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Original Research Article

Predictors of Conversion from Laparoscopic to Open Appendectomy in Complicated Appendicitis: A Retrospective Study

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Abstract:
Background: Laparoscopic appendectomy is the preferred approach for acute appendicitis; however, in complicated cases, conversion to open surgery may be required due to technical difficulties and disease severity. Objective: To determine the predictors of conversion from laparoscopic to open appendectomy in patients with complicated appendicitis and to evaluate associated perioperative factors. Methods: This retrospective analytical study was conducted at shalamar Hospital Lahore from 2 August 2025 to 2 November 2025 including 260 patients with complicated appendicitis who initially underwent laparoscopic appendectomy. Results: Patients requiring conversion were older (46.8 ± 13.5 vs 34.6 ± 12.2 years; p<0.001), had higher BMI (28.2 ± 4.1 vs 25.4 ± 3.6 kg/m^2; p<0.001), and longer symptom duration >48 hours (65.2% vs 36.4%; p=0.001). They also had higher WBC (17.2 ± 4.1 vs 13.8 ± 3.6 ×10^9/L) and CRP (76.4 ± 22.8 vs 42.5 ± 18.6 mg/L) (p<0.001). CT findings of perforation (69.6%), abscess (60.9%), and free fluid (65.2%) were significantly associated with conversion (p<0.001). Intraoperative factors such as dense adhesions (78.3%) and severe inflammation (82.6%) were more frequent in converted cases. Multivariable analysis identified dense adhesions (OR 4.52), perforation (OR 3.84), abscess (OR 3.26), elevated CRP (OR 3.12), and delayed presentation (OR 2.96) as independent predictors (p<0.05). Conclusion: Conversion to open appendectomy in complicated appendicitis is strongly associated with advanced disease and intraoperative difficulty. Recognition of key clinical, laboratory, and imaging predictors can improve preoperative risk assessment, guide surgical decision-making, and enhance patient outcomes.

Keywords: Appendicitis, laparoscopic appendectomy, conversion, predictors, complicated appendicitis, risk factors

INTRODUCTION

One of the most frequent surgical emergencies is acute appendicitis, and laparoscopic appendectomy is a highly popular method because of less postoperative pain, shorter hospitalization, and quick healing [1]. But when dealing with complicated appendicitis in terms of perforation, gangrene, abscess, or dense adhesions, laparoscopic surgery can become technically difficult and necessitate an open operation [2]. The conversion of this kind is a measure of the severity of the disease and the complexity of the operation and can have a negative impact on the postoperative results [3]. The conversion rates are reported as between 5% and 20 percent, depending on patient factors, severity of disease and expertise of the surgeon [4]. It is crucial to determine the predictors of conversion that can be used during preoperative risk assessment, surgical planning, and patient counseling [5]. Advanced age, male gender, obesity, and other related comorbidities are some of the patient factors

that have been demonstrated to predispose the patient to conversion [6]. Also, delayed presentation and increased inflammatory markers are usually linked to complicated appendicitis and increased conversion rates [7]. An earlier study has also shown that increased white blood cell count and C-reactive protein levels are also good predictors of conversion [8]. Factors intraoperative such as thick adhesions, poorly defined anatomy and extreme inflammatory changes also add to the necessity of conversion [9]. Surgeon-related aspects, especially experience and skills in laparoscopic procedures are also significant and the rates of conversion are lower with experienced surgeons [10]. Though it is not a complication, conversion is usually linked with longer operating time, higher postoperative morbidity, and hospital stay [11].

Preoperative imaging, and in particular computed tomography (CT), is now an important instrument in determining the severity of disease and its potential difficulty to operate on. The presence of imaging evidence including perforation, abscess development, appendiceal mass and free intraperitoneal fluid have been closely linked to the presence of increased risk of conversion [12]. An earlier study also has found that CT findings of complicated appendicitis are strongly associated with intraoperative conversion [13]. Although various studies have analysed predictors of conversion, inconsistency in results remains across various groups of the population and in various clinical contexts [14]. This especially applies to complex cases of appendicitis, where chances of conversion are naturally greater and less predictable [15]. Furthermore, there are institutional reasons, as well as disparities in surgical skills that can also affect the outcomes [16]. Since there is clinical relevance in predicting conversion and existing evidence is inconsistent, the proposed study will determine the significant predictors of conversion between laparoscopic and open appendectomy in patients with complicated appendicitis, which will enhance preoperative planning, surgical decision-making, and patient outcomes.

