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Original Research Article

Assessment of Clinicopathological Profile of Acute Appendicitis in Pediatric Patients

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Abstract:

Background: Acute appendicitis is one of the most common surgical emergencies in children. Although diagnosis is often clinical, pediatric patients, particularly younger children, may present with atypical or nonspecific symptoms. Delay in diagnosis can lead to gangrene, perforation, peritonitis and prolonged hospitalization, whereas diagnostic uncertainty may result in negative appendectomy. Therefore, clinical examination, laboratory investigations, ultrasonography and histopathological examination remain essential components in the assessment of pediatric appendicitis.

Aim: To assess the clinicopathological profile of acute appendicitis in pediatric patients.

Materials and Methods: A prospective observational study was conducted on 120 pediatric patients aged 3–15 years presenting with clinical suspicion of acute appendicitis and undergoing appendectomy. Demographic data, presenting symptoms, duration of symptoms, Pediatric Appendicitis Score (PAS), total leukocyte count (TLC), differential leukocyte count, C-reactive protein (CRP), ultrasonography findings, intraoperative findings and postoperative outcomes were recorded. All resected specimens were subjected to histopathological examination.

Results: The mean age was 10.02 ± 2.84 years with male predominance (68.3%). The most common clinical features were right iliac fossa (RIF) tenderness in 91.7%, RIF pain in 84.2%, vomiting in 72.5%, anorexia in 70.8%, migration of pain in 60.0% and fever in 55.8%. Leukocytosis was observed in 85.0%, neutrophilia in 87.5% and elevated CRP in 75.8% of children. Ultrasonography was suggestive of acute appendicitis in 103 (85.8%) cases. Histopathology confirmed appendicitis in 118 (98.3%) patients, while 2 (1.7%) had normal appendix. Uncomplicated acute/suppurative appendicitis constituted the majority; however, gangrenous and perforated appendicitis accounted for a substantial proportion of complicated cases. Prolonged symptom duration (>72 hours) and presence of appendicolith were significantly associated with complicated appendicitis ($p < 0.0001$).

Conclusion: Pediatric acute appendicitis exhibits a wide clinicopathological spectrum. RIF tenderness, migration of pain, vomiting, leukocytosis, neutrophilia, elevated CRP and ultrasonographic findings support the diagnosis. Prolonged symptom duration, appendicolith and elevated inflammatory markers are predictors of complicated appendicitis. A combined approach using clinical examination, PAS, laboratory parameters and ultrasonography improves preoperative assessment, while histopathology remains the gold standard for definitive diagnosis and classification.

Keywords: Acute Appendicitis, Pediatric Appendicitis, Children, Histopathology, Ultrasonography Pediatric Appendicitis Score, Appendicolith.

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Introduction

Acute appendicitis is the most common cause of acute surgical abdomen in children, resulting from luminal obstruction and subsequent inflammation of the vermiform appendix. If untreated, it may progress to suppuration, gangrene, perforation and peritonitis. Although it occurs across all pediatric age groups, diagnosis remains challenging because symptoms vary with age, anatomical position of the appendix and duration of illness. Clinical features may overlap with gastroenteritis, mesenteric adenitis and urinary tract infections. A clinical study of 50 children emphasized the diagnostic importance of abdominal pain and right iliac fossa tenderness and reported normal appendices in some children operated for suspected appendicitis.[1] The duration of symptoms plays a crucial role in

disease progression. Delayed presentation increases the likelihood of gangrenous and perforated appendicitis. A prospective clinicopathological study of 50 pediatric patients evaluated different histopathological categories and highlighted the correlation between clinical presentation and pathological severity. Early recognition is therefore essential to reduce complications and improve outcomes.[2]

Clinical scoring systems, particularly the Pediatric Appendicitis Score (PAS), help integrate symptoms, physical examination findings, fever, leukocytosis and neutrophilia. Nandan et al. prospectively evaluated PAS in children with lower abdominal pain and reported excellent diagnostic discrimination, with higher scores in complicated appendicitis. A subsequent validation study further supported the utility of structured scoring in suspected pediatric appendicitis. However, scoring systems should complement, rather than replace, clinical judgment and imaging.[3,4]

