

Research Article

RADIOLOGICAL SPECTRUM IN SURGICAL CAUSES OF ABDOMINAL EMERGENCIES IN CHILDREN

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Abstract: **Introduction:** Pediatric abdominal emergencies are an important cause of morbidity and require prompt diagnosis and surgical intervention. Radiological imaging plays a crucial role in identifying the underlying pathology and guiding management. This study evaluated the radiological spectrum of surgical causes of abdominal emergencies in children and assessed the utility of different imaging modalities. **Aim:** To study the radiological spectrum of surgical causes of abdominal emergencies in children and assess the diagnostic utility of different imaging modalities in their evaluation and management. **Methods:** A cross-sectional descriptive study was conducted over one year at Tezpur Medical College & Hospital. A total of 78 children aged 0-12 years presenting with acute abdominal symptoms suggestive of surgical emergencies were included. All patients underwent radiological evaluation using ultrasonography (USG), computed tomography (CT), X-ray, or magnetic resonance imaging (MRI). Clinical, radiological, surgical, and outcome data were analyzed using SPSS version 27.0. **Results:** The majority of patients were aged 5–10 years (48.7%), with a slight female predominance (55.1%). Combined CT and USG was the most frequently utilized imaging modality (59.0%). The most common radiological finding was a non-compressible tubular structure in the right lower quadrant with inflammatory changes suggestive of appendicitis (39.7%), followed by the target sign of intussusception (20.5%). Appendicitis was the most common final diagnosis (39.7%), closely followed by intussusception (38.5%). Surgical findings correlated well with radiological diagnoses. Following appropriate surgical management, 76 patients (97.4%) recovered successfully, while only 2 patients (2.6%) developed complications. All major findings were statistically significant ($p < 0.0001$). **Conclusion:** The current study emphasises the critical role of radiological imaging in the diagnosis and management of paediatric surgical abdominal emergencies. Ultrasound emerged as the primary imaging modality owing to its availability, safety, and high diagnostic accuracy.

Keywords: Pediatric abdominal emergencies, Radiological spectrum, Ultrasound, Computed tomography.

INTRODUCTION

Abdominal emergencies constitute a significant proportion of pediatric surgical admissions and represent a major cause of morbidity and mortality in children. Prompt diagnosis and timely intervention are crucial to prevent complications such as bowel ischemia, perforation, sepsis, and death. However, diagnosing acute abdominal conditions in children is often challenging because of non-specific clinical presentations, age-related communication difficulties, and overlapping symptoms among different disease entities. In such situations, radiological imaging plays a pivotal role in establishing an accurate diagnosis, determining disease severity, and guiding appropriate surgical management [1].

The spectrum of surgical abdominal emergencies in children varies according to age and includes conditions such as acute appendicitis, intussusception, intestinal obstruction, malrotation with midgut volvulus, hypertrophic pyloric stenosis, incarcerated hernia, perforation peritonitis, and abdominal trauma [2]. These

conditions require rapid identification because delays in diagnosis can significantly worsen outcomes. Clinical examination alone may be insufficient, particularly in infants and younger children, where symptoms are often atypical and physical findings are difficult to interpret [3].

Radiological investigations have become indispensable in the evaluation of pediatric abdominal emergencies. Advances in imaging technology have enhanced diagnostic accuracy while minimizing invasive procedures. Plain abdominal radiography remains a useful initial imaging modality, particularly in suspected bowel obstruction, perforation, foreign body ingestion, and necrotizing enterocolitis. Characteristic radiographic findings such as air-fluid levels, free intraperitoneal air, or bowel dilatation may provide valuable diagnostic clues and assist in clinical decision-making [4].

Ultrasonography (USG) is considered the first-line imaging modality for most pediatric abdominal emergencies due to its safety, lack of ionizing radiation, portability, and excellent diagnostic performance. It is

particularly effective in diagnosing acute appendicitis, intussusception, pyloric stenosis, and intra-abdominal collections. The “target sign” in intussusception and the enlarged non-compressible appendix in appendicitis are classic sonographic findings that facilitate early diagnosis and treatment [5]. Furthermore, Doppler ultrasonography helps assess vascular compromise in conditions such as volvulus and strangulated hernia [6].

Computed tomography (CT) has emerged as a highly sensitive imaging technique for complex or equivocal cases. CT provides detailed cross-sectional visualization of abdominal organs, bowel loops, mesentery, and vascular structures, making it valuable in evaluating complicated appendicitis, abdominal trauma, perforation, and intestinal obstruction. Despite concerns regarding radiation exposure, CT remains an important diagnostic tool when ultrasound findings are inconclusive or when rapid comprehensive assessment is required [7].

Magnetic resonance imaging (MRI) is increasingly being utilized in selected pediatric patients due to its superior soft tissue contrast and absence of ionizing radiation. Although limited by availability, cost, and longer examination times, MRI has shown promise in evaluating appendicitis, inflammatory bowel disease, and certain congenital anomalies in children [8].

The radiological manifestations of pediatric surgical abdominal emergencies are diverse and often overlap. Understanding the spectrum of imaging findings is therefore essential for radiologists and pediatric surgeons. Accurate interpretation of radiological features not only facilitates early diagnosis but also helps determine the need for surgical intervention, predict complications, and improve patient outcomes [9].

