

EVALUATING THE SAFETY AND EFFICACY OF EARLY VERSUS DELAYED
APPENDECTOMY IN COMPLICATED APPENDICITISDr Dure-e-Zarnab Zahra^{*1}, Dr Ayesha Akram², Dr Ahmad Farooq³, Dr Fiza Ashfaq⁴,
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Abstract**Background:** The optimal timing of surgery for complicated appendicitis remains debated, with early and delayed (interval) appendectomy both being practiced.**Objective:** This study aimed to compare the safety and efficacy of early versus delayed appendectomy in patients with complicated appendicitis.**Methodology:** This prospective comparative study was conducted at Shaikh Zayed Hospital, Lahore from December 2024 to May 2025. A total of 185 patients aged ≥ 12 years with perforated, gangrenous appendicitis or cases with abscess/phlegmon were enrolled using non-probability consecutive sampling. Patients were allocated to Group A (early appendectomy within 24 hours of diagnosis) or Group B (delayed appendectomy after initial non-operative management and elective surgery at 6–8 weeks).**Results:** Of 185 patients, 94 underwent early appendectomy and 91 underwent delayed appendectomy. Baseline demographics and disease severity were comparable between groups ($p > 0.05$). Early appendectomy was associated with significantly shorter operative time (67.5 ± 10.8 vs. 74.9 ± 12.3 minutes; $p < 0.001$), less blood loss (84.6 ± 18.2 vs. 96.2 ± 21.1 mL; $p < 0.001$), shorter hospital stays (5.8 ± 1.4 vs. 9.7 ± 2.3 days; $p < 0.001$), and faster return to normal activities (11.3 ± 3.2 vs. 17.5 ± 4.1 days; $p < 0.001$). Wound infection rates were lower in early appendectomy (8.5% vs. 15.4%; $p = 0.04$), while other complications, including intra-abdominal abscess and ileus, were not significantly different.**Conclusion:** Early appendectomy offers distinct clinical benefits over delayed appendectomy in complicated appendicitis, including faster recovery, reduced hospital stays, and lower wound infection rates, without increasing major complications. Where feasible, early surgical intervention should be considered the preferred approach.**INTRODUCTION**

Acute appendicitis is one of the most frequent causes of acute abdominal pain requiring surgical intervention, with an estimated lifetime incidence of

7–8% in the general population [1]. Although the diagnosis and treatment of uncomplicated appendicitis are fairly straight forward, complicated

appendicitis that entails perforated, gangrenous, or suppurative appendicitis and those with local or generalized peritonitis cases are more challenging to tackle in terms of diagnosis and treatment [2]. Complex cases are only about 20-30 percent of all appendicitis admissions and are characterized by higher morbidity, long post-hospital stay and a higher postoperative complication rate including wound infection, post-abdominal abscesses, bowel obstruction and sepsis [3]. Conventionally early appendectomy has been viewed as the gold standard, which relies on the premise that the quick removal can prevent further progression of the disease, development of septic problems, and recurrence [4]. It has been proved that early intervention can shorten the overall time of the hospital stay, accelerate the normal activities, and save the risk of having the recurrent inflammation of the appendiceal inflammation. Moreover, one of the supporters of the idea is that postponing surgery to a time when perforation occurs can lead to rupture, thus, deteriorating outcomes [5].

Interest in another more recent strategy, delayed or interval appendectomy, has grown, especially in patients with a mature peri-appendiceal abscess or phlegmon. The plan entails the initial management with intravenous antibiotics, fluid resuscitation, and imaging-guided drainage of localized collections in some cases, followed by elective appendectomy 6 to 8 weeks, later [6]. The promotion of delayed surgery explains that it resolves acute inflammation that makes surgery easy and intraoperative complications like damaging the bowel, excessive bleeding, and trouble in locating anatomical structures [7]. Furthermore, delayed appendectomy can be especially useful in patients having severe comorbidities, poor nutrition, hemodynamic instability, and facilities are not available to perform the emergency surgery with high risk of anesthetic and surgical risk. Early versus delayed appendectomy evidence, in complicated appendicitis is conflicting. Randomized controlled trials and meta-analyses concerning whether early surgery reduces the cumulative time by decreasing both the duration of overall treatment and risk of recurrence have had mixed results, with some indicating that it does, and others reporting no significant final outcomes but that delayed surgery is more likely to result in fewer

