Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jw5rpy90

COMPARATIVE ANALYSIS OF METHODS OF STUMP CLOSURE IN LAPAROSCOPIC APPENDECTOMY

Dr Shafaqat Azeemi[1*], Dr Zahid Ali[2], Dr Naheed Akhtar[3], Dr Seema Salim[4], Dr Umar Zeb[5], Dr Rihan Aslam Khan[6]

[1*] Senior Registrar, Department of General Surgery, Dr Ziauddin Hospital Karachi
[2] Assistant Professor, Ziauddin University Hospital, Karachi.
[3] Assistant Professor, Department of Anatomy, Karachi Institute of Medical Sciences, CMH Malir Cantt, Karachi.
[4] Senior RMO, Department of ICU/Wards (medicine, surgery, paeds), Midciti hospital, Karachi
[5,6] Post Graduate Trainee, Department of General Surgery, Dr Ziauddin Hospital Karachi

***Corresponding Author:** Dr Shafaqat Azeemi
*Senior Registrar, Department of General Surgery, Dr Ziauddin Hospital Karachi. Email: drshafaqatsahil@gmail.com

Abstract

BACKGROUND: Acute appendicitis is a frequent surgical emergency. The surgical treatment for this issue is an appendectomy, which is one of the most common surgeries done globally.

OBJECTIVE: To compare various methods of Appendiceal stumps closure in laparoscopic appendectomy.

METHODS: After getting ethical approval from ethical review board of Ziauddin university (REF #2021/01SCS) this comparative observational cross-sectional study was conducted. The data was collected from January 2021 to June 2021. Using the consecutive sampling technique, all patients diagnosed with acute appendicitis (Z) (Anerdala score) undergoing laparoscopic appendectomy in the surgery department of Ziauddin Hospital (North Campus) were taken into either group (G1, G2, G3, or G4). Groups G1 (Endoloop), G2 (Intracorporeal Knotting) Vicryl Size 2'0, G3 (Extracorporeal Knotting) Vicryl Size 2'0, and G4 (Intracorporeal Transfixation) with 2'0 vicryl were used for the closure procedures.

RESULTS: The mean age of the sample stood at 42.57±17.4 years, with the age ranging from 18 to 80 years. Females predominated among study groups. A large number of patients in Group14 18 (18%) and Group 15(12.5%) had the intra operative hemorrhage. Post-operative complications include hematoma, seroma formation, post-operative hemorrhage, knot slippage leading to bowel slippage and peritonitis, abscess formation and surgical site infection were observed at 1%, 2% and 3% equally among them. Time duration for the closure of appendiceal stump by in (1) Endoloop G2(intracorporeal knotting), G3(extracorporeal knotting) and G4 (intracorporeal Transfixation) were 44.7, 77, 78.4 & 12.8, 5.2 & 14.5 and 7.6 to 17.5 minutes respectively where mean hospital stay for G1, G2, G3 and G4 is 0.2, 0.25, 2.5±0.6, 0.6 and 3.5± 1.1 days respectively. Both G1 and G4 had highly significant statistical link with the groups with the p value of <0.001 and <0.001 respectively. On comparison of post-operative VAS pain score index with all the group we observed the highest pain felt group in group1 in 14 patients (13.79, 23.08%) and peak mild pain in group 1 while in group 2, 13 (16%), 16 (20%) in group 3 and 15 (18-8%) in group4 had mild pain VAS scores.

CONCLUSION: A wide array of closure methods may be utilized in laparoscopic appendectomy. Endoloop and Transfixation show superior outcomes in laparoscopic appendectomy. Among the studied techniques for closing the stump in laparoscopic appendectomy, the endoloop group had the fewest VAS scores, less time spent intraoperatively.

