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While the Laparoscopic Appendectomy Is the Gold Standard in the Treatment of Acute Appendicitis, What Should Be the Preference for Closure of the Appendix Stump?

Akut Apandisit Tedavisinde Laparoskopik Apendektomi Altın Standart Olurken, Apendiks Kökünün Kapatılmasında Tercih Ne Olmalı?

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ABSTRACT

Aim: While laparoscopic appendectomy is the gold standard in the treatment of acute appendicitis, there is no consensus on reliable closure of the appendix stump. The aim of this study was to examine appendiceal stump closure techniques and their reliability during laparoscopic appendectomy.

Material and Methods: Between January 2019 and August 2021, 692 patients who underwent laparoscopic appendectomy with the diagnosis of acute appendicitis were included in the study. Demographic characteristics, length of hospital stay, pathology, appendix stump closure methods, operation time, complications, and cost results were analyzed retrospectively.

Results: Intracorporeal knotting (ICK) was used in 66.9% (n=463), and endoclip (EC) was used in 33.1% (n=229) of the patients. There was no statistically significant difference between the two groups in terms of length of hospital stay (p=0.054). While the mean operative time was 55.1±15.6 minutes in the ICK group, it was 45.7±16.5 minutes in the EC group (p<0.001). The general complication rate was 1.7% (n=12). While the complication rate was 2.2% (n=10) in ICK group, it was 0.9% (n=2) in EC group (p=0.354). While pericecal hematoma and ileus were seen only in the ICK group, the fistula was seen only in the EC group. EC was found to be more costly than ICK (p<0.001).

Conclusion: It was concluded that closure of the appendix stump with an EC in patients who underwent laparoscopic appendectomy is more useful, regardless of the severity of appendicitis, with a shorter operation time and shorter length of hospital stay, low complication rate, and ease of application.

Keywords: Appendectomy; laparoscopic surgery; postoperative complications.

ÖZ

Amaç: Akut apandisit tedavisinde laparoskopik apendektomi altın standart olurken, apendiks kökünün güvenilir bir şekilde kapatılması konusunda ise bir fikir birliği yoktur. Bu çalışmanın amacı laparoskopik apendektomi sırasında apendiks güdüğü kapatma tekniklerinin ve bu tekniklerin güvenilirliğinin incelenmesidir.

Gereç ve Yöntemler: Ocak 2019 ile Ağustos 2021 tarihleri arasında, akut apandisit tanısı ile laparoskopik apendektomi yapılmış olan 692 hasta bu çalışmaya dahil edildi. Demografik özellikler, hastanede kalış süresi, patoloji, apendiks kök kapatma yöntemleri, ameliyat süresi, komplikasyonlar ve maliyet sonuçları geriye dönük olarak analiz edildi.

Bulgular: Hastaların %66,9'unda (n=463) intrakorporeal düğümleme (intracorporeal knotting, ICK) yapılırken, %33,1'inde (n=229) ise endoklip (endoclip, EC) uygulandı. Hastanede kalış süresi bakımından iki grup arasında istatistiksel olarak anlamlı bir farklılık yoktu (p=0,054). Ortalama ameliyat süresi ICK grubunda 55,1±15,6 dakika iken, EC grubunda ise 45,7±16,5 dakika idi (p<0,001). Genel komplikasyon oranı %1,7 (n=12) idi. Komplikasyon oranı ICK grubunda %2,2 (n=10) iken, EC grubunda ise %0,9 (n=2) idi (p=0,354). Periçekal hematom ve ileus sadece ICK grubunda görülürken, fistül ise sadece EC grubunda görüldü. EC, ICK'ye göre daha maliyetli olarak bulundu (p<0,001).

Sonuç: Apandisit şiddeti ne olursa olsun, laparoskopik apendektomi yapılan hastalarda apendiks kökünün EC ile kapatılmasının, daha kısa ameliyat süresi ve daha kısa hastanede kalış süresi, düşük komplikasyon oranı ve uygulama kolaylığı ile daha faydalı olduğu sonucuna ulaşılmıştır.

Anahtar kelimeler: Apendektomi; laparoskopik cerrahi; postoperatif komplikasyonlar.

