THE PLANET

Original Article

Preoperative Risk Factors Associated with Conversion from Laparoscopic to Open Appendectomy

Sharif Mushfaqur Rahman[1*], Nur Hossain Shaheen[2], Probir Kumar Sutradhar[3], Nazrul Islam[4], Ridwan Tareen[5]

ARTICLE INFO

Received: 14 October 2026
Accepted: 22 October 2026
Published Online: 03 November 2026

DOI: 10.5281/zenodo.23919873

Volume: 10, Number: 3, Page: 1211-1215

e-ISSN: 2789-5912
ISSN: 2617-0817

*Corresponding author

ABSTRACT

Background: Acute appendicitis is a common surgical emergency, and laparoscopic appendectomy is the preferred operative approach because of its favorable postoperative outcomes. However, conversion to open surgery may be required in patients with severe inflammation, complicated appendicitis, or technical difficulty, and may increase morbidity. **Aim of the study:** This study aimed to identify clinical, laboratory, and radiological preoperative risk factors associated with conversion from laparoscopic to open appendectomy. **Methods & Materials:** This hospital-based observational study was conducted at the Department of Surgery, Cox's Bazar Medical College, Cox's Bazar, Bangladesh, from January 2025 to December 2025 including 250 consecutive patients undergoing laparoscopic appendectomy for acute appendicitis. Demographic, clinical, laboratory, and imaging variables were recorded preoperatively. Conversion to open appendectomy was the primary outcome. Data were analyzed using SPSS version 27.0, with chi-square and independent-samples t-tests for group comparisons and multivariable logistic regression to identify independent predictors of conversion; $p<0.05$ was considered statistically significant. **Results:** Among 250 patients, the mean age was 31.8 ± 12.6 years, and 59.2% were male. Overall, 18 patients (7.2%) required conversion to open appendectomy. Compared with laparoscopically completed cases, converted patients more frequently had symptoms >48 hours, elevated WBC and CRP, suspected perforation, and complicated appendicitis. After adjustment, symptoms >48 hours (AOR 3.08), appendicular mass/phlegmon (AOR 4.15), suspected perforation (AOR 4.42), and complicated appendicitis on imaging (AOR 5.21) independently predicted conversion. **Conclusion:** Conversion to open appendectomy was uncommon but was strongly associated with delayed presentation and complicated appendicitis, particularly phlegmon and perforation. Careful preoperative risk stratification and timely surgical management may help anticipate conversion and improve operative planning.

Keywords: *Acute appendicitis; Laparoscopic appendectomy; Open appendectomy; Conversion to open surgery; Preoperative risk factors.*

1. *Assistant Professor, Department of Surgery, Cox's Bazar Medical College, Cox's Bazar, Bangladesh (ORCID: 0009-0007-5692-8835)*
2. *Professor & Head, Department of Surgery, Cox's Bazar Medical College, Cox's Bazar, Bangladesh*
3. *Assistant Professor, Department of Surgery, Cox's Bazar Medical College, Cox's Bazar, Bangladesh*
4. *Associate Professor, Department of Surgery, Cox's Bazar Medical College, Cox's Bazar, Bangladesh*
5. *Resident Surgeon, Department of Surgery, 250-Bed Sadar Hospital, Cox's Bazar, Bangladesh*

