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Original Article

Relationship between the Duration of Symptoms and Operative Findings in Pediatric Patients Undergoing Appendectomy for Acute Appendicitis

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ABSTRACT

Acute appendicitis is a common surgical emergency in children. The relationship between duration of preoperative symptoms and severity of intraoperative findings remains debated. **Objective:** To compare the duration of preoperative symptoms between pediatric patients with complicated and uncomplicated intraoperative findings undergoing appendectomy for acute appendicitis. **Methods:** This analytical cross-sectional study was conducted at the Department of Pediatric Surgery. A total of 171 children aged 2–12 years with acute appendicitis were recruited through non-probability consecutive sampling. Intraoperative findings were categorized as uncomplicated or complicated appendicitis, and duration of preoperative symptoms was categorized as ≤48 hours or >48 hours. Data were analyzed in SPSS version 26.0 using chi-square and t-tests ($p \leq 0.05$). **Results:** Among 171 patients, 65 (38.0%) presented within ≤48 hours and 106 (62.0%) after >48 hours. Complicated appendicitis was observed in 126 (73.7%) patients, and uncomplicated appendicitis in 45 (26.3%). In the complicated group, 46 (36.5%) presented within ≤48 hours and 80 (63.5%) after >48 hours; in the uncomplicated group, 19 (42.2%) presented within ≤48 hours and 26 (57.8%) after >48 hours. The distribution of symptom duration did not differ significantly between the complicated and uncomplicated groups (p=0.498). Older age (10.29 ± 1.79 vs. 8.95 ± 2.62 years; p<0.001) before appendicitis (19.8%vs.4.4%; p=0.009) was significantly associated with complicated findings. **Conclusion:** Complicated appendicitis was the most frequently observed intraoperative finding. Increased age and a prior history of appendicitis were significantly linked to complicated disease, whereas the duration of symptoms before surgery was not significantly related to disease severity.

INTRODUCTION

Acute appendicitis is one of the most common causes of acute abdomen, with an incidence of 100 new cases per 100,000 persons per year [1]. It is caused by non-specific obstruction of the appendiceal lumen with a breakdown of the mucosal barrier, followed by bacterial invasion of the wall and inflammation [2]. Most commonly involved bacteria include Escherichia coli (37.9%), Streptococcus species (9.3%), Bacteroides fragilis (5%), and Pseudomonas species (5.6%) [3]. Patients may present with anorexia, peri-umbilical pain, migratory pain, vomiting, fever, and signs of peritoneal irritation [4]. Diagnosis of acute appendicitis is based on history, clinical examination, and laboratory and radiological investigations [5]. Various scoring tools are used to assess the possibility and severity of acute appendicitis pre-operatively, including the Alvarado Scoring System and Pediatric Appendicitis Score [6]. Appendicitis is generally categorized as uncomplicated and complicated appendicitis according to the level of appendiceal inflammation and its consequences [7]. Appendicitis, if left untreated, may lead to various complications, including gangrene, perforation, intra-peritoneal abscess, or mass formation [8]. Various factors have been investigated as determinants of complicated appendicitis in children,

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including the duration of symptoms, leukocytosis, hyponatremia, and age [9]. Roushan *et al.* reported that in uncomplicated appendicitis, the median duration of symptoms was 48 hours, while it was 96 hours in complicated cases [10]. Pogorelić *et al.* revealed that complicated appendicitis was generally correlated to symptom persistence longer than 48 hours [11]. Lan *et al.* reported that early presentation was associated with 60.8% of uncomplicated and 39.2% of complicated appendicitis, while delayed presentation was associated with 10.2% of uncomplicated and 89.8% of complicated appendicitis [12]. A study by Khan *et al.* reported complicated appendicitis in 75% of patients. Despite the existing evidence, the relationship between duration of preoperative symptoms and severity of intraoperative findings in pediatric appendicitis remains inconsistent. Some studies report a clear association between delayed presentation and complicated disease, while others suggest that host factors and disease biology may be more influential than symptom duration alone [13].