intraoperative difficulties [8]. To illustrate, some of the studies have revealed that early appendectomy is useful in reducing the total number of absenteeism days at work or school although when the appendectomy is delayed the rate of appearance of postoperative intra-abdominal abscesses can be decreased [9]. These imperfections in the literature could be due to variation in the definition of the studies, the selection of patients, the definition of timing, the expertise of the surgeons and the infrastructure of a healthcare facility [10].

World Society of Emergency Surgery and the American College of Surgeons, give recommendations without forecasting further. The two organizations admit that the treatment is to be personalized, that is, patient stability, comorbidities, American Lung Association (ALA) imaging severity of the disease and surgical expertise should also be kept in mind. In wealthy countries, early laparoscopic appendectomy is frequently performed during complicated cases, in low- and middle-income countries the situation is different because due to low availability of advanced care providers in the perioperative phase, delayed appendectomy surgery after initial stabilization is potentially more sensible and economically efficient [11]. The value of timing decision is also subject to the improved technology and imaging techniques, minimal surgical intervention, and anti-biotic schemes. Ultrasonography and high-resolution computed tomography provide correct diagnosis and disease severity assessment and can be utilized to select patients who should undergo immediate or delayed intervention [12]. Laparoscopic appendectomy may be technically challenging due to intense inflammation or adhesions, but in its early stage, faster recovery and a lower wound complication rate than open surgery can be obtained [13].

Objective

This study aimed to compare the safety and efficacy of early versus delayed appendectomy in patients with complicated appendicitis.

Methodology

This was a prospective comparative study conducted at Shaikh Zayed Hospital, Lahore from December

2024 to May 2025. A total of 185 patients meeting the inclusion criteria were enrolled in the study. Non-probability consecutive sampling was employed.

Inclusion Criteria

Patients aged 12 years and above who had a confirmed diagnosis of complicated appendicitis, including perforation, gangrene, localized abscess, or phlegmon, were eligible for inclusion. The diagnosis was based on a combination of clinical assessment and radiological findings from ultrasound and/or computed tomography scans.

Exclusion Criteria

Patients were excluded if they had generalized peritonitis with hemodynamic instability requiring emergent surgery, severe comorbidities that contraindicated anesthesia, pregnancy, or if they declined to provide informed consent.

Data collection

Participants were allocated into two groups based on the timing of surgical intervention. Group A underwent early appendectomy, defined as surgical removal of the appendix within 24 hours of diagnosis. Group B underwent delayed or interval appendectomy, following initial non-operative management that included intravenous broad-spectrum antibiotics, fluid resuscitation, analgesia, and, when necessary, ultrasound- or CT-guided drainage of abscesses. Surgery in Group B was performed electively after a period of 6–8 weeks, once the acute inflammation had resolved. A structured proforma was used to collect data on demographic characteristics, comorbidities, clinical presentation, laboratory results, imaging findings, operative details, and postoperative outcomes.

Operative details included the surgical approach, operative time, estimated blood loss, and intraoperative findings. Postoperative outcomes recorded were wound infection, intra-abdominal abscess, postoperative ileus, length of hospital stay, and recovery time. All complications were classified according to the Clavien–Dindo classification system. The primary outcome measures of the study were the rate of postoperative complications and the length of hospital stay. Secondary outcomes included operative difficulty, time to recovery, and total duration of treatment from diagnosis to full recovery.