INTRODUCTION

Among emergency general surgical conditions, acute appendicitis remains one of the most frequent causes of acute abdominal pain requiring urgent evaluation and treatment [1,2]. Globally, approximately 17 million new cases of appendicitis occurred in 2021, corresponding to an age-standardized incidence of about 214 per 100,000 population, although incidence and mortality vary considerably by geography [1]. Across populations, lifetime risk has been estimated at approximately 6–7%, with the greatest burden among adolescents and young adults [2]. Although mortality has declined substantially with improvements in diagnosis, antimicrobial therapy, anesthesia, and surgical care, delayed presentation and limited access to timely surgical services continue to contribute to complicated disease, particularly in resource-constrained settings [1,3]. Over recent decades, laparoscopic appendectomy has become the preferred operative approach for acute appendicitis because of its minimally invasive nature, reduced wound complications, faster postoperative recovery, and shorter hospital stay [3-5]. Compared with open appendectomy, laparoscopic surgery has demonstrated favorable postoperative outcomes across different patient populations, including individuals with complicated appendicitis and patients at increased operative risk [3,5]. Nevertheless, laparoscopic completion is not always possible, and conversion to an open procedure may be necessary because of severe inflammation, dense adhesions, distorted anatomy, perforation, abscess formation, peritonitis, hemorrhage, or technical difficulty [6-9]. Recent observational studies report considerable variation in conversion rates. In a large adult series, conversion occurred in approximately 2% of laparoscopic appendectomies, while another study involving 1,220 patients reported a rate of 5.5% [6,7]. Higher conversion rates of 16.7% and 27.5% have been documented in cohorts containing greater proportions of complicated or perforated appendicitis [8,9]. Within South Asia, a recent Pakistani study of complicated appendicitis reported conversion in 19.8% of patients, with delayed presentation beyond 48 hours, obesity, elevated C-reactive protein, and previous abdominal surgery associated with conversion [10]. This variation suggests that conversion risk depends not only on disease severity but also on patient characteristics, referral patterns, diagnostic resources, and institutional surgical experience. Importantly, several potentially recognizable preoperative factors have been associated with conversion. Higher age, obesity, diabetes, previous abdominal surgery, prolonged symptom duration, elevated leukocyte count and C-reactive protein, higher clinical severity scores, and radiological evidence of periappendiceal fluid or complicated appendicitis have been reported as important predictors [6-9,11]. Because converted patients experience substantially greater postoperative morbidity and longer hospitalization than patients whose operations are completed laparoscopically, identifying these factors before surgery has considerable clinical relevance [6,7]. With better preoperative risk stratification, surgeons can improve operative planning, patient counseling, theatre preparedness, and decisions about the need for senior surgical involvement. Within Bangladesh, available studies have

BDJOURNALS.ORG Copyright © 2026 The Planet. Published by Sher-E-Bangla Medical College, Barishal, Bangladesh. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

demonstrated the substantial emergency surgical burden of appendicitis and the feasibility of laparoscopic management, including in complicated presentations [12,13]. During periods of delayed healthcare access, a Bangladeshi tertiary-care study documented a greater proportion of complicated appendicitis among children undergoing appendectomy, while another local study demonstrated favorable outcomes of laparoscopy for appendicular inflammatory masses [12,13]. Despite these observations, locally generated evidence specifically examining preoperative predictors of laparoscopic-to-open conversion among adult patients remains limited. Furthermore, differences in delayed presentation, healthcare accessibility, imaging availability, disease severity, and operative resources may restrict direct application of risk estimates derived from high-income settings. Given these evidence gaps, evaluation of readily identifiable clinical, laboratory, and radiological predictors in the local setting is warranted. Accordingly, this study aimed to identify preoperative risk factors associated with conversion from laparoscopic to open appendectomy among patients undergoing surgery for acute appendicitis.

METHODS & MATERIALS

This hospital-based observational study was conducted in the Department of Surgery of the Department of Surgery, Cox's Bazar Medical College, Cox's Bazar, Bangladesh from January 2025 to December 2025. The study included 250 consecutive patients who underwent laparoscopic appendectomy for clinically and/or radiologically diagnosed acute appendicitis during the study period. Patients of either sex who were considered suitable for laparoscopic appendectomy and in whom a laparoscopic approach was initially attempted were included. Patients undergoing primary open appendectomy, interval appendectomy, appendectomy performed as part of another abdominal procedure, or those with incomplete preoperative records were excluded. Written informed consent was obtained from eligible participants before surgery. Relevant demographic, clinical, laboratory, and radiological information was recorded using a structured data collection form. Preoperative variables included age, sex, body mass index, diabetes mellitus, history of previous abdominal surgery, American Society of Anesthesiologists physical status, symptom duration, fever, abdominal guarding or rebound tenderness, total white blood cell count, neutrophil percentage, C-reactive protein, serum bilirubin, and serum sodium. Preoperative ultrasonography and/or computed tomography findings were reviewed for appendiceal diameter, appendicolith, periappendiceal fluid, appendicular mass or phlegmon, abscess, suspected perforation, and features of complicated appendicitis. All procedures were initially performed laparoscopically using standard surgical techniques. Conversion to open appendectomy was defined as the need to make a formal abdominal incision to complete the operation after laparoscopic access had been established. The primary outcome was the rate of conversion from laparoscopic to open appendectomy. Reasons for conversion were also documented. Data were analyzed using SPSS (V 27.0). Continuous variables were expressed as mean ± standard deviation or median with interquartile range, as appropriate, while categorical variables were presented as frequency and percentage. The chi-square test was used for categorical comparisons, while the independent-samples t-test was applied for continuous variables. Variables with clinically relevant or statistically significant associations in univariate analysis were included in multivariable logistic regression to identify independent preoperative predictors of conversion. Adjusted odds ratios with 95% confidence intervals were reported, and a p-value <0.05 was considered statistically significant.

