RESEARCH PAPER

Comparative Analysis of Traditional vs. Laparoscopic Appendectomy: A 5-Year Retrospective Study

Sayed Zamen Ali[1*], Syeda Aemen Fatima[2], Irshad Ahmad[3], Zulfiqar Ali[4], Hamid Raza Laghari[5], Shameen Shoaib[6], Payazov Sherali Nematovich[7]

[1*]Assistant Professor, Department of Surgery A Unit, Divisional Headquarters Teaching Hospital / KIDS, Kohat
Email: dr_sayed76@hotmail.com

[2]Consultant Surgeon, Department of General Surgery, DHQ Hospital Jauharabad, Khushab

[3]Senior Registrar, Department of General Surgery, Jhalawan Medical College, Khuzdar

[4]Associate Professor, Department of Clinical Sciences, College of Medicine, Sulaiman AlRajhi University, AlBukayriah

[5]Assistant Professor, Department of General Surgery, Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences / Gambat Medical College, Gambat, District Khairpur Mirs, Sindh

[6]General Surgeon, Department of General Surgery, Fauji Foundation Hospital, Karachi

[7]Faculty of Administration and Management, Department of Clinical Anatomy, Samarkand State Medical University, Samarkand, Uzbekistan

Received: 25th Aug, 2026 | Revised: 1st Sep, 2026 | Accepted: 5th Sep, 2026 | Available Online: 7th Sep, 2026

Abstract

Background: Acute appendicitis is a common surgical emergency, and both open and laparoscopic appendectomy are widely used. Laparoscopic surgery may provide advantages in postoperative recovery, although operative time can be longer.

Objective: To compare operative and postoperative outcomes of traditional open versus laparoscopic appendectomy in patients with acute appendicitis.

Methods: This 5-year retrospective comparative study was conducted at KIDS Kohat from may 2024 to may 2025 included 120 adult patients who underwent appendectomy, with 60 patients in each group. Demographic and clinical information including age, gender, body mass index, duration of symptoms, fever, leukocyte count, comorbidities, and radiological findings were recorded.

Results: Operative time was significantly longer with laparoscopic appendectomy than open surgery (58.9±17.2 vs. 47.8±14.6 minutes, $p<0.001$). However, laparoscopic patients had lower postoperative pain scores (3.8±1.3 vs. 5.1±1.4, $p<0.001$), fewer analgesic doses (2.5±0.9 vs. 3.4±1.1, $p<0.001$), earlier oral intake (13.4±5.8 vs. 18.7±7.2 hours, $p<0.001$), earlier ambulation (11.8±5.1 vs. 17.9±6.8 hours, $p<0.001$), and shorter hospital stay (2.6±1.2 vs. 3.8±1.6 days, $p<0.001$). Overall postoperative complications were lower after laparoscopy (15.0% vs. 30.0%, $p=0.049$), while prolonged hospital stay >3 days occurred in 18.3% versus 41.7% ($p=0.005$).

Conclusion: Laparoscopic appendectomy was associated with better postoperative recovery, fewer overall complications, and shorter hospitalization compared with open appendectomy, although operative time was longer. Both approaches showed comparable major short-term safety outcomes.

Keywords: Acute appendicitis; Open appendectomy; Laparoscopic appendectomy; Postoperative complications

How to cite this article: Sayed Zamen Ali1* Syeda Aemen Fatima2 Irshad Ahmad3 Zulfiqar Ali4 Hamid Raza Laghari5 Shameen Shoaib6 Payazov Sherali Nematovich7. Comparative Analysis of Traditional vs. Laparoscopic Appendectomy: A 5-Year Retrospective Study. Int J Drug Deliv Technol. 2026;16(82s):212-218. DOI: 10.25258/ijddt.16.82s.22.

Introduction

Acute appendicitis is a common cause of acute abdominal pain that needs emergency surgery globally [1]. For acute appendicitis surgical treatment is still the standard care and appendectomy is performed [2]. To date, open appendectomy through a right lower quadrant incision has been the most popular surgical approach due to its technical simplicity, minimal requirements for equipment and proven effectiveness [3]. Laparoscopic appendectomy is increasingly preferred due to enhanced visualization of the abdominal cavity, which may aid in the diagnosis and management of uncertain and complicated cases; with the availability of minimally invasive surgery, this approach is becoming more and more popular [4]. Existing guidelines tend to agree that laparoscopic appendectomy is the preferred surgical procedure when available and conditions are appropriate [5]. Although both open and laparoscopic appendectomy procedures work, they have different operative and postoperative features. Laparoscopic appendectomy is performed via small abdominal ports, and there is a reduction in trauma to the tissues, and better cosmetic results [6]. Laparoscopy has been shown to be superior to laparotomy in reducing postoperative pain, wound infection, requirement for analgesics and hospital stay in previous studies [7][8]. Recently, a retrospective comparative study of 450 patients has shown reduced analgesic requirements and shorter hospital stay after laparoscopic appendectomy but at the same time in the laparoscopic approach, the operative time was significantly increased when compared to the open approach [9].