Statistical Analysis

Data analysis was performed using the Statistical Package for Social Sciences (SPSS) version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation (SD) and compared between groups using the independent sample t-test, depending on the normality of distribution. A p-value of ≤ 0.05 was considered statistically significant.

Results

Data were collected from 185 patients, mean age was 34.2 ± 13.1 years in early appendectomy ($n = 94$) and 35.0 ± 12.5 in delayed ($n = 91$). Males were 57/94 (60.6%) vs 55/91 (60.4%). Diabetes and hypertension were similarly infrequent: 11 (11.7%) vs 9 (9.9%) and 8 (8.5%) vs 10 (11.0%), respectively. Symptom duration was 46.3 ± 12.4 hours vs 45.7 ± 11.9 , and fever at presentation occurred in 79 (84.0%) vs 75 (82.4%). Disease subtypes were evenly distributed: perforation 32 (34.0%) vs 30 (33.0%), gangrene 27 (28.7%) vs 25 (27.5%), abscess 21 (22.3%) vs 24 (26.4%), and phlegmon 14 (14.9%) vs 12 (13.1%).

Table 1: Baseline demographic and clinical characteristics of patients

Characteristic	Group A (n = 94)	Group B (n = 91)
Age (years), mean $\pm$ SD	34.2 ± 13.1	35.0 ± 12.5
Male, n (%)	57 (60.6)	55 (60.4)
Diabetes mellitus, n (%)	11 (11.7)	9 (9.9)
Hypertension, n (%)	8 (8.5)	10 (11.0)
Duration of symptoms (hours)	46.3 ± 12.4	45.7 ± 11.9
Fever at presentation, n (%)	79 (84.0)	75 (82.4)
Type of Complicated Appendicitis		

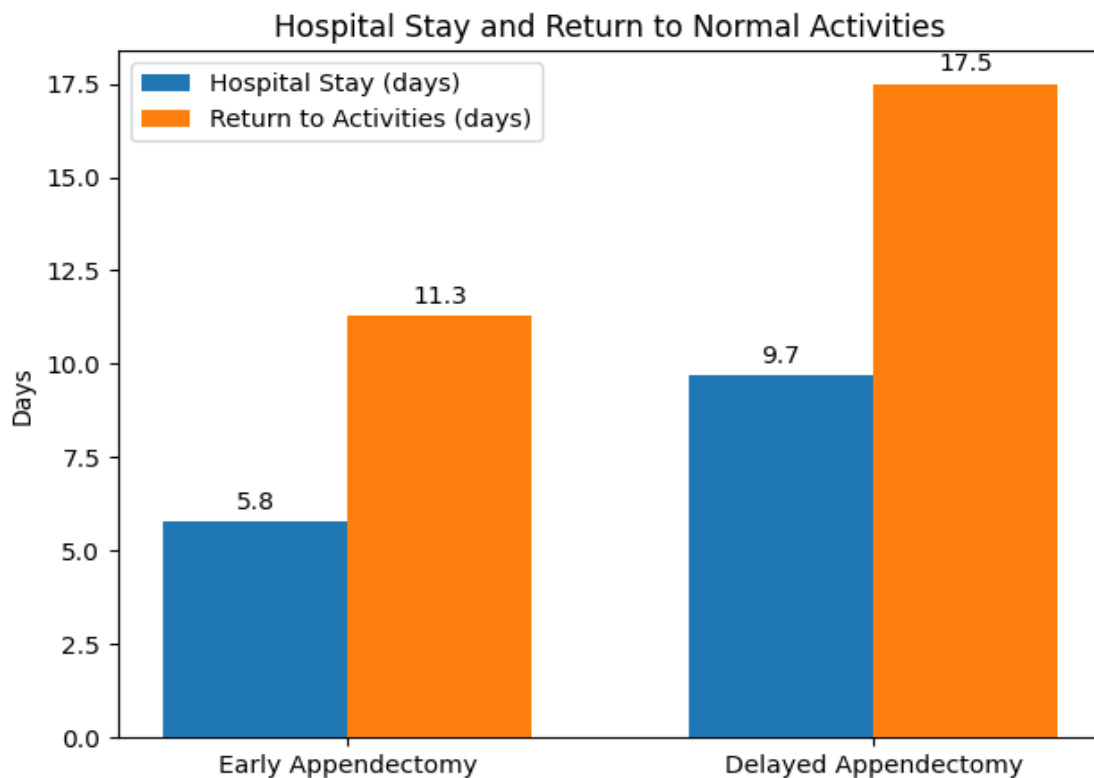
Perforated appendicitis, n (%)	32 (34.0)	30 (33.0)
Gangrenous appendicitis, n (%)	27 (28.7)	25 (27.5)
Appendicular abscess, n (%)	21 (22.3)	24 (26.4)
Appendicular phlegmon, n (%)	14 (14.9)	12 (13.1)