Key words: Acute appendicitis, laparoscopic appendectomy, appendiceal stump, visual analogue scale, post operative complications

Introduction

Among the many surgical emergencies with which patients report to the emergency department, the most common is acute appendicitis. In Asian and European population, the estimated rate of acute appendicitis is 47.4% and 41.3% respectively [1]. Etiology of appendicitis is multifactorial and a spectrum of causes include obstruction of appendiceal lumen (65-90%) caused by fecaliths (appendicoliths), inadequate intake of fiber in the diet. Appendectomy is among the common procedures in general surgery [2]. Despite the fact that modern diagnostic facilities, surgical skills, fluids, and antibiotic medication have reduced death from 50% (before 1925) to less than 0.001%, morbidity is more than 5-8%, primarily due the delayed wound infection treatment [3]. Appendectomy is the surgical treatment that over 12% males and 25% females around the world require at some point in their life. The advantages of diagnosis and treatment in one procedure with the least amount of morbidity are combined in laparoscopic appendicectomy [4]. As previously stated, surgery (i.e. appendectomy) is the best treatment for acute appendicitis, whether open or laparoscopic. However, since its introduction in 1987, laparoscopic surgery has surpassed open appendectomies as the ideal therapeutic modality due to its minimally invasive nature, less trauma with bleeding and infection risk, less scar, and small hospital stay as compared with open appendectomy [5]. Another wave for modernization that is being explored in laparoscopic surgery is the different techniques used to access the abdomen since most complications occur commonly while striving to access the peritoneal cavity [6]. The entry is linked to gastrointestinal tract injuries and damage to its vasculature and according to estimates, many of the complications take place before the intended surgery has even commenced. Central colicky abdominal pain that develops gradually over the course of 24 hours and is accompanied by anorexia, nausea, vomiting, and typically constipation is the classic history. Pain is aggravated by moving or coughing [7]. Unfortunately, only half of the patients give this typical history. In another third of cases the pain presents over 1–2 days and it may present in the right iliac fossa. Vomiting may be absent and diarrhea occurs in 20% of patients [8]. An atypical presentation is common in the very young, elderly and also during pregnancy. The patient appears ill, typically has mild pyrexia, and may flush.

Bad breath and mild tachycardia are common. As previously mentioned, symptoms of widespread peritonitis are looked for during an abdominal examination [9]. The patient is asked to identify the location of their greatest pain, which in appendicitis should match McBurney's point (Pointing Sign). Traditionally, there is mild but enduring rigidity along with right iliac fossa tenderness and rebound tenderness, which is again maximal at McBurney's point. Rebound tenderness may be elicited in the absence or ambiguity of these symptoms, which may then congregate with other indications of peritonitis. In about 75% of cases, the appendix is located retrocecally [10]. The right flank and the posterior part of the abdominal wall, lateral to the sacrospinalis muscle, may exhibit symptoms and indicators of a partially or completely retrocecal appendicitis [11]. Tenderness may be felt just medial to the right anterior superior iliac spine when the patient is asked to roll over onto the left side. Because of malrotation, a high cecum may cause even more tenderness [12].

Objective

To compare various methods of Appendiceal stumps closure in laparoscopic appendectomy.

Methodology

This comparative observational cross-sectional study was conducted at Department of Surgery, Ziauddin University Hospital, North Campus from January 2021 to June 2021. Patients of acute appendicitis undergoing laparoscopic appendectomy were included in the study. Study by Delibegovic et al. in 2018 using closure methods for the appendiceal stump i.e endoloop, Hem-o-lok clips, titanium clips, and endostapler (n=30 each) in current study same sample size was chosen at 95% confidence interval and 5% margin of error. Sample size of 120 divided equally into four groups, namely: G1: Endoloop G2: Intracorporeal Knotting, G3: Extracorporeal Knotting and G4: Vicryl/Intracorporeal Transfixation (n=30 each). Data were collected through Non-Probability Consecutive Sampling technique.

Inclusion Criteria:

Acute appendicitis patients undergoing laparoscopic appendectomy aged 18 to 70 years, either gender.

Exclusion Criteria:

History of sepsis, tuberculosis, diabetes, pneumoperitoneum, failure, poor cardiac health.

Ethical Consideration:

The Ethics Review Committee (ERC) of Ziauddin University Karachi was contacted for ethical approval in accordance with institutional guidelines. All four groups were included in the analysis after receiving informed consent.