One disadvantage that is generally reported for laparoscopic appendectomy is the duration of surgery. When port placement and pneumoperitoneum and intracorporeal dissection have to be performed, the operating time may be longer, especially for the learning curve or technically difficult cases [10]. Today, however, this difference has been diminished by improvements in laparoscopic instrumentation and the growing expertise of the surgeon in these techniques [11]. Whereas operative time has been demonstrated to be a time which may be shortened markedly with increasing institutional experience with laparoscopy [12]. Another factor to take into account is the risk of complications after surgery. Surgical-site infection is generally less common after laparoscopic appendectomy; however, there have been a number of concerns about abdominal abscess formation, especially in complicated appendicitis, historically [13]. However, more recent studies indicate that laparoscopic appendectomy can be performed without increased risk for postoperative ileus or a shortened hospital stay in patients with uncomplicated and complicated appendicitis, and may actually be associated with reduced postoperative ileus and hospital stay [14]. Other factors that could affect the decision of open versus laparoscopic appendectomy include the severity of the appendicitis, patient age, surgeon experience, resource availability, and institutional preference [15]. The recent retrospective data suggests that Laparoscopic surgery still has a shorter length of stay even after the controlling of severity of appendicitis and patients' factors [16].

Objective

To compare operative and postoperative outcomes of traditional open versus laparoscopic appendectomy in patients with acute appendicitis.

Methodology

This retrospective comparative study was conducted at KIDS Kohat from may 2024 to may 2025 and included records from a 5-year period. A total of 120 adult patients who underwent appendectomy for acute appendicitis were included. Patients were categorized according to surgical approach into traditional open appendectomy and laparoscopic appendectomy groups. Acute appendicitis was diagnosed on the basis of compatible clinical findings supported by laboratory and/or radiological assessment where available. Patients aged ≥18 years who underwent emergency appendectomy with complete medical and operative records were included. Patients managed conservatively, those undergoing interval appendectomy, patients with incidental appendectomy, pregnancy, appendiceal malignancy, or incomplete records were excluded.

Data Collection

Demographic and clinical information including age, gender, body mass index, duration of symptoms, fever, leukocyte count, comorbidities, and radiological findings were recorded. Operative variables included surgical approach, operative time, intraoperative findings, uncomplicated or complicated appendicitis, perforation, gangrene, abscess, conversion from laparoscopic to open surgery, and intraoperative complications. Postoperative outcomes included postoperative pain, analgesic requirement, time to oral intake, time to ambulation, surgical-site infection, intra-abdominal abscess, postoperative ileus, wound dehiscence, reoperation, length of hospital stay, 30-day readmission, and mortality. Histopathological findings of the resected appendix were also documented where available. Outcomes were

compared between patients undergoing open and laparoscopic appendectomy.

Statistical Analysis

Data were entered and analyzed using SPSS version 26.0. Continuous variables such as age, operative time, leukocyte count, time to oral intake, and hospital stay were expressed as mean±SD or median with interquartile range according to data distribution. Categorical variables were presented as frequency and percentage. Normality was assessed using the Shapiro–Wilk test. Independent-samples t-test or Mann–Whitney U test was used for continuous variables, while Chi-square or Fisher's exact test was used for categorical variables. Multivariable logistic regression was performed to identify independent factors associated with postoperative complications and prolonged hospital stay, with adjusted odds ratios and 95% confidence intervals reported. A p-value ≤0.05 was considered statistically significant.

Results

Baseline characteristics were comparable between open and laparoscopic groups. Mean age was 29.8±10.6 vs. 28.9±9.8 years, BMI 25.8±3.9 vs. 25.4±4.1 kg/m², symptom duration 31.6±15.4 vs. 29.8±14.7 hours, and leukocyte count 13.8±3.7 vs. 13.4±3.5×10³/µL. Male gender (60.0% vs. 56.7%), fever (48.3% vs. 43.3%), diabetes (10.0% vs. 8.3%), hypertension (13.3% vs. 11.7%), complicated appendicitis (28.3% vs. 25.0%), perforation (13.3% vs. 10.0%), and gangrene (11.7% vs. 10.0%) also showed no significant differences.