This study aimed to compare the duration of preoperative symptoms between pediatric patients with complicated and uncomplicated intraoperative findings undergoing appendectomy for acute appendicitis, and to identify additional factors associated with complicated appendicitis.

METHODS

This analytical cross-sectional study was conducted at the Department of Pediatric Surgery from 12 April 2025 to 12 October 2025. The study was initiated after receiving approval from the Ethical Review Committee (ERC) and the College of Physicians and Surgeons Pakistan (CPSP) (ERC approval reference number: IERB-22/2025, dated 8th January 2025). Written informed consent was obtained from the parents or legal guardians of all participants before enrolment. Pediatric patients aged 2–12 years of either gender presenting to the emergency department with a diagnosis of acute appendicitis and planned for open appendectomy were enrolled through non-probability consecutive sampling, whereby all eligible patients presenting during the study period were recruited consecutively until the required sample size was achieved. This approach was selected to minimize arbitrary selection of participants and facilitate recruitment of eligible cases in the tertiary-care emergency setting. Patients managed non-operatively or conservatively, those with a grossly normal appendix on exploration, patients with a history of steroids or immunosuppressive drugs, and severely ill patients with chronic liver or kidney disease were excluded. Duration of preoperative symptoms was defined as the time in hours between the onset of abdominal pain, fever, anorexia, or vomiting until the time of admission. The time of symptom onset was obtained from the parent or caregiver history at admission. It was classified into two categories: early (≤48 hours) and delayed (>48 hours) presentation. Intraoperative findings were defined as either uncomplicated appendicitis (inflamed appendix with no gangrene or perforation) or complicated appendicitis (gangrenous or perforated appendix, phlegmon, abscess, or localized or generalized peritonitis). The sample size of 171 patients was calculated using the WHO formula for estimating a single proportion: $n=Z^2 \times p(1-p) / d^2$, where Z=1.96 (at 95% confidence level), p=0.75 based on the reported prevalence of complicated appendicitis in a previous local pediatric study, and d=0.065 (margin of error), yielding a minimum required sample of 171 patients [14]. This estimate was selected as a context-specific prevalence for sample size estimation and may not represent the prevalence in other pediatric populations. Data were collected using a predesigned proforma to capture demographic data, clinical history, time of onset of symptoms, and intraoperative findings. All patients underwent standard preoperative assessment and open appendectomy. Postoperative management was provided during the hospital stay, and no further follow-up beyond the hospital stay was recorded.

Data were analyzed using SPSS version 26. Normality of continuous variables was assessed using the Shapiro–Wilk test. Age and total leukocyte count were normally distributed; therefore, parametric tests were applied. Levene's test was used to assess the equality of variances before applying the independent samples t-test. Descriptive statistics were reported as mean ± standard deviation for continuous variables and frequency (percentage) for categorical variables. The duration of preoperative symptoms was compared between the complicated and uncomplicated intraoperative-finding groups using the Chi-square test (≤48 hours vs.>48 hours); the independent samples t-test was used for continuous variables between the complicated and uncomplicated groups, with p≤0.05 considered statistically significant. Effect estimates were reported with corresponding 95% confidence intervals where applicable.

RESULTS

A total of 171 pediatric patients were included in the study. The table presents the baseline demographic and clinical characteristics of the study participants. The mean age was 9.94 ± 2.12 years, and the mean total leukocyte count (TLC) was 13.51 ± 5.58 $\times 10^3/\mu L$. There was a male preponderance with 128 (74.9%) males and 43 (25.1%) females. Most participants were from urban areas (148; 86.5%), while 23 (13.5%) resided in rural settings. Right iliac fossa pain was the presenting complaint in all patients (171; 100%), followed by vomiting in 125 (73.1%) and fever in 99

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(57.9%) cases. Regarding the duration of preoperative symptoms, 65 (38.0%) patients presented within ≤48 hours, and 106 (62.0%) presented after >48 hours. A previous history of appendicitis was reported in 27 (15.8%) patients (Table 1).