Data Collection

After getting ethical approval from ethical review board of Ziauddin university (REF #0900121SCS) this comparative observational cross-sectional study was conducted. The data was collected from January 2021 to June 2021. Using the consecutive sampling technique, all patients diagnosed with acute appendicitis (Z7 Alvarado score) undergoing laparoscopic appendectomy in the surgery department of Ziauddin Hospital (North Campus) were taken into either group (G1, G2, G3, or G4). Groups G1 (Endoloop), G2 (Intracorporeal Knotting) Vicryl Size 2'0, G3 (Extracorporeal Knotting) Chromic Catgut Zero, and G4 (Intracorporeal Transfixation) with 2'0 vicryl, underwent the stump closure procedures. Consent was taken from each patient and form was available in both Urdu and English languages for the ease of the patient. Data was collected using a pre-structured questionnaire that includes socio-demographic information, history of abdominal surgery, stump closure type, operative time, hospital stay, cost of knot, intra and post operative complications. All patients had laboratory test and an abdominal ultrasound performed prior to surgery. A consultant general surgeon with over five years of post-fellowship experience performed all surgeries (according to all established institutional protocols). Every procedure was performed using a standard three-trocars approach, disposable equipment, and general anaesthesia. Following surgery, the appendiceal stump was cleaned with povidone-iodine before either of the closure techniques could be applied. The patients received an intravenous antibiotic prophylaxis an hour before the procedure, and a therapeutic dose was administered while they were in the hospital. Throughout the procedure, patients were monitored for intra-operative haemorrhage, knot tying difficulties, operative time, and closure technique type. A postoperative follow-up was conducted at one, two, and four weeks. During the follow-up period, patients were examined for signs of post-operative haemorrhage, hematoma, seroma formation, knot slippage that resulted in peritonitis and bowel slippage, abscess formation, surgical site infection, and post-operative pain (VAS score).

Data Analysis

Data was analyzed via SPSS v. 21. Qualitative data like gender, residential/socio-economic status, type of stump closure technique adopted, presence of post complications, hematoma, seroma formation, post-operative hemorrhage, knot slippage leading to bowel slippage and peritonitis,

abscess formation, surgical site infection, cost of knot and post operative pain was expressed as number and percentage. Quantitative data including age, operative time, and hospital stay were expressed as mean & standard deviation. Chi square test/one-way ANOVA/Post hoc for multiple comparisons was used to assess presence of association between type of approach for stump closure and outcomes. p- value ≤0.05 was taken as significant.

Results

Data were collected from 120 patients, with a mean age of 42.57 ± 17.4 years. The majority were between 18–38 years (45%), and 60% of the patients were female. Past abdominal surgery was reported in 20% of cases. The mean operative time was 63.9 ± 21.4 minutes, with most procedures categorized as very easy or easy (73.4%). Intra-operative hemorrhage occurred in 35.8% of patients, while the mean hospital stay was 2.55 ± 0.632 days, with two-day admissions being the most common. The average cost for knotting techniques used in stump closure was PKR 5007.5 ± 2748.7.

Table 1: Qualitative and Quantitative Parameters Distribution Among Study Subjects

Variables (n=120)	**Mean ± SD / n (%)**
Age Groups (Years)	
Mean ± SD	42.57 ± 17.4
18 to 38 Years	54 (45.0%)
39 to 58 Years	39 (32.5%)
59 to 80 Years	27 (22.5%)
Gender	
Male	48 (40.0%)
Female	72 (60.0%)
Past Abdominal Surgery	
Yes	24 (20.0%)
No	96 (80.0%)
Operative Time (minutes)	Mean ± SD = 63.9 ± 21.4
Difficulty Index	
Very easy	44 (36.7%)
Easy	44 (36.7%)
Difficult	23 (19.2%)
Hard	9 (7.5%)
Intra-operative Hemorrhage	
Yes	43 (35.8%)
No	77 (64.2%)
Hospital Stay (Days)	Mean ± SD = 2.55 ± 0.632
Two days	76 (63.3%)
Three days	39 (32.5%)
Four days	3 (2.5%)
Seven days	2 (1.7%)
Total Cost of Knot (PKR)	Mean ± SD = 5007.5 ± 2748.7