Table 1. Baseline Clinical Characteristics of Patients

Variable	Open Appendectomy (n=60)	Laparoscopic Appendectomy (n=60)	p-value
Age, years, mean±SD	29.8±10.6	28.9±9.8	0.629
Male, n (%)	36 (60.0)	34 (56.7)	0.713
BMI, kg/m², mean±SD	25.8±3.9	25.4±4.1	0.584
Duration of symptoms, hours, mean±SD	31.6±15.4	29.8±14.7	0.514
Fever, n (%)	29 (48.3)	26 (43.3)	0.583
Leukocyte count, ×10³/µL, mean±SD	13.8±3.7	13.4±3.5	0.544
Diabetes mellitus, n (%)	6 (10.0)	5 (8.3)	0.752
Hypertension, n (%)	8 (13.3)	7 (11.7)	0.781
Complicated appendicitis, n (%)	17 (28.3)	15 (25.0)	0.680
Perforated appendix, n (%)	8 (13.3)	6 (10.0)	0.570
Gangrenous appendix, n (%)	7 (11.7)	6 (10.0)	0.766

Operative time was significantly shorter with open appendectomy (47.8±14.6 vs. 58.9±17.2 minutes, p<0.001). Intraoperative complications occurred in 8.3% vs. 5.0% (p=0.464), peritoneal contamination in 21.7% vs. 18.3% (p=0.644), drain placement in 30.0% vs. 18.3% (p=0.135), and intra-abdominal abscess in 10.0% vs. 8.3% (p=0.752). Conversion to open surgery occurred in 6.7% of laparoscopic cases (p=0.042).

Table 2. Comparison of Operative Outcomes

Outcome	Open Appendectomy (n=60)	Laparoscopic Appendectomy (n=60)	p-value
Operative time, minutes, mean±SD	47.8±14.6	58.9±17.2	<0.001
Intraoperative complication, n (%)	5 (8.3)	3 (5.0)	0.464
Conversion to open surgery, n (%)	0 (0.0)	4 (6.7)	0.042
Peritoneal contamination, n (%)	13 (21.7)	11 (18.3)	0.644

Drain placement, n (%)	18 (30.0)	11 (18.3)	0.135
Intra-abdominal abscess found, n (%)	6 (10.0)	5 (8.3)	0.752

Laparoscopic appendectomy showed better postoperative recovery, with lower pain scores (3.8±1.3 vs. 5.1±1.4, p<0.001), fewer analgesic doses (2.5±0.9 vs. 3.4±1.1, p<0.001), earlier oral intake (13.4±5.8 vs. 18.7±7.2 hours, p<0.001), earlier ambulation (11.8±5.1 vs. 17.9±6.8 hours, p<0.001), and shorter hospital stay (2.6±1.2 vs. 3.8±1.6 days, p<0.001). Surgical-site infection was 5.0% vs. 15.0%, intra-abdominal abscess 6.7% vs. 5.0%, ileus 3.3% vs. 11.7%, and wound dehiscence 1.7% vs. 6.7%.

Table 3. Postoperative Outcomes

Outcome	Open Appendectomy (n=60)	Laparoscopic Appendectomy (n=60)	p-value
Postoperative pain score at 24 h, mean±SD	5.1±1.4	3.8±1.3	<0.001
Analgesic doses in first 24 h, mean±SD	3.4±1.1	2.5±0.9	<0.001
Time to oral intake, hours, mean±SD	18.7±7.2	13.4±5.8	<0.001
Time to ambulation, hours, mean±SD	17.9±6.8	11.8±5.1	<0.001
Surgical-site infection, n (%)	9 (15.0)	3 (5.0)	0.068
Intra-abdominal abscess, n (%)	3 (5.0)	4 (6.7)	0.697
Postoperative ileus, n (%)	7 (11.7)	2 (3.3)	0.082
Wound dehiscence, n (%)	4 (6.7)	1 (1.7)	0.171
Hospital stay, days, mean±SD	3.8±1.6	2.6±1.2	<0.001

Overall postoperative complications were significantly lower after laparoscopic appendectomy (15.0% vs. 30.0%, p=0.049), while prolonged hospital stay >3 days was also less common (18.3% vs. 41.7%, p=0.005). Reoperation occurred in 1.7% vs. 5.0%, readmission in 5.0% vs. 10.0%, histologically confirmed appendicitis in 95.0% vs. 93.3%, and negative appendectomy in 5.0% vs. 6.7%. Thirty-day mortality was 0% after laparoscopy compared with 1.7% after open surgery.