INTRODUCTION

Acute appendicitis (AA) is currently, as it has been in the past, the most common reason for acute abdominal pain in every age group. The lifetime risk of AA is 8.6% for males and 6.7% for females (1). Whilst 10% of the emergency department visits are abdominal pain, 1.9% of these cases are AA. Although the method of treatment for AA is a medical treatment for selected cases, the most common procedure is appendectomy (2). During appendectomy, the state of the appendix stump and its closure technique plays an important role in the safety of the appendix stump.

From the 19th century until recently, appendectomy was performed using the incision technique described by McBurney where the appendix stump is closed using non-absorbable sutures. Since the start of the practice of laparoscopic appendectomy (LA) in 1980, it has almost become the gold standard with its low surgical site infections, low postoperative pain, short length of stay (LOS) in hospital, and early back to work durations.

With that being said, techniques for closing the appendix stump vary. The most commonly employed closure techniques are endostapler, endoloop, intracorporeal knotting (ICK), titanium clips, polymeric clips, and electrothermal devices. Whilst endoloop and endoclip (EC) are similarly low-cost, lower operation durations have been detected in cases where the closure was made using an EC. Endostapler has the lowest perioperative complication rate (3.56%); however, its' usage is restricted by its' high cost. Postoperative complication rate and the length of hospital stay were detected to be similar for all stump-closure techniques (4). In this study, we aimed to retrospectively examine the ICK and EC results of the LAs we have performed in our clinic in the last two years.

MATERIAL AND METHODS

Our study started after the ethics committee approval of the University of Health Sciences Prof. Dr. Cemil Taşçıoğlu City Hospital Ethics Committee, dated 08.11.2021 and numbered 384. The patients with an AA diagnosis to whom LA was applied in our hospital's (University of Health Sciences, Prof. Dr. Cemil Taşçıoğlu City Hospital, İstanbul, Türkiye) emergency surgery department between the dates of 01.01.2019 and 01.08.2021 were included in the study. The patients who were subjected to open surgery and medical treatment and the patients whose stumps were closed by endoloop or stapler were excluded from the study. As a result, 692 patients were included in the study (Figure 1).

The demographic data of the patients, such as age and gender, the appendix closure techniques, the operation duration, the LOS, costs, and the morbidity and mortality rates were evaluated. The results of the closure techniques were compared statistically.

Laparoscopic appendectomy was performed with the Hasson technique with supraumbilical 10 mm, left-bottom quadrant, and suprapubic 5 mm trocars. Intra-abdominal pressure was set to 12 mmHg with CO_2 insufflation. Mesoappendix was separated from the appendix using electrocautery devices. As for the closure technique, the type of the EC used was polymeric hem-o-lock (Figure 2), the ICK was double-layered, and the suture material was 2-0 silk or 2-0 prolene (Figure 3).