The distribution of age among the study groups was not statistically significant (p = 0.430). In the 18–38-year age group, Group 1 had 12 (10.0%), Group 2 had 15 (12.5%), Group 3 had 11 (9.2%), and Group 4 had 12 (10.0%) participants. For the 39–58-year category, there were 10 (8.3%) in Group 1, 7 (5.8%) in Group 2, 12 (10.0%) in Group 3, and 10 (8.3%) in Group 4. In the 59–80-year category, 8 (6.7%) were in Group 1, 4 (3.3%) in Group 2, 7 (5.8%) in Group 3, and 8 (6.7%) in Group 4. Regarding gender, no significant difference was noted (p = 0.964). Group 1 had 12 (10.0%) males and 18 (15.0%) females, Group 2 had 13 (10.8%) males and 17 (14.2%) females, Group 3 had 12 (10.0%) males and 18 (15.0%) females, and Group 4 had 11 (9.2%) males and 19 (15.8%) females. This suggests a well-balanced distribution of age and gender across all groups.

Table 2: Association Between Study Groups and Age Categories

Variables (n=120)	Group 1 (n=30)	Group 2 (n=30)	Group 3 (n=30)	Group 4 (n=30)	p-value
18 to 38 Years	12 (10.0%)	15 (12.5%)	11 (9.2%)	12 (10.0%)	**0.430**
39 to 58 Years	10 (8.3%)	7 (5.8%)	12 (10.0%)	10 (8.3%)	
59 to 80 Years	8 (6.7%)	4 (3.3%)	7 (5.8%)	8 (6.7%)	
Gender					
Male	12 (10.0%)	13 (10.8%)	12 (10.0%)	11 (9.2%)	**0.964**
Female	18 (15.0%)	17 (14.2%)	18 (15.0%)	19 (15.8%)	

The comparison of past abdominal surgery among the four groups revealed no statistically significant difference (p = 0.741). In Group 1, 4 patients (3.3%) had a history of surgery 3 with inguinal hernia repair and 1 with cesarean section (C/S). Group 2 had 7 patients (5.8%) who all underwent laparoscopic cholecystectomy. Group 3 included 6 patients (5.0%) 1 with a C/S and 5 with laparoscopic cholecystectomy. Group 4 had 7 patients (5.8%) with a history of surgery, including 4 C/S and 3 laparoscopic cholecystectomies. The remaining patients with no surgical history were fairly distributed: 26 (21.7%) in Group 1, 23 (19.2%) each in Groups 2 and 4, and 24 (20.0%) in Group 3, indicating uniformity in baseline surgical history across the groups.

Table 3: Comparison of Previous Abdominal Surgery Between Groups

Variables (n=120)	Group 1 (n=30)	Group 2 (n=30)	Group 3 (n=30)	Group 4 (n=30)	p-value
Yes	4 (3.3%) – 3 (Inguinal hernia), 1 C/S	7 (5.8%) – 7 (Lap. Chole)	6 (5.0%) – 1 (C/S), 5 (Lap. Chole)	7 (5.8%) – 4 (C/S), 3 (Lap. Chole)	**0.741**
No	26 (21.7%)	23 (19.2%)	24 (20.0%)	23 (19.2%)	

There was a statistically significant difference in the difficulty index across the four study groups (p < 0.001). Group 1 had the highest proportion of "Very Easy" procedures, with 26 patients (21.7%), while no patients in Groups 2 or 4 were rated in this category. Group 2 had the highest proportion of "Easy" cases (16; 13.3%), while Groups 3 and 4 each had 12 patients (10.0%) rated as "Easy." The "Difficult" category was most frequent in Group 4 (13; 10.8%) and Group 2 (10; 8.3%), with none in Groups 1 or 3. "Hard" procedures were distributed among Group 2 (4; 3.3%), Group 3 (3; 2.5%), and Group 4 (5; 4.2%). No cases in any group were rated as "Very Difficult." These findings indicate that Group 1 (Endoloop) had the easiest procedures, while Group 4 (Transfixation) involved more challenging operations.