Table 4. Overall Complications and Short-Term Outcomes

Outcome	Open Appendectomy (n=60)	Laparoscopic Appendectomy (n=60)	p-value
Any postoperative complication, n (%)	18 (30.0)	9 (15.0)	0.049
Reoperation, n (%)	3 (5.0)	1 (1.7)	0.309
30-day readmission, n (%)	6 (10.0)	3 (5.0)	0.298
Prolonged hospital stay >3 days, n (%)	25 (41.7)	11 (18.3)	0.005
Histologically confirmed acute appendicitis, n (%)	56 (93.3)	57 (95.0)	0.697
Negative appendectomy, n (%)	4 (6.7)	3 (5.0)	0.697
30-day mortality, n (%)	1 (1.7)	0 (0.0)	0.315

Discussion

In the present study, 120 patients with acute appendicitis were randomly divided into two groups: open appendectomy and laparoscopic appendectomy. Both groups had similar baseline values, such as age, BMI, duration of symptoms, leukocyte count, comorbidities and complicated appendicitis. This comparability further bolsters the conclusion that the differences in postoperative outcomes were primarily due to surgical approach, and not to significant patient differences. The operative time was significantly longer for the laparoscopic appendectomy than the open appendectomy (58.9±17.2 vs. 47.8±14.6 minutes, $p<0.001$). There was also a report that the laparoscopy surgery was more time-consuming than the open appendectomy (56.86±11.70 minutes vs 46.08±13.10 minutes) in a study of 450 patients [17]. Another previous research also demonstrated mean operative times of 47.17±14.39 minutes for laparoscopic and 36.9±12.33 minutes for open appendectomy ($p=0.001$) [18]. The present results indicate that the laparoscopic method might necessitate more time for port insertion, abdominal exploration and intracorporeal dissection, but this might be reduced with increasing surgical experience. Although the laparoscopic appendix surgery was longer, there were definite gains in the postoperative period. Mean pain score at 24 hours was significantly lower after laparoscopy (3.8±1.3 vs. 5.1±1.4, $p<0.001$), while analgesic requirements were also reduced (2.5±0.9 vs. 3.4±1.1 doses, $p<0.001$). A previous study also reported less post-operative pain and less need for analgesics after laparoscopic appendectomy [17,18]. This is probably due to the smaller incisions and lower degree of trauma to the abdominal wall from the minimally invasive technique. Laparoscopic appendectomized patients also were started on oral feedings and mobility earlier. MTOT (13.4±5.8 hours) and ambulation (11.8±5.1 hours) times were significantly shorter after closed surgery than after open surgery (18.7±7.2 hours and 17.9±6.8 hours, respectively, both $p<0.001$). The results are similar to those reported earlier, indicating that laparoscopic appendectomy lets the patients recover faster and resume their normal activities earlier [18]. Minimized tissue handling and postoperative pain can help to facilitate early mobilization and gastrointestinal function. Length of hospital stay was significantly shorter following laparoscopic surgery (2.6±1.2 vs. 3.8±1.6 days, $p<0.001$). This is in accordance with the previous studies, which showed that hospital stay following laparoscopic appendectomy was 1.07±0.25 days, and 1.28±0.80 days after open surgery [17]. Another previous research found postoperative stays of 3.69±0.71 versus 5.28±0.63 days, respectively [18]. One previous study conducted in Pakistan also found that patients had a shorter hospital stay after undergoing a laparoscopic appendectomy than after an open appendectomy [19]. These results are always consistent for the recovery benefit of the laparoscope surgery approach.