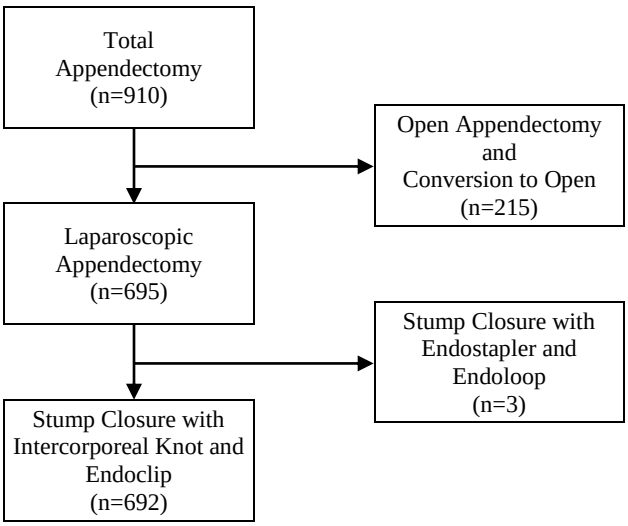

Figure 1. Including and excluding criteria of the study

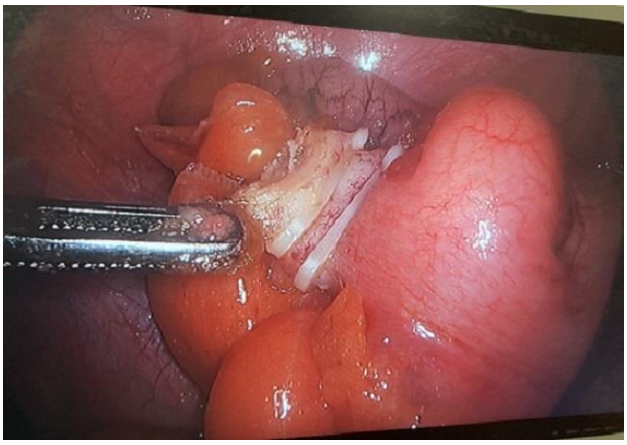

Figure 2. Endoclip

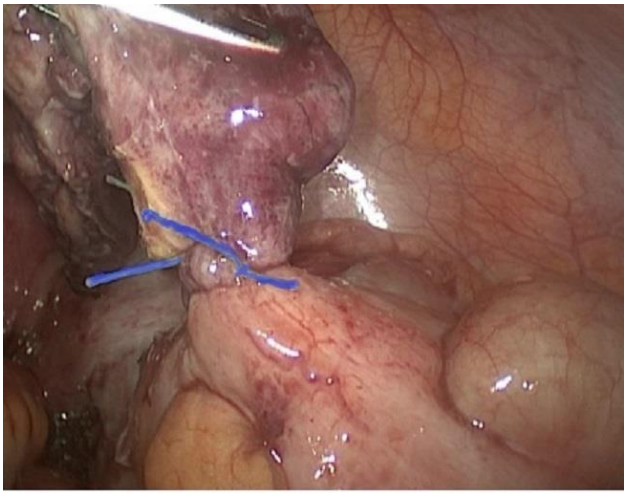

Figure 3. Intracorporeal knotting

Statistical Analysis

The statistical analysis was performed with SPSS v.22.0 (IBM Corp., Armonk, NY, USA). The normality tests were performed by the Kolmogorov-Smirnov test, and skewness and kurtosis values were also controlled. The

mean±standard deviation, median, minimum-maximum, frequency, and percentage values were used in the descriptive statistics. Intergroup analyses were performed with the independent samples t or the Mann-Whitney U test depending on the normality. Categorical data were evaluated with Pearson's chi-square and Fischer's exact test. $p<0.05$ was accepted as significant.

RESULTS

Of the 692 patients, 67.6% (n=468) that were included in the study were male, and %32.4 (n=224) were female. The mean age was 32.6±13.1 years, and the median LOS was detected as 1 (range, 0-14) days. Whilst the most common postoperative appendix pathology was phlegmonous appendicitis (Figure 4) with 86.1% (n=596), perforated appendicitis was observed in 12.7% (n=88) of the cases.

As the stump closure technique, ICK was performed for 66.9% (n=463), and EC was used for 33.1% (n=229) of the patients. The mean operation duration was 52.6±16.4 minutes. The general complication rate was 1.7% (n=12), and the mortality rate was zero. The most common morbidity was intra-abdominal abscess with 0.9% (n=6). The median cost was detected as 1526 (range, 931-4300) Turkish Liras (TL). The demographic and clinical characteristics of the patients were presented in Table 1.

As for the comparison of the stump closure techniques, while 67.4% (n=312) of the patients were male in the ICK group, 68.1% (n=156) of the patients were male in the EC group. No statistically significant difference in gender was found between the groups (p=0.846). The mean age was 31.8±12.6 years in the ICK group, and it was 33.9±13.9 years in the EC group. There was a statistically significant difference in the mean age between the groups (p=0.046). The median LOS was detected as 1 (range, 0-14) days for the ICK group and as 1 (range, 0-6) days for the EC group. There was no statistically significant difference in LOS between the two groups (p=0.054). For both groups, the most common pathology was detected as phlegmonous appendicitis. There was no statistically significant difference in pathology between the two groups (p=0.886). Operation duration was detected as 55.1±15.6 minutes for the ICK group and as 45.7±16.5 for the EC group. There was a statistically significant difference in the operation duration between the groups (p<0.001). The median cost was 1423 (range, 931-3808) TL for the ICK group and 1663 (range, 1127-4300) TL for the EC group. There was a statistically significant difference in cost between the groups (p<0.001). Whilst there was a complication in 2.2% (n=10) of the patients in the ICK group, the rate of complication was 0.9% (n=2) in the EC group. There was no significant difference in the number of complications between the groups (p=0.354). The comparison of the techniques were presented in Table 2. Among complication types (n=12), the most common one was intra-abdominal abscess with 50% (n=6). Rates of pericecal hematoma, ileus, fistula, and port site hernia were %16.7 (n=2), %16.7 (n=2), %8.3 (n=1), and %8.3 (n=1), respectively.