Early appendectomy had shorter operative time (67.5 ± 10.8 vs 74.9 ± 12.3 minutes; $p < 0.001$) and lower blood loss (84.6 ± 18.2 vs 96.2 ± 21.1 mL; $p < 0.001$). Hospital stay was reduced (5.8 ± 1.4 vs 9.7 ± 2.3 days; $p < 0.001$) with faster return to activities (11.3 ± 3.2 vs 17.5 ± 4.1 days; $p < 0.001$). Wound

infection occurred in 8/94 (8.5%) vs 14/91 (15.4%; $p = 0.04$). Intra-abdominal abscess and ileus were not significantly different: 3 (3.2%) vs 6 (6.4%; $p = 0.29$) and 5 (5.3%) vs 7 (7.7%; $p = 0.51$).

Table 2: Operative and postoperative outcomes

Outcome	Group A (n = 94)	Group B (n = 91)	p-value
Operative time (min), mean $\pm$ SD	67.5 ± 10.8	74.9 ± 12.3	<0.001
Blood loss (mL), mean $\pm$ SD	84.6 ± 18.2	96.2 ± 21.1	<0.001
Wound infection, n (%)	8 (8.5)	14 (15.4)	0.04
Intra-abdominal abscess, n (%)	3 (3.2)	6 (6.4)	0.29
Postoperative ileus, n (%)	5 (5.3)	7 (7.7)	0.51
Mean hospital stay (days)	5.8 ± 1.4	9.7 ± 2.3	<0.001
Time to return to activities (d)	11.3 ± 3.2	17.5 ± 4.1	<0.001