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants (n=171)

Characteristics	Categories	Mean ± SD, Frequency (%)
Age (years)	–	9.94 ± 2.12
TLC (×10^3/µL)	–	13.51 ± 5.58
Gender	Male	128 (74.9%)
	Female	43 (25.1%)
Residential Status	Urban	148 (86.5%)
	Rural	23 (13.5%)
Presenting Complaint*	Pain in RIF	171 (100.0%)
	Fever	99 (57.9%)
	Vomiting	125 (73.1%)
Duration of Preoperative Symptoms	≤48 hours	65 (38.0%)
	>48 hours	106 (62.0%)
Previous History of Appendicitis	Yes	27 (15.8%)
	No	144 (84.2%)

More than one presenting complaint was possible per patient; therefore, percentages for presenting complaints do not sum to 100%. The table presents the comparison of baseline characteristics, including the duration of preoperative symptoms, between the complicated and uncomplicated intraoperative-finding groups. Complicated appendicitis was identified in 126 (73.7%) patients, and uncomplicated appendicitis in 45 (26.3%) patients. The mean age in the complicated group (10.29 ± 1.79 years) was significantly higher than in the uncomplicated group (8.95 ± 2.62 years; p<0.001). In the complicated group, 46 (36.5%) presented within ≤48 hours and 80 (63.5%) after >48 hours, whereas in the uncomplicated group, 19 (42.2%) presented within ≤48 hours and 26 (57.8%) after >48 hours. The distribution of symptom duration did not differ significantly between the two groups (p=0.498). There were no significant differences in TLC (p=0.874), gender distribution (p=0.899), residential status (p=0.592), fever (p=0.300), or vomiting (p=0.726). A previous history of appendicitis was significantly associated with complicated appendicitis (19.8% vs. 4.4%; p=0.009) (Table 2).

Table 2: Association of Baseline Characteristics with Intraoperative Findings (n=171)

Baseline Characteristics	Category	Complicated (n=126)	Uncomplicated (n=45)	Test Statistic	p-value
Age (years), Mean ± SD	–	10.29 ± 1.79	8.95 ± 2.62	t = 3.56†	< 0.001*
TLC (×10^3/µL), Mean ± SD	–	13.55 ± 5.45	13.40 ± 5.98	t = 0.16†	0.874
Gender	Male	94 (74.6%)	34 (75.6%)	χ^2 = 0.016‡	0.899
	Female	32 (25.4%)	11 (24.4%)		
Residential Status	Urban	108 (85.7%)	40 (88.9%)	χ^2 = 0.286‡	0.592
	Rural	18 (14.3%)	5 (11.1%)		
Duration of Preoperative Symptoms	≤48 hours	46 (36.5%)	19 (42.2%)	χ^2 = 0.460‡	0.498
	>48 hours	80 (63.5%)	26 (57.8%)		
Fever	–	70 (55.6%)	29 (64.4%)	χ^2 = 1.074‡	0.300
Vomiting	–	93 (73.8%)	32 (71.1%)	χ^2 = 0.123‡	0.726
Previous History of Appendicitis	Yes	25 (19.8%)	2 (4.4%)	χ^2 = 5.77‡	0.009*

*Statistically significant (p≤0.05); † Independent samples t-test; ‡ Chi-square test

DISCUSSION

Acute appendicitis among children remains a major diagnostic and therapeutic problem, especially in the process of differentiating between uncomplicated inflammation and complicated disease during presentation. The biological progression of disease between luminal obstruction and gangrene and perforation is heterogeneous, and delay in recognition is a key factor in morbidity [15]. Despite the improvements in clinical scoring systems and imaging, intraoperative findings remain an important basis for assessing the macroscopic severity of appendiceal disease during surgery [16-18]. The observed frequency of complicated appendicitis (73.7%) was similar to the 75% reported by Khan *et al.* in a local pediatric population. However, given the single-centre and relatively small sample of that study, this comparison should be interpreted cautiously and should not be considered representative of pediatric populations more broadly [13]. This variation can be explained by the patterns of referral to the tertiary centers, lateness of access to healthcare, socioeconomic factors, or the disease behavior in the region. Pathophysiologically, progressive transmural inflammation with bacterial invasion, predominantly by enteric organisms, may result in gangrene or perforation without timely intervention [19]. However, there are growing indications that appendicitis does not necessarily have a linear progression in time, and early perforation can take place regardless of symptom duration [20]. When the duration of preoperative symptoms was compared between the two intraoperative-finding groups, the distribution did not differ significantly