Objective: To determine the predictors of conversion from laparoscopic to open appendectomy in patients with complicated appendicitis and to evaluate associated perioperative factors.

METHODOLOGY:

This was a retrospective analytical study conducted at conducted at shalamar Hospital Lahore from 2 August 2025 to 2 November 2025, including 260 patients diagnosed with complicated appendicitis who initially underwent laparoscopic appendectomy.

Inclusion Criteria

- Patients aged ≥18 years diagnosed with complicated appendicitis (perforation, gangrene, abscess, or appendicular mass)
- Patients who underwent laparoscopic appendectomy as the initial surgical approach
- Both genders
- Complete medical and operative records available

Exclusion Criteria

- Patients with uncomplicated appendicitis
- Patients directly undergoing open appendectomy without laparoscopic attempt
- Patients with prior abdominal surgery leading to planned open approach
- Pregnant patients
- Patients with incomplete records

Data Collection

Data were retrieved from hospital records using a structured proforma. Baseline variables included age, gender, BMI, duration of symptoms, and comorbidities (e.g., diabetes mellitus, hypertension). Laboratory parameters included white blood cell (WBC) count and C-reactive protein (CRP) levels. Radiological findings from CT scan included appendiceal diameter, presence of perforation, abscess, phlegmon, and free fluid. Intraoperative variables included operative duration, degree of inflammation, presence of adhesions, perforation, abscess, and intra-abdominal contamination. Patients were categorized into two groups: those who completed laparoscopic appendectomy and those who required conversion to open surgery. Postoperative variables included length of hospital stay, wound infection, intra-abdominal collection, and overall complications.

Statistical Analysis

Data were analyzed using SPSS version 25. Quantitative variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Independent sample t-test was used to compare continuous variables between converted and non-converted groups, while chi-square test was applied for categorical variables. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

Patients who required conversion were older (46.8 ± 13.5 vs 34.6 ± 12.2 years; p<0.001) and more frequently male (73.9% vs 59.8%; p=0.048). They had higher BMI (28.2 ± 4.1 vs 25.4 ± 3.6 kg/m^2; p<0.001) and longer symptom duration >48 hours (65.2% vs 36.4%; p=0.001). Comorbidities were more common in the converted group, including diabetes (34.8% vs 17.8%; p=0.012) and hypertension (39.1% vs 24.3%; p=0.041). Inflammatory markers were significantly elevated, with higher WBC (17.2 ± 4.1 vs 13.8 ± 3.6 ×10^9/L) and CRP (76.4 ± 22.8 vs 42.5 ± 18.6 mg/L) (both p<0.001), indicating more severe disease.

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Table 1: Baseline Demographic, Clinical and Laboratory Characteristics (n = 260)

Variable	Completed Laparoscopic (n=214)	Converted to Open (n=46)	p-value
Age (years)	34.6 ± 12.2	46.8 ± 13.5	<0.001
Male Gender	128 (59.8%)	34 (73.9%)	0.048
BMI (kg/m²)	25.4 ± 3.6	28.2 ± 4.1	<0.001
Symptom Duration >48 hrs	78 (36.4%)	30 (65.2%)	0.001
Diabetes Mellitus	38 (17.8%)	16 (34.8%)	0.012
Hypertension	52 (24.3%)	18 (39.1%)	0.041
WBC Count ($\times10^9$/L)	13.8 ± 3.6	17.2 ± 4.1	<0.001
CRP (mg/L)	42.5 ± 18.6	76.4 ± 22.8	<0.001

Radiological findings strongly differed between groups. Converted patients had larger appendiceal diameter (13.6 ± 3.4 vs 9.8 ± 2.1 mm; p<0.001). CT evidence of perforation (69.6% vs 29.9%), abscess (60.9% vs 22.4%), phlegmon (43.5% vs 16.8%), and free fluid (65.2% vs 33.6%) were all significantly higher in the converted group (p<0.001). Appendicolith was also more frequent (43.5% vs 27.1%; p=0.031), supporting the association of complicated imaging features with conversion.