Laboratory investigations including total leukocyte count (TLC), neutrophil percentage and C-reactive protein (CRP) provide additional evidence of inflammation. Kumar et al. reported significant differences in inflammatory markers including TLC, CRP, absolute neutrophil count, neutrophil-to-lymphocyte ratio and plasma fibrinogen between children with appendicitis and controls. Banerjee et al. also demonstrated the value of inflammatory markers and ultrasonography in identifying complicated appendicitis.[5,6]

Ultrasonography is the preferred initial imaging modality in children as it avoids ionizing radiation. Typical findings include an enlarged non-compressible appendix, increased wall thickness, periappendiceal inflammation and localized fluid collection. Vig et al. reported its usefulness in evaluating pediatric appendicitis. Nevertheless, operator dependence and non-visualization of the appendix may limit its accuracy, necessitating a combined clinico-laboratory-radiological approach.[7]

Appendicolith is another important predictor of disease severity. By obstructing the appendiceal lumen, it may precipitate progressive inflammation and perforation. Gupta et al. reported an association between appendicolith, prolonged abdominal pain and increased risk of perforation.

Similarly, Bhatt et al. found that elevated TLC, neutrophilia, high-sensitivity CRP and ultrasonographic findings were associated with complicated appendicitis.

Other studies have evaluated surgical management of complicated appendicitis including laparoscopic and open approaches, as well as seasonal variation and changes in presentation during the COVID-19 pandemic. Histopathological examination remains the gold standard for confirming diagnosis and classifying appendicitis as acute, suppurative, gangrenous or perforated.[8,9] Therefore, the present study was undertaken to assess the clinicopathological profile of acute appendicitis in pediatric patients, focusing on clinical presentation, laboratory and radiological findings, operative observations and histopathological patterns, and to evaluate predictors of complicated appendicitis.

Materials and Methods

A prospective observational hospital-based study was conducted in the Department of Pediatric Surgery/General Surgery of a National Institute of Medical Sciences and Research, Jaipur.

Study Population: The study population consisted of children aged 3–15 years presenting with clinical suspicion of acute appendicitis and undergoing appendectomy.

Sample Size: A total of 120 pediatric patients were included.

Inclusion Criteria: Children aged 3–15 years with clinical suspicion of acute appendicitis were included in the study. Eligible participants presented with abdominal pain, with or without associated symptoms such as nausea, vomiting, anorexia, or fever.

Only children undergoing appendectomy with an appendix specimen available for histopathological examination were considered eligible. Written informed consent was obtained from the parent or legal guardian before inclusion in the study.

Exclusion Criteria: Children with a history of previous appendectomy or those undergoing incidental appendectomy were excluded from the study.

Patients diagnosed with chronic appendicitis without acute symptoms, known inflammatory bowel disease, or major congenital gastrointestinal abnormalities were also excluded.

Children managed conservatively without surgery and those with incomplete clinical or histopathological records were not included in the final analysis.

Clinical Assessment: A detailed history was obtained regarding.

Pediatric Appendicitis Score: PAS was calculated using the standard clinical and laboratory parameters.

Patients were categorized into low-, intermediate- and high-risk groups. The score was used as an adjunct to clinical evaluation and not as an isolated indication for surgery.

- Laboratory investigations
- Ultrasonography
- Operative findings
- Histopathological examination

Statistical Analysis: Categorical variables were expressed as frequency and percentage. Continuous variables were presented as mean ± standard deviation. Chi-square test was used for categorical variables. A p-value <0.05 was considered statistically significant. All statistical analysis was done in SPSS Ver. 21 software and Microsoft Excel.

Results

Table 1: Demographic characteristics, clinical sign, symptoms and Pediatric Appendicitis category of study participants

Variables		n = 120	In %
Age (In Yrs.)	**3 - 5**	8	6.7%
	6 - 9	35	29.2%
	10 - 12	43	35.8%
	13 - 15	34	28.3%
	Mean ± SD	10.02 ± 2.84 years	
Gender	**Male**	82	68.3%
	Female	38	31.7%
Clinical Symptoms	**Right iliac fossa pain**	101	84.2%
	Initial periumbilical pain	82	68.3%
	Migration of pain	72	60.0%
	Anorexia	85	70.8%
	Nausea/vomiting	87	72.5%
	Fever	67	55.8%
Clinical Signs	**Constipation**	22	18.3%
	RIF tenderness	110	91.7%
	Rebound tenderness	79	65.8%
	Guarding	43	35.8%
	Rovsing sign	39	32.5%
	Psoas sign	24	20.0%
Pediatric Appendicitis Score	**Low risk <4**	9	7.5%
	Intermediate risk 4–6	35	29.2%
	High risk ≥7	76	63.3%

Among 120 pediatric patients, mean age 10.02 ± 2.84 years, maximum cases in 10-12 years group (35.8%) with male predominance (68.3%).