Table 4: Statistical Link Between the Study Groups and Difficulty Index

Difficulty Index	Group 1 (n=30)	Group 2 (n=30)	Group 3 (n=30)	Group 4 (n=30)	p-value
Very Easy	26 (21.7%)	0 (0.0%)	15 (15.0%)	0 (0.0%)	**<0.001***
Easy	4 (3.3%)	16 (13.3%)	12 (10.0%)	12 (10.0%)	
Difficult	0 (0.0%)	10 (8.3%)	0 (0.0%)	13 (10.8%)	
Hard	0 (0.0%)	4 (3.3%)	3 (2.5%)	5 (4.2%)	
Very Difficult	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	

The analysis of operative time revealed statistically significant differences between all group comparisons (p < 0.001). Group 1 (Endoloop) had the shortest mean operative time, significantly less than Group 2 by 18.13 minutes, Group 3 by 28.17 minutes, and Group 4 by a striking 53.00 minutes. Group 2 (Intracorporeal knotting) also showed significantly shorter operative times compared to Group 3 (by 9.83 minutes) and Group 4 (by 34.87 minutes). Similarly, Group 3 (Extracorporeal knotting) had significantly shorter times than Group 4 by 25.03 minutes, indicating that Group 4 (Transfixation) was the most time-consuming technique. For hospital stay, Group 1 again showed a significantly shorter duration compared to Group 2 (by 0.5 days), Group 3 (by 2.5 days), and Group 4 (by 0.67 days), with all differences being statistically significant (p < 0.001). Group 2 also had a significantly shorter stay than Group 3 (by 2 days), but no significant difference was observed

between Group 2 and Group 4 ($p = 0.180$). Group 3 had the longest hospital stay, significantly greater than all others, including Group 4 (by 1.83 days, $p < 0.001$).

Table 5: Multiple Comparisons of Operative Time and Hospital Stay Among Groups (n=30 each)

Operative time Group (I)	Group (J)	Mean Difference (I–J)	Std. Error	Sig.	95% CI Lower	95% CI Upper
Group 1	Group 2	-18.13333	2.19801	0.000	-22.6844	-13.5823
Group 1	Group 3	-28.16667	2.19801	0.000	-32.7177	-23.6156
Group 1	Group 4	-53.00000	2.19801	0.000	-57.5510	-48.4489
Group 2	Group 3	-9.83333	2.19801	0.000	-14.3844	-5.2823
Group 2	Group 4	-34.86667	2.19801	0.000	-39.4177	-30.3156
Group 3	Group 4	-25.03333	2.19801	0.000	-29.5844	-20.4823
Hospital stay						
Group 1	Group 2	-0.50000	.12723	0.000	-0.7528	-0.2472
Group 1	Group 3	-2.50000	.12723	0.000	-2.7528	-2.2472
Group 1	Group 4	-0.66667	.12723	0.000	-0.9195	-0.4138
Group 2	Group 3	-2.00000	.12723	0.000	-2.2528	-1.7472
Group 2	Group 4	-0.16667	.12723	0.180	-0.4195	0.0862
Group 3	Group 4	1.83333	.12723	0.000	1.5805	2.0862

*** The mean difference is significant at the 0.05 level.**

Discussion

The present study assessed the clinical efficacy, safety, and resource implications of four different laparoscopic appendiceal stump closure techniques: Endoloop, Intracorporeal Knotting, Extracorporeal Knotting, and Transfixation. Significant differences were observed in operative duration, intraoperative difficulty, hemorrhagic complications, hospital stay, and procedural cost among the groups. The Endoloop group exhibited the most favorable outcomes in terms of operative time and ease of performance [13]. The significantly reduced operative time in this group is consistent with previous findings by Delibegovic et al., who reported that Endoloop requires less time due to its simplified application process. In this study, Endoloop closures were predominantly categorized as "very easy," reflecting minimal technical demand compared to the knotting and transfixation techniques, which involved a greater degree of intraoperative manipulation [14]. The Transfixation group, although clinically comparable to Endoloop in terms of safety, required the longest operative time, suggesting that while it may be effective, it is more technically demanding [15].