DISCUSSION

Laparoscopic appendectomy has become the gold standard due to low postoperative pain, early back to work, low surgical site infection, low postoperative adhesive ileus, and better cosmetic results. On top of these, due to the fact that it allows for more exploration, the laparoscopic approach is an important differential diagnostic tool for diseases that are confused with AA such as pelvic inflammatory disease, inflammatory bowel disease, tumor, diverticulitis, ovarian cyst, and ectopic pregnancy (5). Closure of the appendix stump is important for avoiding complications such as postoperative fistula, peritonitis, and intra-abdominal sepsis. For the closure, endostapler, endoloop, intracorporeal or extracorporeal suture, titanium or polymer EC, or tissue sealer devices are used (6).

Makaram et al. (4) have reported the mean age of the patients who have been subjected to ICK as 29.6 years and as 30.95 years for the patients who have been subjected to EC in their review article. In their study, there was no statistically significant difference in the compared stump closure techniques, age, and gender. In our study, EC was performed, statistically significantly, on older patients.

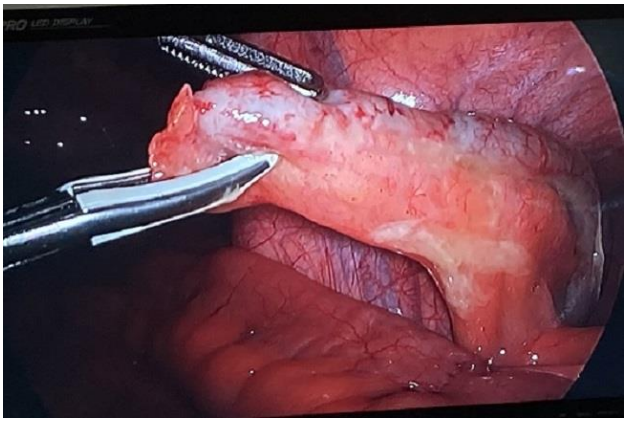

Figure 4. Phlegmonous appendicitis

Table 1. Demographic and clinical characteristics

Age (years), mean±SD	32.6±13.1
Gender, n (%)	
Male	468 (67.6)
Female	224 (32.4)
LOS (days), median (min-max)	1 (0-14)
Pathology, n (%)	
Phlegmonous	596 (86.1)
Perforated	88 (12.7)
Plastron	8 (1.2)
Type of stump closure, n (%)	
Intracorporeal knot	463 (66.9)
Endoclip	229 (33.1)
Duration of Surgery (minute), mean±SD	52.6±16.4
Complication, n (%)	
No	680 (98.3)
Yes	12 (1.7)
Type of Complication, n (%)	
Intraabdominal abscess	6 (0.9)
Pericecal hematoma	2 (0.3)
Ileus	2 (0.3)
Fistula	1 (0.1)
Port site hernia	1 (0.1)
Cost (TL), median (min-max)	1526 (931-4300)