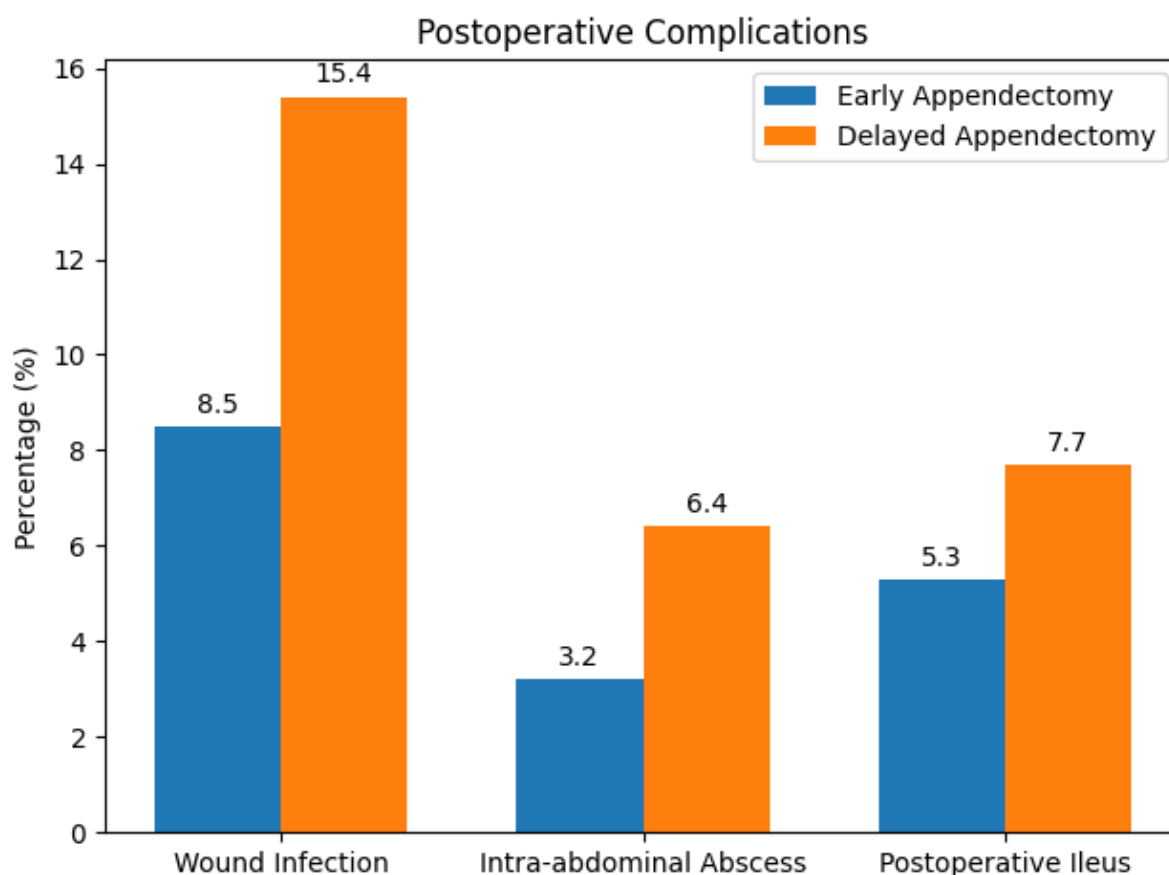


Most events were minor. Grade I occurred in 5 (5.3%) vs 7 (7.7%; $p = 0.51$) and Grade II in 6 (6.4%) vs 10 (11.0%; $p = 0.27$). Grade III complications were 3 (3.2%) vs 5 (5.5%; $p = 0.48$),

while Grade IV were 1 (1.1%) vs 2 (2.2%; $p = 0.53$). There was one death only in the delayed group (0 vs 1; 1.1%; $p = 0.31$).

Table 3: Postoperative complications by Clavien–Dindo classification

Complication Grade	Group A (n = 94)	Group B (n = 91)	p-value
Grade I (minor, no intervention)	5 (5.3)	7 (7.7)	0.51
Grade II (pharmacological)	6 (6.4)	10 (11.0)	0.27
Grade III (surgical intervention)	3 (3.2)	5 (5.5)	0.48
Grade IV (ICU care required)	1 (1.1)	2 (2.2)	0.53
Grade V (death)	0 (0.0)	1 (1.1)	0.31



Readmissions were low overall: 4/94 (4.3%) in early vs 6/91 (6.6%) in delayed ($p = 0.47$). By cause, wound infection recurrence was 2 (2.1%) vs 3 (3.3%; $p = 0.63$), intra-abdominal abscess 1 (1.1%) vs 2 (2.2%; $p = 0.53$), and bowel obstruction/ileus 1 (1.1%) vs 1 (1.1%; $p = 0.99$).