Table 2: Radiological (CT) Findings Associated with Conversion

Variable	Completed (n=214)	Converted (n=46)	p-value
Appendiceal Diameter (mm)	9.8 ± 2.1	13.6 ± 3.4	<0.001
Perforation on CT	64 (29.9%)	32 (69.6%)	<0.001
Abscess Formation	48 (22.4%)	28 (60.9%)	<0.001
Phlegmon	36 (16.8%)	20 (43.5%)	<0.001
Free Fluid	72 (33.6%)	30 (65.2%)	<0.001
Appendicolith	58 (27.1%)	20 (43.5%)	0.031

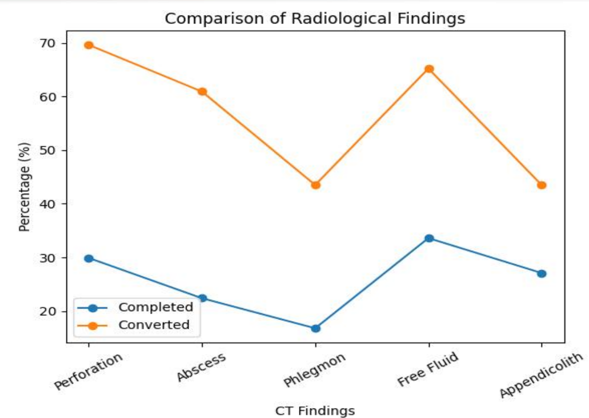

Figure 1: Comparison of Radiological (CT) Findings Between Completed and Converted Appendectomy Groups

Operative time was significantly longer (92.6 ± 18.5 vs 58.4 ± 14.2 minutes; p<0.001). Dense adhesions were present in 78.3% vs 29.9%, severe inflammation in 82.6% vs 41.1%, and perforation in 73.9% vs 33.6% (all p<0.001). Intra-abdominal abscess (65.2% vs 24.3%) and purulent contamination (69.6% vs 31.8%) were also significantly more common, reflecting increased technical difficulty leading to conversion.

Table 3: Intraoperative Findings and Surgical Characteristics

Variable	Completed (n=214)	Converted (n=46)	p-value
Operative Time (min)	58.4 ± 14.2	92.6 ± 18.5	<0.001
Dense Adhesions	64 (29.9%)	36 (78.3%)	<0.001
Severe Inflammation	88 (41.1%)	38 (82.6%)	<0.001
Perforated Appendix	72 (33.6%)	34 (73.9%)	<0.001
Intra-abdominal Abscess	52 (24.3%)	30 (65.2%)	<0.001
Contamination (Purulent)	68 (31.8%)	32 (69.6%)	<0.001

Dense adhesions had the strongest association (OR 4.52, 95% CI: 2.41–8.48; p<0.001), followed by perforation on CT (OR 3.84, 95% CI: 2.12–6.96; p<0.001) and abscess (OR 3.26, 95% CI: 1.82–5.83; p<0.001). Elevated CRP >50 mg/L (OR 3.12) and symptom duration >48 hours (OR 2.96) were also significant predictors (p<0.001). Higher BMI (OR 2.74), elevated WBC (OR 2.45), and age >40 years (OR 2.18).

Table 4: Multivariable Logistic Regression Analysis of Predictors of Conversion

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Variable	Adjusted OR	95% CI	p-value
Age (>40 years)	2.18	1.32–3.61	0.002
BMI (>27 kg/m^2)	2.74	1.56–4.82	<0.001
Symptom Duration >48 hrs	2.96	1.68–5.21	<0.001
WBC (>15 $\times 10^9/L$)	2.45	1.38–4.32	0.002
CRP (>50 mg/L)	3.12	1.76–5.52	<0.001
Perforation on CT	3.84	2.12–6.96	<0.001
Abscess on CT	3.26	1.82–5.83	<0.001
Dense Adhesions	4.52	2.41–8.48	<0.001

