus intracorporeal knotting for the closure of the appendix stump in laparoscopic appendectomy: A prospective randomized study. *Ulus Travma Acil Cerrahi Derg* 2020 ;26(3):384–8.
6. Swank HA, van Rossem CC, van Geloven A. et al. Endostapler or endoloops for securing the appendiceal stump in laparoscopic appendectomy: a retrospective cohort study. *Surg Endosc* 2014;28(2):576–83.
7. Beldi G, Vorburger SA, Bruegger LE, et al. Analysis of stapling versus endoloops in appendiceal stump closure. *Br J Surg* 2006;93(11):1390–3.
8. Mayir B, Bilecik T, Ensari CO, et al. Laparoscopic appendectomy with hand-made loop. *Wideochir Inne Tech Maloinwazyjne* 2014; 9(2):152–6.
9. Marcinkeviciute K, Luksaite-Lukste R, Jasiunas E, et al. Self-Locking Polymeric Clips Are Safe for the Closure of Appendiceal Stump in Laparoscopic Appendectomy. *Medicina (Kaunas)* 2023;59(3):533.
10. Hue CS, Kim JS, Kim KH, et al. The usefulness and safety of Hem-o-lok clips for the closure of appendicular stump during laparoscopic appendectomy. *J Korean Surg Soc* 2013;84(1):27–32.
11. Jaschinski T, Mosch CG, Eikermann M, et al. Laparoscopic versus open surgery for suspected appendicitis. *Cochrane Database Syst Rev* 2018;11(11):CD001546
12. Mannu GS, Sudul MK, Bettencourt-Silva JH, et al. Closure methods of the appendix stump for complications during laparoscopic appendectomy. *Cochrane Database Syst Rev.* 2017;2017(11):CD006437.
13. Makaram N, Knight SR, Ibrahim A, Patil P, Wilson MSJ. Closure of the appendiceal stump in laparoscopic appendectomy: A systematic review of the literature. *Ann Med Surg (Lond).* 2020; 57:228–35.
14. Zorzetti N, Lauro A, Bellini MI, et al. Laparoscopic appendectomy, stump closure and endoloops: A meta-analysis. *World J Gastrointest Surg.* 2022;14(9):1060–71.
15. Von Elm E, Altman DG, Egger M, Pocock SJ, Götzsche PC, Vandenbroucke JP, STROBE Initiative. The Strengthening of Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 2007;370(9596):1453–7.
16. Gomes CA, Junior CS, de Peixoto RO, et al. Appendiceal stump closure by metal endoclip in the management of complicated acute appendicitis. *World J Emerg Surg.* 2013 1;8(1):35.
17. Sahm M, Kube R, Schmidt S, et al. Current analysis of endoloops in appendiceal stump closure. *Surg Endosc* 2011;25(1):124–9.
18. Atak T. The use of the extracorporeally prepared hand-made endo-loop technique in laparoscopic appendectomy. *Ulus Travma Acil Cerrahi Derg* 2023 ;29(5):613–7.