Hospital stay data further supported the procedural efficiency of Endoloop. Patients in this group had significantly shorter admissions, with the majority discharged within two days. The Extracorporeal Knotting group had the longest mean hospital stay, which may reflect increased postoperative morbidity and slower recovery [16]. These findings are aligned with existing literature indicating that simpler closure techniques correlate with reduced post-surgical recovery time and fewer complications. Regarding intraoperative bleeding, the incidence was significantly higher in the Transfixation and Intracorporeal Knotting groups [17]. The greater degree of hemorrhage associated with these methods may be attributed to deeper tissue handling and prolonged manipulation during stump closure [18]. Although the difference in postoperative complications such as wound infection and abscess formation was not statistically significant, a higher number of such events was observed in the knotting groups. This trend suggests that technical complexity and the potential for knot slippage may increase postoperative morbidity [19].

Cost analysis revealed that Endoloop was the most expensive closure method, which may limit its routine use in low-resource settings. Nonetheless, its shorter operative time and reduced hospital stay could offset the initial expense, making it cost-effective in high-volume centers. Extracorporeal Knotting, while the most economical option upfront, resulted in extended hospitalization and increased complication rates, which may contribute to higher indirect costs over time [20]. The comparative outcomes of Transfixation were of particular interest. While it required the longest operative time, its complication profile and hospital stay were favorable relative to the knotting

techniques. This suggests that, despite technical demands, Transfixation may be a viable and safe alternative when Endoloop is unavailable or cost-prohibitive [21]. This study provides evidence supporting the use of Endoloop as a preferred closure method in laparoscopic appendectomy, especially where surgical efficiency and rapid recovery are prioritized [22]. Transfixation also appears to be a reliable technique in skilled hands. Knotting techniques, though cost-effective, may be better suited for centers with limited access to disposable closure devices and should be performed with caution due to higher rates of intraoperative difficulty and complications. Limitations of the study include the single-center design and the relatively small sample size in each group, which may affect the generalizability of the results. Furthermore, long-term follow-up beyond the postoperative period was not conducted, which limits assessment of late complications such as stump leaks or adhesions.

Conclusion

Based on the findings of this study, Endoloop emerged as the most efficient and clinically favorable method for appendiceal stump closure in laparoscopic appendectomy. It was associated with significantly reduced operative time, fewer intraoperative and postoperative complications, and shorter hospital stays compared to intracorporeal and extracorporeal knotting techniques. While Endoloop was found to be more expensive, its advantages in surgical efficiency and patient outcomes may justify its cost, particularly in high-volume or resource-adequate surgical settings. However, its financial limitations should be considered, especially in cases where multiple loops are required. In contrast, knotting techniques remain cost-effective alternatives but may be associated with increased difficulty and higher complication rates.

References

1. Delibegovic S, Mehmedovic Z. The influence of the different forms of appendix base closure on patient outcome in laparoscopic appendectomy: a randomized trial. Surgical Endoscopy. 2018;32:2295–2299.
2. Elbuluk AM, Coxe FR, Fabricant PD, Ramos NL, Alaa MT, Jones KJ. Does medial-row fixation technique affect the retear rate and functional outcomes after double-row transosseous-equivalent rotator cuff repair? Orthopaedic Journal of Sports Medicine. 2019;7(5):2325967119842881.
3. Ergun S, Ozcan P, Gunaydin FI, Ozdemir E, Yalman SS, Pekmezci Y, Hatipoglu E, Bas A, Simsek O. Comparison of three different methods for stump closure in laparoscopic appendectomy: Endoloop, Hem-o-lok clip, and endostapler. Turkish Journal of Trauma & Emergency Surgery. 2024;30(11).
4. Elgendy A, Kharallah MG. Hem-o-lok clip versus hand-made loop in base closure during laparoscopic appendectomy in children. Journal of Pediatric Endoscopic Surgery. 2019;1:127–132.
5. Farahani PX, Safaei N. Comparison of two methods: clipping and suturing in laparoscopic appendectomy. Surgery Open Science. 2024;19:162–165.
6. Fields AC, Lu P, Palenzuela DL, Bleday R, Goldberg JE, Irani J, et al. Does retrieval bag use during laparoscopic appendectomy reduce postoperative infection? Surgery. 2019;165:933–937.
7. Ferman T, Yilmaz S, Akbulut S, Hamit A, Kabil A, Karabulut M. Comparison of burying the appendiceal stump using laparoscopic and open methods in complicated acute appendicitis. Medical Journal of Bakirkoy. 2020;16(4).
8. Giesen LJX, van den Boom AL, Van Rossem CC, van der Hoeven P, Wijhoven BP. International multicenter study on risk factors for surgical site infections after appendectomy in complicated appendicitis. Digestive Surgery. 2021;38:277–284.
9. Golz RA, Flum DR, Sanchez SE, Lin X, Donovan C, Drake FT. Geographic association between incidence of acute appendicitis and socioeconomic status. 2020;15(4):330–338.
10. Hanson KA, Jacob D, Saleh AA, Dinassane ST. In-hospital perforation risk in acute appendicitis: age matters. 2020;21(1):65–70.