DISCUSSION

The current research paper has found that there are a number of important clinical, radiological and intraoperative predictors to conversion of laparoscopic to open appendectomy among patients with complicated appendicitis. The patients that needed to be converted were significantly older (46.8 ± 13.5 vs 34.6 ± 12.2 years), had higher BMI (28.2 ± 4.1 vs 25.4 ± 3.6 kg/m^2), and were more likely to present after 48 hours (65.2% vs 36.4%), which showed that delayed presentation and Also, an increase in the prevalence of diabetes (34.8) and hypertension (39.1) in the converted group indicates that comorbidities can worsen the severity of diseases and make the laparoscopic process more complex. Another study has also indicated that advanced age, obesity and late presentation of symptoms are powerful predictors of conversion [17]. The inflammatory markers were also significantly higher in patients who needed conversion with a higher WBC (17.2 ± 4.1 vs 13.8 ± 3.6 $\times 10^9/L$) and CRP (76.4 ± 22.8 vs 42.5 ± 18.6 mg/L) indicating more severe systemic inflammation. These results emphasize the importance of biochemical markers as beneficial preoperative predictors of complicated disease. An earlier study also showed that high CRP and leukocytosis are directly correlated with high risk of conversion, and they can be used to stratify risks [18]. The conversion risk was strongly correlated with radiological results in this study. A bigger appendiceal diameter (13.6 + 3.4 mm), perforation (69.6%), abscess (60.9%), phlegmon (43.5%), and free fluid (65.2%) were significantly more likely to result in conversion among patients. The results of these studies underpin the relevance of preoperative CT scans to forecast surgical difficulty. An earlier study also indicated that evidence of perforation and abscess formation, as detected by CT scans, is a strong predictor of open conversion [19].

Findings during intraoperation also supported the notion that technical difficulty is a primary factor of conversion. Significantly, dense adhesions (78.3%), severe inflammation (82.6%), perforation (73.9%) and intra-abdominal abscess (65.2%), were more prevalent in converted cases. The operative time also significantly increased (92.6 ± 18.5 vs 58.4 ± 14.2 minutes) as it is an indicator of the difficulty in laparoscopic dissection. These results indicate that conversion is in many cases a critical requirement to guarantee safe and effective management in case of advanced disease. Another study that has been conducted previously also brought out the dense adhesions and distorted anatomy as important intraoperative predictors of conversion [20]. Multivariable logistic regression was used to determine that dense adhesions (OR 4.52), perforation on CT (OR 3.84), and abscess formation (OR 3.26) were the most significant independent predictors of conversion. High CRP (OR 3.12) and an extended duration of symptoms (OR 2.96) were also noteworthy, as well as an increase in BMI and WBC. These findings show that both preoperative and intraoperative variables have a separate role to play in the risk of conversion. A prior study also discovered that a blend of clinical, lab and imaging parameters gives the best prediction of conversion risk [21]. In general, the paper indicates that the laparoscopic to open appendectomy conversion in complex appendicitis is greatly dependent on the severity of the disease, which is measured by clinical presentation, laboratory levels, imaging results, and difficulty during surgery. Identification of these predictors before surgery can enhance surgical outcomes, resource utilization and patient counselling.

CONCLUSION:

It is concluded that conversion from laparoscopic to open appendectomy in complicated appendicitis is significantly associated with increased disease severity and operative difficulty. Factors such as older age, higher BMI, delayed presentation, elevated inflammatory markers (WBC and CRP), and adverse CT findings including perforation and abscess markedly increase the likelihood of conversion. Intraoperative findings, particularly dense adhesions and severe inflammation, are the strongest predictors.

REFERENCES:

1. Saridas A, et al. Comparison of the ability of newly inflammatory markers to predict complicated appendicitis. *Open Med (Wars)*. 2024;19(1):20241002. doi:10.1515/med-2024-1002.