SD: standard deviation, LOS: length of stay, TL: Turkish lira

Table 2. Comparison of the stump closure techniques

	Intracorporeal Knot (n=463)	Endoclip (n=229)	p
Age (years), mean±SD	31.8±12.6	33.9±13.9	**0.046**
Gender, n (%)			
Male	312 (67.4)	156 (68.1)	0.846
Female	151 (32.6)	73 (31.9)	
LOS (days), median (min-max)	1 (0-14)	1 (0-6)	0.054
Pathology, n (%)			
Phlegmonous	398 (86.0)	198 (86.5)	0.886
Perforated	59 (12.7)	29 (12.6)	
Plastron	6 (1.3)	2 (0.9)	
Duration of Surgery (minute), mean±SD	55.1±15.6	45.7±16.5	**<0.001**
Complication, n (%)			
No	453 (97.8)	227 (99.1)	0.354
Yes	10 (2.2)	2 (0.9)	
Type of Complication, n (%)			
Intraabdominal abscess	5 (1.1)	1 (0.4)	0.595
Pericecal hematoma	2 (0.4)	0 (0.0)	
Ileus	2 (0.4)	0 (0.0)	
Fistula	0 (0.0)	1 (0.4)	
Port site hernia	1 (0.2)	0 (0.0)	
Cost (TL), median (min-max)	1423 (931-3808)	1663 (1127-4300)	**<0.001**

SD: standard deviation, LOS: length of stay, TL: Turkish lira

In the literature, although it has been reported that LA was superior in LOS compared to open appendectomy, no difference in LOS has been reported for different appendix stump closure techniques. In the review article written by Makaram et al. (4), the mean LOS for ICK was reported as 2.2 (range, 0.8-2.8) days and as 2.2 (range, 0.8-4.0) days for EC. In our study, even though the LOS was relatively longer for the patients that underwent EC compared to the ones that underwent ICK, the difference was not statistically significant.

Appendix stump closure technique carries more importance for complications in complicated appendicitis cases. According to the comparative study conducted by Durán Muñoz-Cruzado et al. (7), endostapler was used in 51.1% of the complicated AA cases, whereas it was used in 16.5% of the non-complicated cases. According to the study conducted by Lasek et al. (8), 69.1% of the patients for whom EC was used, 26.2% of those for whom endostapler was used, and 33.3% of those for whom endoloop was used had gangrenous appendicitis. In the same study, it has been reported that 17.82% of the patients for whom EC was used, 21.72% of those for whom endostapler was used, and 5.76% of those for whom endoloop was used had perforated/auto-amputated appendicitis. In our study, for different appendicitis severities, no difference between stump closure techniques was observed. ICK was performed as the stump closure technique for 67% (59/88) of the perforated appendicitis cases and for 75% (6/8) of the plastron appendicitis cases.

The operation duration is an important consideration, and in a general sense, open operations take shorter than laparoscopic operations (9). Similarly, for stump closure techniques, it is preferred that the selected technique does not lengthen the operation duration even further. In the study conducted by Ateş et al. (10), it was reported that the mean operation duration was 62.8±15.4 minutes for ICK applications and 41.2±12.2 minutes for titanium EC applications and that this difference was statistically significant. In their review study, Makaram et al. (4) reported a mean operation duration of 68.2 (61.9-79.6) minutes for ICK and 47.7 (31.1-66) minutes for EC applications. In our study, the general mean operation duration for LA was detected to be 52.6±16.4 minutes. The duration was 55.1±15.6 minutes for ICK applications and 45.7±16.5 minutes for EC applications. Hence, according to our evaluations, as a stump closure technique, EC carries an advantage over ICK in that it provides shorter operation durations.

The occurrence of postoperative complications is another important consideration in the comparison of stump closure techniques. In their study, Makaram et al. (4) reported a postoperative complication rate of 7.83% for ICK and 2.09% for polymeric EC. In polymeric EC applications, while intra-abdominal abscess was observed in 0.37%, surgical site infection in 2.29%, and hematoma in 0.89% of the cases, ileus or peritonitis was not detected in any of the cases. As for the ICK applications, intra-abdominal abscess was observed in 1.67%, surgical site infection in 1.81%, hematoma in 0.83%, ileus in 1.43%, and peritonitis in 0.7% of the cases. In our study, the general LA postoperative complication rate was detected as 1.7%. This rate was detected as 2.2% for ICK and 0.9% for EC applications. Hence, according to our evaluations, whilst the occurrence of postoperative complications, especially intra-abdominal abscess, hematoma, and ileus turned out to be less likely for EC, one patient who developed fistula was also in the EC group.