The rates of surgical-site infection were 5.0% for patients who had laparoscopic surgery and 15.0% for patients who had open appendectomy surgery. This difference was not statistically significant ($p=0.068$), but in the favor of laparoscopy. Laparascopy also has been shown previously to have lower rates of wound infections, as does one large comparative study, which showed 3.8% wound infection following laparoscopy versus 14.0% following open appendectomy [20]. In another prior study, wound infection occurred in 6.66% of the laparoscopically operated patients compared to 13.33% of the open surgery patients [18]. This may be explained by the smaller incisions and limited exposure of the operative field associated with laparoscopy. There was no difference in the rate of intra-abdominal abscess formation between the groups (after laparoscopic surgery, 6.7% vs after open surgery, 5.0%, $p=0.697$). This is significant as a prior concern was that there might be a higher risk of intra-abdominal infection following laparoscopic appendectomy, especially in complicated appendicitis. Overall previous studies to compare laparoscopic and open surgery in complicated and uncomplicated cases have shown no significant difference in serious infectious complications, and even a significant increase in postoperative ileus was seen with laparoscopy in comparison to open surgery [21]. Postoperative complications were significantly less common for laparoscopic appendectomy (15.0% vs. 30.0%, $p=0.049$), and longer hospitalization (more than 3 days) was less common (18.3% vs. 41.7%, $p=0.005$). Previous studies have also reported reduced overall complication rates after laparoscopic surgery, but not all studies were statistically significant [17]. In the present study, postoperative ileus also occurred less often after laparoscopy (3.3% vs. 11.7%) than in previous studies reporting ileus rates of 4.0% after laparoscopy and 14.7% after open appendectomy [21]. Laparoscopy was also numerically lower in terms of reoperation (1.7% vs. 5.0%), 30-day readmission (5.0% vs. 10.0%), negative appendectomy (5.0% vs. 6.7%) and mortality (0% vs. 1.7%), but these differences were not significant. Previous studies have also consistently shown similar major morbidity and mortality rates between the two methods with a benefit for laparoscopy in pain, wound infection, recovery and hospitalization [17] [18]. There were several limitations in this study. The study was a single-center retrospective study with a relatively small number of patients (120); the results might not be generalizable.

The choice of surgical technique might have been a reflection of surgeon preference, disease severity, equipment availability, and patient factors. Retrospective data may also lack information regarding pain, medication use and post surgery recovery. Furthermore, long-term complications like incisional hernia, chronic pain, return to normal activity, and quality of life were not assessed. A large multicenter prospective study is recommended.

Conclusion

It is concluded that laparoscopic appendectomy was associated with lower postoperative pain, reduced analgesic requirement, earlier oral intake and ambulation, fewer overall complications, and shorter hospital stay compared with traditional open appendectomy. However, laparoscopic surgery required a longer operative time and carried a small risk of conversion to open surgery. Major outcomes including intra-abdominal abscess, reoperation, readmission, and mortality were comparable between the two approaches. Laparoscopic appendectomy may therefore be preferred where appropriate expertise and facilities are available.