RESULTS

Among the 250 participants, the mean age was 31.8 ± 12.6 years, while 59.2% were male. Regarding important baseline risk factors, 32.8% presented more than 48 hours after symptom onset, 41.2% had BMI ≥25 kg/m², and 13.6% had a history of previous abdominal surgery (*Table I*).

Table I
Baseline demographic and clinical characteristics (*n*=250).

Variables	n (%) / Mean ± SD
Age (years)	31.8 ± 12.6
Age >40 years	70 (28.0)
Male sex	148 (59.2)
BMI ≥25 kg/m²	103 (41.2)
Diabetes mellitus	29 (11.6)
Previous abdominal surgery	34 (13.6)
ASA II–III	61 (24.4)
Duration of symptoms >48 hours	82 (32.8)

Compared with patients whose procedures were completed laparoscopically, converted patients more frequently had symptoms >48 hours (66.7% vs. 30.2%), WBC >15 ×10⁹/L (72.2% vs. 35.8%), and elevated CRP (77.8% vs. 39.7%). Converted cases also had higher frequencies of fever, guarding, neutrophilia, hyperbilirubinemia, and hyponatremia, with statistically significant differences (*Table II*).

Table II
Preoperative clinical and laboratory findings according to conversion status.

Variables	Laparoscopic (n=232)	Converted (n=18)	p-value
	n (%)	n (%)	
Symptoms >48 hours	70 (30.2)	12 (66.7)	0.003
Fever ≥38°C	67 (28.9)	10 (55.6)	0.031
Guarding/rebound tenderness	78 (33.6)	11 (61.1)	0.038
WBC >15 ×10⁹/L	83 (35.8)	13 (72.2)	0.004
Neutrophilia ≥80%	76 (32.8)	12 (66.7)	0.008
Elevated CRP	92 (39.7)	14 (77.8)	0.002
Hyperbilirubinemia	50 (21.6)	8 (44.4)	0.04
Sodium <135 mmol/L	39 (16.8)	7 (38.9)	0.029

Regarding preoperative imaging, converted patients had substantially higher frequencies of complicated appendicitis (77.8% vs. 26.7%), suspected perforation (55.6% vs. 11.2%), appendicular mass/phlegmon (44.4% vs. 8.2%), and appendicular abscess (38.9% vs. 6.0%). These findings showed strong associations between advanced radiological disease and conversion to open surgery (*Table III*).

Table III
Preoperative imaging findings according to conversion status.

Imaging findings	Laparoscopic (n=232) n (%)	Converted (n=18) n (%)	p-value
Appendix diameter >10 mm	99 (42.7)	13 (72.2)	0.024
Appendicolith	55 (23.7)	8 (44.4)	0.086
Periappendiceal fluid	69 (29.7)	12 (66.7)	0.003
Appendicular mass/phlegmon	19 (8.2)	8 (44.4)	<0.001
Appendicular abscess	14 (6.0)	7 (38.9)	<0.001
Suspected perforation	26 (11.2)	10 (55.6)	<0.001
Complicated appendicitis on imaging	62 (26.7)	14 (77.8)	<0.001

Overall, 232 of 250 patients (92.8%) completed laparoscopic appendectomy successfully, while 18 patients (7.2%) required conversion to open surgery. Among converted cases, dense adhesions or severe inflammation (33.3%) represented the most common reason, followed by appendicular mass/phlegmon (22.2%) and perforation with difficult dissection (16.7%) (*Table IV*).