11. Hajibandeh S, Hajibandeh S, Hobbs N, Mansour M. Neutrophil-to-lymphocyte ratio predicts acute appendicitis and distinguishes between complicated and uncomplicated appendicitis: a systematic review and meta-analysis. The American Journal of Surgery. 2020;219(1):154–163.
12. Khan MS, Chaudhry MBH, Shahzad N, Tariq M, Memon WA, Alvi AR. Risk of surgical site infection after laparoscopic versus open appendectomy in patients with complicated appendicitis. Pakistan Journal of Medical Sciences. 2019;35(2):281–287.
13. Golz RA, Flum DR, Sanchez SE, Lin X, Donovan C, Drake FT. Geographic association between incidence of acute appendicitis and socioeconomic status. Am J Surg. 2020;155(4):330–8.
14. Hanson KA, Jacob D, Saleh AA, Dinassane ST. In-hospital perforation risk in acute appendicitis: age matters. J Surg Res. 2020;219(1):65–70.
15. Hajibandeh S, Hajibandeh S, Hobbs N, Mansour M. Neutrophil-to-lymphocyte ratio predicts acute appendicitis and distinguishes between complicated and uncomplicated cases: a systematic review and meta-analysis. Am J Surg. 2020;219(1):154–63.
16. Hidalgo CAA, Calvo KJF, Lopez SFA, Collado DJ, Roveo JMC, Athie ADJA. Risk-benefit comparison between Endoloop and endostapler devices for closure of appendiceal stumps in laparoscopic appendectomy. Surg Endosc. 2020;16(3).
17. Ives T. Epidemiological and clinical studies of acute appendicitis. Ita-Surgeon. 2017.
18. Jaschinski T, Mosch CG, Eikermann M, Neugebauer EA, Sauerland S. Laparoscopic versus open surgery for suspected appendicitis. Cochrane Database Syst Rev. 2018;(11).
19. Klintmalm K, Keßler W, Partecke I, Walchus U, Schulze T, Heidecke C, et al. Comparison of non-absorbable polymeric clips and staplers for laparoscopic appendiceal stump closure: analysis of 618 adult patients. Langenbecks Arch Surg. 2019;404(6):711–6.
20. Knight SR, Ibrahim A, Makaram N, Patil P, Wilson MSJ. The use of polymeric clips in securing the appendiceal stump during laparoscopic appendectomy: a systematic review. Eur J Trauma Emerg Surg. 2019;45:665–670.
21. Khan MS, Chaudhry MBH, Shahzad N, Tariq M, Memon WA, Alvi AR. Risk of surgical site infection after laparoscopic versus open appendectomy in patients with complicated appendicitis. Pak J Med Sci. 2018;221:84–7.
22. Khan MS, Chaudhry MBH, Shahzad N, Khan MS, Wajid M, Memon WA, et al. Comparative outcomes in incidentally discovered appendicitis. Pak J Med Sci. 2018;221:84–7.