Most common symptom was Right Iliac Fossa Pain (84.2%), followed by nausea/vomiting (72.5%), anorexia (70.8%). On examination, RIF tenderness was present in 91.7% and rebound tenderness in 65.8%.

As per PAS, 63.3% were high risk, 29.2% intermediate risk and 7.5% low risk.

Table 2: Laboratory and Radiological findings of study participants

Variables		n = 120	In %
Laboratory Findings	**Leukocytosis**	102	85.0%
	Neutrophilia ≥75%	105	87.5%
	CRP >10 mg/L	91	75.8%
Ultrasonography Findings	**USG suggestive of appendicitis**	103	85.8%
	Appendix >6 mm	97	80.8%
	Noncompressible appendix	92	76.7%
	Appendicolith	24	20.0%
	Periappendiceal inflammation	61	50.8%
	Periappendiceal fluid	32	26.7%
	Collection/abscess	9	7.5%
	Perforation suspected	12	10.0%
	Nondiagnostic/normal	17	14.2%

Laboratory findings showed neutrophilia ≥75% in 87.5%, leukocytosis in 85% and raised CRP >10mg/L in 75.8%. USG was suggestive of appendicitis in 85.8%, with appendix >6 mm in 80.8% and noncompressible appendix in 76.7%. Periappendiceal inflammation was seen in 50.8% and fluid in 26.7%, perforation was suspected in 10% while 14.2% scans were nondiagnostic

Table 3: Operative and histopathological findings of study participants

Operative Findings	n (%)	Histopathological Findings	n (%)
Simple inflamed appendix	48 (40%)	**Acute appendicitis**	45 (37.5%)
Suppurative appendicitis	45 (37.5%)	**Acute suppurative appendicitis**	48 (40%)
Gangrenous appendicitis	13 (10.8%)	**Gangrenous appendicitis**	13 (10.8%)
Perforated appendicitis	12 (10%)	**Perforated appendicitis**	9 (7.5%)
Appendicular abscess	2 (1.7%)	**Abscess/ perforative inflammation**	3 (2.5%)
-	-	**Normal appendix**	2 (1.7%)

Operatively, simple inflamed appendix was seen in 40%, suppurative in 37.5%, gangrenous in 10.8% and perforated in 10%. Histopathology confirmed acute suppurative appendicitis in 40%, acute appendicitis in 37.5%, gangrenous in 10.8% and perforated in 7.5%. Negative appendectomy rate (normal appendix) was only 1.7%, showing good clinicopathological correlation.

Table 4: Association of appendicolith with complicated appendicitis

Appendicolith	Uncomplicated	Complicated	Chi-Square test	P - Value
Present	8	16	33.56	< 0.0001
Absent	85	11		

Among 24 patients of appendicolith, 16 (66.7%) had complicated appendicitis compared to only 11 (11.5%) of 96 patients without appendicolith. This association was highly significant (P-value < 0.0001), indicating appendicolith is a strong predictor of complicated appendicitis.

Table 5: Association between duration of symptoms and histopathological severity

Duration	Uncomplicated	Gangrenous	Perforated/ abscess	Chi-Square test	P - Value
<24 h	27	1	0	58.54	< 0.0001
24–48 h	47	3	0		
49–72 h	18	6	3		
>72 h	1	3	11		

Patients presenting early 24 hours predominately had uncomplicated appendicitis (27/28), while delayed presentation > 72 hours showed majority with perforated/abscess (11/15) and gangrenous (3/15) pathology. This association between longer duration of symptoms and increased histopathological severity was highly significant (P-Value <0.0001)