Table IV
Operative outcome and reasons for conversion.

Operative findings/outcome	n (%)
Total laparoscopic appendectomies attempted	250 (100.0)
Completed laparoscopically	232 (92.8)
Converted to open appendectomy	18 (7.2)
Reason for conversion (n=18)	
Dense adhesions/severe inflammation	6 (33.3)
Appendicular mass/phlegmon	4 (22.2)
Perforation with difficult dissection	3 (16.7)
Poor visualization/difficult anatomy	2 (11.1)
Intraoperative bleeding	2 (11.1)
Other technical difficulty	1 (5.6)

After multivariable adjustment, symptom duration >48 hours (AOR 3.08, 95% CI 1.01–9.39), appendicular mass/phlegmon (AOR 4.15, 95% CI 1.18–14.58), suspected perforation (AOR 4.42, 95% CI 1.27–15.39), and complicated appendicitis on imaging (AOR 5.21, 95% CI 1.51–17.98), remained significant independent predictors of conversion. Among these factors, complicated appendicitis on imaging showed the strongest independent association with conversion to open appendectomy (*Table V*).

Table V
Preoperative factors associated with conversion to open appendectomy.

Variables	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age >40 years	3.11 (1.02–9.50)	0.012	1.74 (0.55–5.47)	0.345
Previous abdominal surgery	3.35 (1.07–10.48)	0.022	2.18 (0.65–7.31)	0.207
Symptoms >48 hours	4.13 (1.33–12.83)	0.003	3.08 (1.01–9.39)	0.048
WBC >15 ×10⁹/L	4.40 (1.43–13.55)	0.004	2.09 (0.63–6.90)	0.227
Elevated CRP	4.89 (1.43–16.69)	0.002	2.32 (0.67–8.01)	0.183
Periappendiceal fluid	4.20 (1.35–13.10)	0.003	1.86 (0.54–6.38)	0.324
Appendicular mass/phlegmon	7.73 (2.35–25.41)	<0.001	4.15 (1.18–14.58)	0.027
Appendicular abscess	8.31 (2.34–29.50)	<0.001	2.91 (0.76–11.21)	0.12
Suspected perforation	8.26 (2.50–27.34)	<0.001	4.42 (1.27–15.39)	0.019
Complicated appendicitis on imaging	9.37 (2.90–30.27)	<0.001	5.21 (1.51–17.98)	0.009

DISCUSSION

In the present study, conversion from laparoscopic to open appendectomy occurred in 7.2% of 250 patients, while 92.8% were completed laparoscopically. This rate was slightly lower than the pooled conversion rate of 8.7% reported in a 2025 meta-analysis of 45 studies involving more than 3.2 million patients [14]. By comparison, a German cohort reported 5.5% conversion a large US database analysis identified conversion risk ranging from ≤5% in low-risk patients to 10–25% in higher-risk groups and a 15-year single-center series reported only 2.0% [6, 7,15]. Conversely, a Turkish study reported 19.2% conversion while another recent Turkish series reported 3.8% [16,17]. These variations likely reflect differences in case selection, disease severity, surgeon experience, imaging use, and institutional conversion thresholds. Regarding delayed presentation, symptoms lasting >48 hours were independently associated with conversion in the present study (AOR 3.08; 95% CI 1.01–9.39). Similar evidence was reported from Pakistan, where delayed presentation >48 hours were significantly associated with conversion (p=0.001) [10]. Likewise, the APPE survey found perforation in 44% of late presenters compared with 11% of early presenters, while another study reported a 9% increase in perforation risk for each day