Table 4: Readmissions within 30 days and causes

Cause of Readmission	Group A (n = 94)	Group B (n = 91)	p-value
Wound infection recurrence, n (%)	2 (2.1)	3 (3.3)	0.63
Intra-abdominal abscess, n (%)	1 (1.1)	2 (2.2)	0.53
Bowel obstruction/ileus, n (%)	1 (1.1)	1 (1.1)	0.99
Total readmissions, n (%)	4 (4.3)	6 (6.6)	0.47

Discussion

This study compared the safety and efficacy of early appendectomy and delayed (interval) appendectomy in patients presenting with complicated appendicitis,

including perforated, gangrenous, and suppurative cases with abscess or phlegmon. As our findings show, earlier appendectomy is related to the considerably shorter operative duration, less

intraoperative blood loss, shorter hospitalization, and faster arrival to normal activity when compared to delayed surgery. Moreover, early appendectomy experienced a less prevalence rate of wound infections whereas other complications, including intra-abdominal abscess and postoperative ileus remained not substantially different between the two groups of patients [13]. The baseline characteristics of these two groups were similar in the age, gender distribution, comorbidities, duration of symptoms, and symptoms presentation [14]. Such comparability enhances the internal validity of our results since it reduces the effects of confounding demographic issues. We found that operative time and blood loss was significantly reduced in early appendectomy patients using our data [15]. The results of this study are complementary to other reports stating that early surgery with timely surgical intervention and treatment before a significant accumulation of adhesions and before fibrosis on the tissue can generate surgical simplicity. On the other hand, delay surgery even though done after the acute inflammation has cleared up may be complex by too many adhesions that add time to the operation and risk factors on causing bleeding [16]. The complication profile of post-operative outcomes showed a statistically significant difference in the wound infection complications in the early appendectomy group. Such observation confirms the idea that early extraction of the sick appendix and source of peritoneal contamination can minimize bacteria and consequent wound sepsis [17]. Nonetheless, the rate of intra-abdominal abscesses was a little higher among the delayed group without significant results. Such findings are in-line with earlier meta-analyses where early appendectomy compared to delayed surgery showed similar or better outcomes in relation to infectious complications. Using the ClavienDindo system, most complications occurred among both Category I and II, which proves the fact that the majority of postoperative incidents were not life-threatening and could be treated in a conservative way [18]. The incidence of serious complications that necessitated surgical reintervention (Grade III) and those needing ICU admission (Grade IV) was rare and a single death (Grade V) which was in the delayed appendectomy group in the study. The subtypes of complicated

appendicitis in the two groups were similar implying that they did not show poor outcomes due to changes in disease severity [19]. Particularly, the presence of appendicular abscesses and phlegmons that could be deemed more appropriate to delayed surgery was found in both groups with no notable difference in outcomes to further refute the established inclination toward non-operative care when dealing with appendicular abscesses and phlegmons [20]. The rate of readmission in the within 30 days had a low rate in accumulated with no statistically significant difference. The wound infection responsive to treatment (and therefore most frequent) was at the head of the list followed by intra-abdominal abscess and postoperative bowel obstruction or ileus that was treated successfully [21]. In terms of health system, early appendectomy promises the benefit of lowering the overall length of stay and number of hospital admissions. In our study, early surgery decreased the length of stay in the hospital almost by four days in average and the time to engage into normal activities decreased as well almost by six days [22]. These disparities are clinically significant, especially when it comes to resource constrained environments wherein the availability of hospital beds and price control of the same is a major consideration. Weaknesses of our study consist in the single-center nature of the study and adoption of the non-probability sampling method, which might reduce the study generalizability. Moreover, though there was balance in the baseline characteristics, there might be some unmeasured confounding, including nutritional status and variation in the skill level during the operation, which affect the outcome. There was as well failure to conduct longer-term follow up to determine late complications like adhesive small bowel obstruction.

Conclusion

It is concluded that early appendectomy in patients with complicated appendicitis offers significant advantages over delayed appendectomy, including shorter operative time, reduced intraoperative blood loss, decreased length of hospital stay, quicker return to normal activities, and a lower incidence of wound infections, without a corresponding increase in

major complications. While delayed appendectomy remains a viable option in select high-risk or clinically unstable patients, the findings of this study support early surgical intervention as the preferred approach in most cases.

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