 © 2025 European Journal of Clinical Pharmacy; All Right Reserved

2. Kim HJ, Lee S, Kim SH, Lee S, Sim JH, Ro YJ. Association of C-reactive protein to albumin ratio with postoperative delirium and mortality in elderly patients undergoing hip fracture surgery: a retrospective cohort study in a single large center. *Exp Gerontol*. 2023;172:112068. doi:10.1016/j.exger.2022.112068.
3. Utsumi M, Inagaki M, Kitada K, Tokunaga N, Yunoki K, Sakurai Y, et al. C-reactive protein-to-albumin ratio predicts conversion from laparoscopic to open cholecystectomy in acute cholecystitis. *In Vivo*. 2023;37(2):887-893. doi:10.21873/invivo.13157.
4. Tekeli A, et al. Evaluation of systemic immune-inflammation index efficacy in predicting complicated appendicitis in pediatric emergency department. *Turk J Trauma Emerg Surg*. 2023;29(5):566-573. doi:10.14744/tjtes.2022.42472.
5. Zarog M, et al. Circulating fibrocyte percentage and neutrophil-lymphocyte ratio are accurate biomarkers of uncomplicated and complicated appendicitis: a prospective cohort study. *Int J Surg*. 2023;109(3):343-351. doi:10.1097/JS9.0000000000000234.
6. Pushpanathan NR, Hashim MNM, Zahari Z, Aziz S, Zain WZW, Ramely R, et al. Conversion rate and risk factors of conversion to open in laparoscopic appendicectomy. *Ann Coloproctol*. 2022;38(6):409-414. doi:10.3393/ac.2020.00437.0062.
7. Hou J, Feng W, Liu W, Hou J, Die X, Sun J, et al. The use of the ratio of C-reactive protein to albumin for the diagnosis of complicated appendicitis in children. *Am J Emerg Med*. 2022;52:148-154. doi:10.1016/j.ajem.2021.12.007.
8. Yuksel ME, Ozkan N, Avci E. C-reactive protein/albumin ratio greater than 7.1 is a good candidate to be used as an inflammation biomarker to predict perforation in appendicitis. *Eur Rev Med Pharmacol Sci*. 2022;26(22):8333-8341. doi:10.26355/eurrev_202211_30366.
9. Ayeni A, et al. Predicting the severity of acute appendicitis in children using neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR). *Cureus*. 2022;14(8):e28619. doi:10.7759/cureus.28619.
10. Salminen P, et al. Antibiotics versus placebo in adults with CT-confirmed uncomplicated acute appendicitis (APPAC III): randomized double-blind superiority trial. *Br J Surg*. 2022;109(6):503-509. doi:10.1093/bjs/znac086.
11. Kalayci T, Kartal M. Significance of neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, serum albumin and prognostic nutritional index as predictors of morbidity in super-elderly patients operated on for acute appendicitis. *Eur Rev Med Pharmacol Sci*. 2022;26(3):820-827. doi:10.26355/eurrev_202202_27990.
12. Moris D, et al. Diagnosis and management of acute appendicitis in adults: a review. *JAMA*. 2021;326:2299-2311. doi:10.1001/jama.2021.20502.
13. Podda M, et al. Appendectomy versus conservative treatment with antibiotics for patients with uncomplicated acute appendicitis: a propensity score-matched analysis of patient-centered outcomes (the ACTUAA prospective multicenter trial). *Int J Colorectal Dis*. 2021;36(3):589-598. doi:10.1007/s00384-021-03843-8.
14. Lapsa S, Ozolins A, Strumfa I, Gardovskis J. Acute appendicitis in the elderly: a literature review on an increasingly frequent surgical problem. *Geriatrics (Basel)*. 2021;6(3):93. doi:10.3390/geriatrics6030093.
15. Di Saverio S, et al. Diagnosis and treatment of acute appendicitis: 2020 update of the WSES Jerusalem guidelines. *World J Emerg Surg*. 2020;15(1):27. doi:10.1186/s13017-020-00306-3.
16. Lee JW, Sharma AR, Lee SS, Chun WJ, Kim HS. The C-reactive protein to albumin ratio predicts postoperative complication in patients who undergo gastrectomy for gastric cancer. *Heliyon*. 2020;6(6):e04220. doi:10.1016/j.heliyon.2020.e04220.
17. Karabacak K, Kubat E, Akyol FB, Kadan M, Erol G, Doğancı S, et al. The C-reactive protein/albumin ratio as a new predictor for postoperative atrial fibrillation after coronary artery bypass graft surgery. *J Card Surg*. 2020;35(10):2747-2753. doi:10.1111/jocs.14898.
18. Hajibandeh S, et al. Neutrophil-to-lymphocyte ratio predicts acute appendicitis and distinguishes between complicated and uncomplicated appendicitis: a systematic review and meta-analysis. *Am J Surg*. 2020;219(1):154-163. doi:10.1016/j.amjsurg.2019.04.018.
19. Shimoda M, Maruyama T, Nishida K, Suzuki K, Tago T, Shimazaki J, et al. Comparison of clinical outcome of laparoscopic versus open appendectomy, single center experience. *Heliyon*. 2018;4(5):e00635. doi:10.1016/j.heliyon.2018.e00635.
20. Salminen P, et al. Five-year follow-up of antibiotic therapy for uncomplicated acute

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appendicitis in the APPAC randomized clinical trial. *JAMA*. 2018;320(12):1259-1265. doi:10.1001/jama.2018.13201.

21. van Dijk ST, et al. Meta-analysis of in-hospital delay before surgery as a risk factor for complications in patients with acute appendicitis. *Br J Surg*. 2018;105(8):933-945. doi:10.1002/bjs.10873.

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