of delay [18,19]. More recently, a prospective study of 804 patients found that symptom duration, rather than in-hospital delay, predicted complicated appendicitis and morbidity [20]. This consistency suggests that delayed community presentation may allow progression from uncomplicated inflammation to perforation, abscess, or phlegmon, making laparoscopic dissection more difficult. Concerning inflammatory markers, WBC >15×10⁹/L was present in 72.2% of converted patients compared with 35.8% of laparoscopically completed cases, while elevated CRP occurred in 77.8% versus 39.7%. A German study similarly found elevated WBC and CRP to independently predict conversion, with ORs of 1.9 and 2.3, respectively [6]. A Turkish cohort also demonstrated significant associations between CRP and conversion ($p<0.001$) [17]. Similarly, Akturk et al. found CRP significantly associated with conversion ($p=0.018$) [21]. In Pakistan, CRP >100 mg/L was associated with conversion ($p=0.001$) [10]. These markers likely reflect greater inflammatory burden, but their lack of independence in the present adjusted model indicates that radiological evidence of complicated disease may capture severity more directly. Radiological findings showed the strongest associations. Complicated appendicitis on imaging occurred in 77.8% of converted patients versus 26.7% of non-converted patients and remained the strongest independent predictor (AOR 5.21; 95% CI 1.51–17.98). Suspected perforation also remained significant (AOR 4.42), while appendicular mass or phlegmon had an AOR of 4.15. Consistently, the large cohort by Finnerty et al. found abscess or peritonitis to increase conversion odds sevenfold (OR 7.00) while the 2,193-patient study identified complicated appendicitis and peritonitis as independent predictors [7, 15]. Similarly, complicated appendicitis occurred in 40.9% of converted patients but only 0.6% of laparoscopically completed cases in another study [16]. Additional radiological evidence supports these observations. An appendix diameter >10 mm was found in 72.2% of converted patients compared with 42.7% of non-converted patients. Akturk et al. reported that an appendiceal diameter of 14 mm increased conversion odds approximately threefold (OR 3.03) [21]. Likewise, a 2025 CT study identified appendiceal diameter as an independent predictor of complicated appendicitis (OR 1.263) and reported strong discrimination for CT fascial involvement [22]. More recently, a Vietnamese cohort found periappendiceal free fluid (AOR 2.45), appendicolith (AOR 2.08), and increasing appendiceal diameter (AOR 1.12 per mm) to predict complicated appendicitis [23]. Regarding external comparability, a multi-ethnic Asian series including Bangladeshi and Indian patients reported a 4.9% conversion rate [24]. In contrast, a Pakistani study limited to complicated appendicitis reported 19.8% conversion, with dense adhesions accounting for 41% of conversions whereas a resource-limited Peruvian study reported only 0.76% conversion and identified adhesions (OR 8.91) and appendicolith (OR 11.49) as significant factors [10,25]. In the present study, dense adhesions or severe inflammation were also the leading reason for conversion (33.3%). Across settings, differences may reflect referral patterns, proportions of complicated cases, surgical expertise, equipment availability, and thresholds for persisting laparoscopically. Clinically, these findings support structured preoperative risk stratification. For patients presenting after 48 hours with markedly elevated inflammatory markers, phlegmon, abscess, perforation, free fluid, or other imaging evidence of complicated appendicitis, counseling regarding a higher likelihood of conversion is warranted. Early senior surgical involvement, appropriate theatre preparation, and timely recognition of unsafe laparoscopic dissection may reduce avoidable morbidity. Importantly, conversion should be regarded as a safety decision rather than procedural failure, particularly when severe inflammation or distorted anatomy prevents secure laparoscopic dissection.

LIMITATION

The study was limited by its single-center design, relatively small sample size, and low number of conversion events, which may restrict generalizability and the stability of multivariable estimates. Surgeon experience and intraoperative technical factors were also not fully evaluated.

CONCLUSION

Overall, conversion from laparoscopic to open appendectomy occurred in a small but clinically important proportion of patients. Greater conversion risk was independently associated with prolonged symptom duration, appendicular mass or phlegmon, suspected perforation, and complicated appendicitis on preoperative imaging. Elevated inflammatory markers and advanced radiological findings were also more frequent among converted cases. Therefore, careful preoperative risk assessment, timely surgical intervention, appropriate imaging, and early involvement of experienced surgeons may help anticipate technical difficulty and improve operative planning and patient outcomes.