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(p=0.498): 63.5% of the complicated cases and 57.8% of the uncomplicated cases presented after >48 hours, while 36.5% of the complicated and 42.2% of the uncomplicated cases presented within ≤48 hours. In contrast, Roushan *et al.* in a separate pediatric population, reported a median symptom duration of 96 hours in complicated cases compared with 48 hours in uncomplicated cases [10]. Differences in study setting, population characteristics, and definitions of complicated appendicitis may partly explain the discrepancy. Comparatively, Lan *et al.* revealed that 89.8% of the delayed presenters had complicated disease as opposed to 39.2% of the early presenters [12]. The absence of a statistically significant difference in symptom duration between our two groups does not necessarily exclude a clinically relevant association and may partly reflect limited statistical power or residual confounding. Therefore, symptom duration alone should not be considered a sufficient predictor of intraoperative severity based on the present findings. Recent literature increasingly acknowledges that host inflammatory response, the type of obstruction of the appendix, virulence of microbes, and immune modulation play a role in the disease phenotype beyond temporal delay alone. Age demonstrated a statistically significant association with complicated appendicitis in our study (10.29 ± 1.79 years vs. 8.95 ± 2.62 years; p<0.001). In the past, younger age, especially below five years, has been linked to greater rates of perforation owing to atypical presentation and delay in diagnosis [11-16]. Nevertheless, our results indicate that older children in this cohort had more severe intraoperative pathology. This could be due to differences in health-seeking behavior, differences in reporting of symptoms, or unmeasured confounding factors that affect delay patterns. Notably, no significant differences in total leukocyte count were observed between groups (p=0.874), which is in line with systematic reviews suggesting that isolated laboratory variables do not have adequate discriminatory ability in the distinction between complicated and uncomplicated appendicitis. The combination of clinical evaluation with laboratory indices is stronger than the use of individual markers [14, 15]. A history of prior appendicitis had a significant association with complicated intraoperative findings (19.8% vs. 4.4%; p=0.009). Previous episodes of subclinical inflammation have been shown to predispose the appendix to fibrosis, luminal compromise, and altered vascular perfusion, which may accelerate progression when acute inflammation supervenes [20]. This is biologically plausible, although causality cannot be inferred given the cross-sectional design.

This study has several limitations. Its single-center design, non-probability consecutive sampling, and inclusion of only patients undergoing open appendectomy may limit generalizability and introduce selection bias. Symptom duration was caregiver-reported and may have been affected by recall bias. Intraoperative findings were not systematically correlated with histopathology, and potentially important confounders, including prior antibiotic use, socioeconomic status, and time from admission to surgery, were not assessed. Furthermore, no multivariable analysis was performed, and the relatively small uncomplicated group may have limited the ability to detect modest associations. The sample size was estimated using a 75% prevalence of complicated appendicitis reported in a previous local pediatric study; therefore, this prevalence estimate may not be representative of other pediatric populations and may have influenced the precision of the calculated sample size. Future multicenter prospective studies with larger samples and standardized assessment of prehospital and in-hospital delays are warranted.

CONCLUSIONS

Complicated appendicitis was the predominant intraoperative finding in this pediatric cohort. Although a higher proportion of complicated cases presented after >48 hours than uncomplicated cases (63.5% vs. 57.8%), the difference was not statistically significant (p=0.498). Older age and previous history of appendicitis were significantly associated with complicated findings. These findings suggest that symptom duration alone may be insufficient to predict intraoperative severity and should be considered alongside other clinical factors. Early assessment and timely referral may help reduce diagnostic and presentation delays.

Authors' Contribution

Conceptualization: AC
Methodology: AC, RM, MN, AA
Formal analysis: AC, AA, RM, MN, AA
Writing and Drafting: AC
Review and Editing: AC, AA, RM, MN, AA

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflict of Interest

All the authors declare no conflict of interest.

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