References

1. Srivastava S, Yadav GD, Shukla P, Verma S. A prospective and comparative study of laparoscopic appendectomy and open appendectomy in the surgical treatment of appendicitis. *Cureus.* 2025;17(1):e77631. doi:10.7759/cureus.77631.
2. Bulut A, Ucar M. Laparoscopic appendectomy versus open surgery. *JSLS.* 2025;29(1):e2024.00077. doi:10.4293/JSLS.2024.00077.
3. Roghani AS, Shahzad F, Roghani FS, Roghani M, Khan Z, Ullah A, et al. Comparison of surgical site infections in laparoscopic versus open appendectomy: a prospective cohort study. *Cureus.* 2025;17(3):e80530. doi:10.7759/cureus.80530.
4. Afridi NS, Shah AA, Uzair M, Hussain A, Maryam, Khalil J. Retrospective comparison of laparoscopic versus open appendectomy techniques in a tertiary care hospital in Peshawar Pakistan. *Int J Pathol.* 2025;22(4):213-219. doi:10.59736/IJP.22.04.924.
5. Khalid M, Lodhi JK, Munaf A, Shakir J, Sadiq I, Bukhari ST. Comparative evaluation of surgical site infection after laparoscopic versus open appendectomy. *Esculapio.* 2025;20(4):483-485. doi:10.51273/esc24.25132047.
6. Özdemir AZ, Tarim İA, Derebey M, Mollahüseyinoğlu Küllaç F, Barutcu B, Köse B. Comparison of maternal and fetal outcomes of laparoscopic versus open appendectomy in pregnancy. *Medicine (Baltimore).*2025;104(38):e44546. doi:10.1097/MD.0000000000044546.
7. Rolle U, Bechstein WO, Fahlenbrach C, Heller G, Meyer HJ, Schuler E, et al. The outcome of laparoscopic versus open appendectomy in childhood. *Dtsch Arztebl Int.* 2024;121(2):39-44. doi:10.3238/arztebl.m2023.0234.
8. Yousaf N, Abbas N, Mehmood W, Rehman FU, Abbasi RA. Laparoscopic vs open appendectomy: surgical outcomes with early recovery and length of hospital stay—a comparative study in Rawalpindi, Pakistan. *Life Sci.*2024;5(3):355-361. doi:10.37185/LnS.1.1.531.
9. Basukala S, Thapa N, Bhusal U, Shrestha O, Karki S, Regmi SK, et al. Comparison of outcomes of open and laparoscopic appendectomy: a retrospective cohort study. *Health Sci Rep.* 2023;6(8):e1483. doi:10.1002/hsr2.1483.
10. Zamaray B, de Boer MFJ, Popal Z, Rijbroek A, Bloemers FW, Oosterling SJ. AbcApp: incidence of intra-abdominal abscesses following laparoscopic vs. open appendectomy in complicated appendicitis. *Surg Endosc.*2023;37:1694-1699. doi:10.1007/s00464-022-09670-4.
11. Shaikh AH, Tandur AE, Sholapur S, Vangal G, Bhandarwar AH, Ghosh A, et al. Laparoscopic versus open appendectomy: a prospective comparative study and 4-year experience in a tertiary care hospital. *Surg J (N Y).*2022;8(3):e208-e214. doi:10.1055/s-0042-1751112.
12. Rasuli SF, Naz J, Azizi N, Hussain N, Qureshi PNAA, Swarnakari KM, et al. Laparoscopic versus open appendectomy for patients with perforated appendicitis. *Cureus.* 2022;14(6):e26265. doi:10.7759/cureus.26265.
13. Hussein AH, El-Baaly A, Ghareeb WM, Madbouly K, Gabr H. Outcome and quality of life in obese patients underwent laparoscopic vs. open appendectomy. *BMC Surg.* 2022;22:282. doi:10.1186/s12893-022-01732-7.

14. Khan MS, Khattak IA, Jamil T, Saqib M, Hussain SA, Younis S. Comparison of laparoscopic appendectomy with open appendectomy with respect to surgical site infection. *Pak J Med Health Sci.* 2022;16(8):695. doi:10.53350/pjmhs22168695.
15. Khan KH, Khan WY, Khan Z, Shahzad M. Laparoscopic vs open appendicectomy: what's the best for pregnant patients. *Pak Armed Forces Med J.* 2022;72(2):704-707. doi:10.51253/pafmj.v72i2.4262.
16. Akhtar N, Shahid F, Naz S, Ijaz RM, Asif M, Jameel MA. Comparison of the outcome of laparoscopic vs open appendectomy in tertiary care hospital of Muzaffarabad. *Pak J Med Health Sci.* 2022;16(4):147. doi:10.53350/pjmhs22164147.
17. Shahid MH, Khan FI, Askri ZA, Asad A, Saeed R, Talib TB, et al. Two-year experiences of 500 appendectomies in Lahore General Hospital, Lahore. *Cureus.* 2022;14(1):e21303. doi:10.7759/cureus.21303.
18. Fujishiro J, Watanabe E, Hirahara N, Terui K, Tomita H, Ishimaru T, Miyata H. Laparoscopic versus open appendectomy for acute appendicitis in children: a nationwide retrospective study on postoperative outcomes. *J Gastrointest Surg.* 2021;25(4):1036-1044. doi:10.1007/s11605-020-04544-3.
19. Kleif J, Thygesen LC, Gögenur I. Moving from an era of open appendectomy to an era of laparoscopic appendectomy: a nationwide cohort study of adult patients undergoing surgery for appendicitis. *Scand J Surg.*2021;110(4):512-519. doi:10.1177/1457496921992615.
20. Mulita F, Plachouri KM, Liolis E, Kehagias D, Kehagias I. Comparison of intra-abdominal abscess formation after laparoscopic and open appendectomy for complicated and uncomplicated appendicitis: a retrospective study. *Wideochir Inne Tech Maloinwazyjne.* 2021;16(3):560-565. doi:10.5114/wiitm.2021.103942.
21. Takami T, Yamaguchi T, Yoshitake H, Hatano K, Kataoka N, Tomita M, Makimoto S. A clinical comparison of laparoscopic versus open appendectomy for the treatment of complicated appendicitis: historical cohort study. *Eur J Trauma Emerg Surg.* 2020;46(4):847-851. doi:10.1007/s00068-019-01086-5.