RECOMMENDATION

Preoperative risk stratification should be emphasized, particularly in patients with delayed presentation, elevated inflammatory markers, appendicular mass or phlegmon, suspected perforation, or other features of complicated appendicitis. High-risk cases should receive early imaging, timely surgical intervention, and involvement of experienced laparoscopic surgeons. Larger multicenter prospective studies are also needed to validate these predictors and develop reliable conversion-risk models.

FUNDING

No funding sources.

CONFLICT OF INTEREST

None declared.

ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee.

REFERENCES

1. Han H, Letourneau ID, Abate YH, Abdelmasseh M, Abu-Gharbieh E, Adane TD, Ahinkorah BO, Ahmad A, Ahmadi A, Ahmed A, Alhalaiqa FN. Trends and levels of the global, regional, and national burden of appendicitis between 1990 and 2021: findings from the Global Burden of Disease Study 2021. The Lancet Gastroenterology & Hepatology. 2024 Sep 1;9(9):825-58.
2. Téoule P, de Laffolie J, Rolle U, Reissfelder C. Acute appendicitis in childhood and adulthood: an everyday clinical challenge. Deutsches Ärzteblatt International. 2020 Nov 6;117(45):764.
3. Di Saverio S, Podda M, De Simone B, Ceresoli M, Augustin G, Gori A, Boermeester M, Sartelli M, Coccolini F, Tarasconi A, De'Angelis N. Diagnosis and treatment of acute appendicitis: 2020 update of the WSES Jerusalem guidelines. World journal of emergency surgery. 2020 Apr 15;15(1):27.
4. Doleman B, Fonnes S, Lund JN, Boyd-Carson H, Javanmard-Emamghissi H, Moug S, Hollyman M, Tierney G, Tou S, Williams JP. Appendectomy versus antibiotic treatment for acute appendicitis. Cochrane Database of Systematic Reviews. 2024(4).
5. Wang D, Dong T, Shao Y, Gu T, Xu Y, Jiang Y. Laparoscopy versus open appendectomy for elderly patients, a meta-analysis and systematic review. BMC surgery. 2019 May 28;19(1):54.
6. Bancke Laverde BL, Maak M, Langheinrich M, Kersting S, Denz A, Krautz C, Weber GF, Grützmann R, Brunner M. Risk factors for conversion from laparoscopic to open appendectomy. Journal of Clinical Medicine. 2023 Jun 27;12(13):4299.
7. Monrabal Lezama M, Casas MA, Angeramo CA, Bras Harriott C, Schlottmann F. Conversion from laparoscopic to open appendectomy: trends, risk factors and outcomes. A 15-year single-center analysis of 2193 adult patients. World Journal of Surgery. 2022 Nov;46(11):2642-7.
8. Cherif M, Mesbahi M, Zaafouri H, Zebda H, Khedhiri N, Hadded D, Ben-Maamer A. Laparoscopic appendicectomy: risk factors for conversion to laparotomy. ABCD. Arquivos Brasileiros de Cirurgia Digestiva (São Paulo). 2023 Jun 2;36:e1737.