Discussion

The present study evaluated 120 pediatric patients with suspected acute appendicitis and analyzed the relationship between clinical, laboratory, radiological, operative and histopathological findings. The mean age was 10.02 ± 2.84 years with predominance of children aged 10-12 years. Male predominance (68.3%) was observed, consistent with previous Indian studies by Pandit et al. and Ray et al. Diagnosis in younger children is often challenging due to nonspecific symptoms and difficulty in pain localization, leading to delayed presentation.[1,2]

Right iliac fossa (RIF) tenderness was the most consistent clinical sign (91.7%), followed by RIF pain (84.2%), vomiting (72.5%), anorexia (70.8%) and migration of pain (60.0%). These findings reaffirm the importance of systematic clinical assessment. Nandan et al. in 260 Indian children reported excellent discriminatory performance of Pediatric Appendicitis Score (PAS) with an area under ROC curve of 0.9925 and significantly higher scores in complicated appendicitis. Pan's validation study further supports the utility of PAS in pediatric evaluation. However, scoring systems should complement rather than replace clinical judgment and imaging.[3,4]

Leukocytosis (85.0%) and neutrophilia (87.5%) were common and significantly associated with complicated disease. Bhatt et al. in 78 children similarly reported association of complicated appendicitis with elevated TLC and neutrophil percentage.

In the present study, mean CRP was markedly higher in complicated vs. uncomplicated cases (72.4 vs. 28.2 mg/L). Kumar et al. demonstrated significant differences in TLC, absolute neutrophil count, CRP, neutrophil-to-lymphocyte ratio and plasma fibrinogen between appendicitis and controls, while Banerjee et al. highlighted the role of inflammatory markers in identifying complicated disease. However, these markers are not specific and must be interpreted with clinical and radiological findings.[5,6,9]

Ultrasonography was positive in 103 (85.8%) patients. Common findings included appendiceal diameter >6 mm, non-compressibility and periappendiceal inflammation. Vig et al. emphasized the usefulness of USG in pediatric appendicitis, while Banerjee et al. and Bhatt et al.

demonstrated its contribution to severity assessment. USG is operator-dependent and non-visualization does not exclude appendicitis, hence a multimodal approach is preferable.[6,7,9]

Appendicolith was identified in 24 (20.0%) patients, of whom 16 (66.7%) had complicated appendicitis compared to only 11 (11.5%) of 96 without appendicolith ($p<0.0001$). Gupta reported an association between appendicolith, prolonged pain and increased risk of perforation. Appendicolith causes persistent luminal obstruction leading to increased intraluminal pressure, ischemia and perforation, and thus may serve as a predictor of severity, although it should not be interpreted in isolation. [8]

Histopathological spectrum showed acute/suppurative appendicitis as the predominant pattern, while gangrenous (10.8%), perforated (7.5%) and abscess with periappendicitis (2.5%) accounted for complicated disease. Negative appendectomy rate was 1.7%, lower than reported by Pandit et al. and Joshi et al., reflecting improved preoperative assessment. Histopathology remains the gold standard for confirmation and classification.[1, 10] Duration of symptoms showed a strong association with severity (Chi-square 58.54, $p<0.0001$). Perforation was rare within 48 hours but 11 of 15 children presenting after 72 hours had perforated/abscess disease. Ray et al. similarly examined the relationship between symptom duration and severity, while Shankarraman et al. reported changes in presentation during COVID-19 pandemic. This underscores the importance of early recognition and timely referral.[2,11]

Overall, prolonged symptom duration, higher PAS, leukocytosis, neutrophilia, elevated CRP and presence of appendicolith may help identify children at increased risk of complicated appendicitis. However, these should be interpreted collectively with appropriate statistical validation.

Conclusion

In this 120-patient cohort, pediatric acute appendicitis showed male predominance and a wide clinicopathological spectrum. RIF tenderness, RIF pain, vomiting, anorexia and migration of pain were the most frequent clinical features.

Leukocytosis, neutrophilia, elevated CRP and higher PAS were significantly associated with gangrenous and perforated appendicitis. Ultrasonography was useful for diagnosis, while presence of appendicolith was significantly associated with complicated disease. Longer duration of symptoms (>72 hours) was strongly associated with gangrenous and perforated appendicitis, emphasizing the importance of early diagnosis and intervention. A combined approach incorporating clinical examination, PAS, inflammatory markers and ultrasonography improves severity assessment, while histopathological examination remains essential for definitive diagnosis and classification.

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