Like most of the aforementioned factors, the cost of the operation is also an important consideration. In the studies evaluating the cost of LA stump closure techniques, the costs were evaluated based on the materials used for the investigated techniques, and the costs were detected as 380 USD for stapler, 70 USD for endoloop, 2 USD for ICK

with silk suture, and 3 USD for metallic EC (11). At the same time, in the study conducted by Bali et al. (12), the mean cost of ICK was reported as 675 TL, and the mean cost of stump closure with endoloop was reported as 768 TL (12). In our study, we detected that EC had a higher cost for the hospital compared to ICK.

CONCLUSION

In conclusion, laparoscopic appendectomy is accepted as the gold standard in the treatment of acute appendicitis. We evaluated the ICK and EC techniques for the closure of the appendix stump. According to our evaluations, the use of EC in the treatment of acute appendicitis can be preferred as an appendiceal stump closure technique, regardless of the severity of appendicitis, owing to its shorter operation time and shorter hospital stay, low complication risk, and ease of application. However, more high-quality prospective randomized studies are needed for the use of ECs to be accepted as a standard.

Ethics Committee Approval: The study was approved by the Ethics Committee of Prof. Dr. Cemil Taşçıoğlu City Hospital (08.11.2021, 384).

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REFERENCES

1. Snyder MJ, Guthrie M, Cagle S. Acute appendicitis: Efficient diagnosis and management. Am Fam Physician. 2018;98(1):25-33.
2. Karakaş DÖ, Yeşiltaş M, Gökçek B, Eğin S, Hot S. Is language disability a risk factor for complicated appendicitis? A retrospective cohort study. J Surg Med. 2020;4(8):631-5.
3. Wagner M, Tubre DJ, Asensio JA. Evolution and current trends in the management of acute appendicitis. Surg Clin North Am. 2018;98(5):1005-23.
4. 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.
5. Lucchi A, Berti P, Grassia M, Siani LM, Gabbianelli C, Garulli G. Laparoscopic appendectomy: Hem-o-lok versus Endoloop in stump closure. Updates Surg. 2017;69(1):61-5.
6. Mayir B, Ensari CÖ, Bilecik T, Aslaner A, Oruç MT. Methods for closure of appendix stump during laparoscopic appendectomy procedure. Ulus Cerrahi Derg. 2015;31(4):229-31.
7. Durán Muñoz-Cruzado V, Anguiano-Diaz G, Tallón Aguilar L, Tinoco González J, Sánchez Arteaga A, Aparicio Sánchez D, et al. Is the use of endoloops safe and efficient for the closure of the appendicular stump in complicated and uncomplicated acute appendicitis? Langenbecks Arch Surg. 2021;406(5):1581-9.
8. Lasek A, Wysocki M, Mavrikis J, Myśliwiec P, Bobowicz M, Dowgiałło-Wnukiewicz N, et al. Comparison of stump closure techniques during laparoscopic appendectomies for complicated appendicitis - results from Pol-LA (Polish laparoscopic appendectomy) multicenter large cohort study. Acta Chir Belg. 2020;120(2):116-23.
9. Lippert H, Koch A, Marusch F, Wolff S, Gastinger I. [Open vs. laparoscopic appendectomy]. Chirurg. 2002;73(8):791-8. German.
10. Ates M, Dirican A, Ince V, Ara C, Isik B, Yilmaz S. Comparison of intracorporeal knot-tying suture (polyglactin) and titanium endoclips in laparoscopic appendiceal stump closure: a prospective randomized study. Surg Laparosc Endosc Percutan Tech. 2012;22(3):226-31.
11. Gonenc M, Gemici E, Kalayci MU, Karabulut M, Turhan AN, Alis H. Intracorporeal knotting versus metal endoclip application for the closure of the appendiceal stump during laparoscopic appendectomy in uncomplicated appendicitis. J Laparoendosc Adv Surg Tech A. 2012;22(3):231-5.
12. Bali İ, Karateke F, Özyazıcı S, Kuvvetli A, Oruç C, Menekşe E, et al. Comparison of intracorporeal knotting and endoloop for stump closure in laparoscopic appendectomy. Ulus Travma Acil Cerrahi Derg. 2015;21(6):446-9.