9. Pushpanathan NR, Hashim MN, Zahari Z, Abd Aziz SH, Zain WZ, Ramely R, Wong MP, Mohamad IS, Mokhter WM, Yahya MM, Merican SR. Conversion rate and risk factors of conversion to open in laparoscopic appendicectomy. Annals of Coloproctology. 2021 Aug 18;38(6):409.
10. Sadaf FN, Asif M, Iqbal A, Fatima P, Younas A, Mushtaq J, Shakeel I, Younas AY. Conversion rates and outcomes of laparoscopic appendectomy in complicated appendicitis: a retrospective study. Cureus. 2025 Aug 18;17(8).
11. Podda M, Pisanu A, Sartelli M, Coccolini F, Damaskos D, Augustin G, Khan M, Pata F, De Simone B, Ansaloni L, Catena F. Diagnosis of acute appendicitis based on clinical scores: is it a myth or reality?. Acta Bio Medica: Atenei Parmensis. 2021 Sep 2;92(4):e2021231.
12. Al Farooq MA, Kabir SH, Chowdhury TK, Sadia A, Alam MA, Farhad T. Changes in children's surgical services during the COVID-19 pandemic at a tertiary-level government hospital in a lower middle-income country. BMJ Paediatrics Open. 2021 Mar 31;5(1):e001066.
13. Chowdhury MZ, Al Farooq MA, Rahman MM, Chowdhury TK. Management of early appendicular lump in children-laparoscopic technique versus open surgery: a comparative study in low-middle income country perspective. World Journal of Pediatric Surgery. 2020 Jul 2;3(2):e000131.
14. Mirdamadi A, Javid M, Amini-Salehi E, Mohammadyari F, Tavakoli S, Javid M, Keivanlou MH, Samidoust P, Nayak R, Lincango EP, Borkar R. Preoperative risk factors for laparoscopic to open appendectomy conversion: a systematic review and meta-analysis. International Journal of Surgery. 2025 Aug 1;111(8):5435-50.
15. Finnerty BM, Wu X, Giambrone GP, Gaber-Baylis LK, Zabih R, Bhat A, Zarnegar R, Pomp A, Fleischut P, Afaneh C. Conversion-to-open in laparoscopic appendectomy: A cohort analysis of risk factors and outcomes. International Journal of Surgery. 2017 Apr 1;40:169-75.
16. Azılı C, Tokgöz S, Chousein B, Tamam S, Benk MŞ, Culcu S, Hasdemir AO. Determination of risk factors for conversion from laparoscopic to open appendectomy in patients with acute appendicitis. Turkish Journal of Trauma & Emergency Surgery. 2023 Sep 8;29(10):1103.
17. Ceylan C, Elbistan İS, Barut BO. Laparoskopik apendektomiden açık appendektomiye konversiyon için risk faktörleri: Tek merkezli deneyimin retrospektif analizi. ULUSAL TRAVMA VE ACIL CERRAHI DERGISI. 2025;31(4).
18. Ehlers AP, Drake FT, Kotagal M, Simianu VV, Achar C, Agrawal N, Joslyn SL, Flum DR. Factors influencing delayed hospital presentation in patients with appendicitis: the APPE survey. Journal of Surgical Research. 2017 Jan 1;207:123-30.
19. Westfall KM, Charles AG. Risk of perforation in the era of nonemergent management for acute appendicitis. The American Surgeon. 2019 Nov;85(11):1209-12.
20. Agnesi S, Mauro Di Lucca G, Benedetti F, Fattori L, Degrate L, Roccamatisi L, Braga M, Ceresoli M. Effect of in-hospital delay on acute appendicitis severity: does time really matter?. Updates in surgery. 2024 Sep;76(5):1775-81.
21. Akturk OM, Cakir M, Yildirim D, Vardar YM, Ozdemir S, Akinci M. Preoperative appendix diameter obtained by computerized tomography scanning predicts conversion from laparoscopic to open appendectomy. Nigerian Journal of Clinical Practice. 2020 Jul 1;23(7):975-9.
22. Wu L, Zhang ZG, Chen XY, Xu BX, Mao XP. Fascial involvement score on unenhanced CT potentially helps predict complicated appendicitis. European Journal of Radiology. 2025 Jan 1;182:111843.
23. Le KL, Le NK, Pham TN, Trinh MT, Tran MQ, Pham PC, Thai KP, Mai-Phan TA, Nguyen DA. Clinical, laboratory, and computed tomography predictors of complicated acute appendicitis in adults selected for surgery: An internally validated cohort study. Medicine. 2026 Jun 19;105(25):e49367.
24. Sy MB. Predictors of clinical outcomes in acute appendicitis: a retrospective study. Med J Malaysia. 2022 May;77(3):331.
25. Rodriguez-Prado E, Rioja-Torres F, De La Cruz-Ku G, Razuri-Bustamante C. Risk Factors for Conversion in Laparoscopic Appendicectomy: A Cross-Sectional Study in a Middle-Income Country. Digestive Surgery. 2026 Jun 13;43(2):69-80.