Given the wide variety of surgical causes of acute abdomen in children and the growing importance of imaging in clinical practice, studying the radiological spectrum of these conditions is highly relevant. Such evaluation can provide insights into disease patterns, optimize diagnostic algorithms, and contribute to better management strategies in pediatric surgical emergencies.[10] To study the radiological spectrum of surgical causes of abdominal emergencies in children and assess the diagnostic utility of different imaging modalities in their evaluation and management.

MATERIALS AND METHODS

Place of Study: The study was conducted at Tezpur Medical College & Hospital.

Duration of Study: The study was conducted over a period of one year.

Study Design: A cross-sectional descriptive study was conducted.

Study Population: Patients included in the study were those who were clinically referred for radiological investigation at Tezpur Medical College & Hospital.

Sample Size: 78

Inclusion Criteria

- Children aged 0-12 years presenting with acute abdominal symptoms suggestive of a surgical emergency.
- Patients who undergo one or more radiological investigations (X-ray, Ultrasonography, CT, or MRI).
- Parents/guardians who provide informed consent for participation in the study.

Exclusion Criteria

- Children above 12 years of age.
- Patients with non-surgical causes of acute abdomen (e.g., gastroenteritis, urinary tract infection, hepatitis, pancreatitis managed conservatively).
- Patients with chronic abdominal conditions without acute surgical presentation.
- Patients who did not undergo radiological evaluation.

Statistical Analysis:

For statistical analysis, data were entered into a Microsoft Excel spreadsheet and analyzed using SPSS version 27.0 and GraphPad Prism version 5. Data were summarized as frequencies and percentages for categorical variables. Age and sex distribution, anatomical sites, and cytomorphological patterns of metastatic lymph nodes were analyzed descriptively. Sensitivity, specificity, and diagnostic accuracy of FNAC were calculated by correlating cytological findings with histopathological examination wherever available. Results were presented in the form of tables and charts. A p-value of ≤ 0.05 was considered statistically significant wherever applicable.

RESULTS

TABLE 1: DEMOGRAPHIC CHARACTERISTICS OF STUDY PARTICIPANTS (N=78)

	Variable	Frequency (%)	p-value
Age Group	<5 years	22 (28.2)	0.013
	5–10 years	38 (48.7)	
	10–12 years	18 (23.1)	
	Total	78 (100.0%)	
Sex	Male	35 (44.9)	0.364
	Female	43 (55.1)	
	Total	78 (100.0%)	

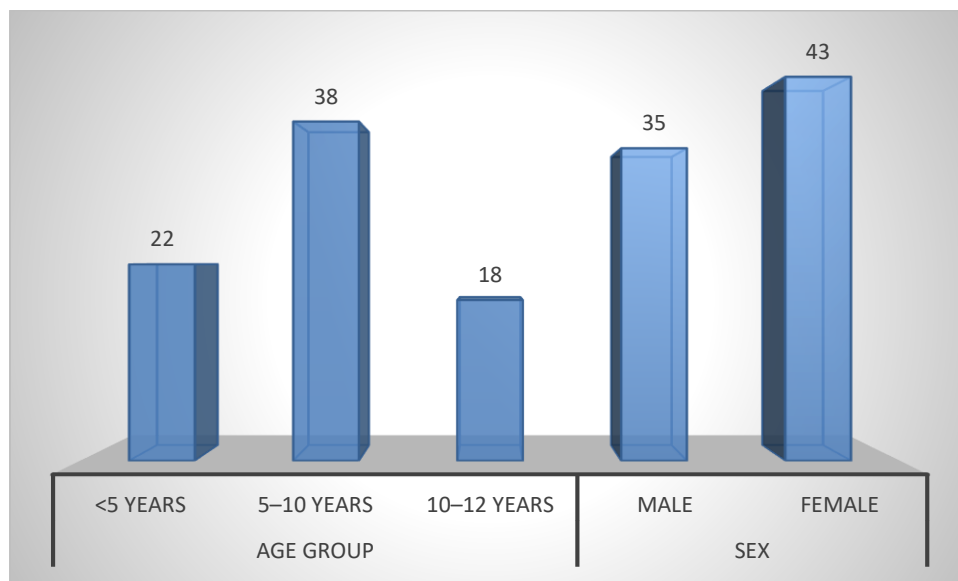


FIGURE 1: DEMOGRAPHIC CHARACTERISTICS OF STUDY PARTICIPANTS

TABLE 2: IMAGING MODALITIES AND RADIOLOGICAL FINDINGS

		Frequency (%)	P value
Imaging Modality	CT + USG	46 (59.0%)	< 0.0001
	CT + USG + X-ray	8 (10.3%)	
	USG	12 (15.4%)	
	USG + MRI	5 (6.4%)	
	USG + X-ray	7 (9.0%)	
	Total	78 (100.0%)	
Radiological Findings	Dilated bowel loops with multiple air-fluid levels and target sign	14 (17.9%)	< 0.0001
	Enlarged ovary with peripheral follicles and absent Doppler flow	6 (7.7%)	
	Free fluid in peritoneum with solid organ laceration	11 (14.1%)	

	Non-compressible tubular structure in RLQ with inflammatory changes	31 (39.7%)	
	Target sign on USG with bowel-within-bowel appearance	16 (20.5%)	
	Total	78 (100.0%)	

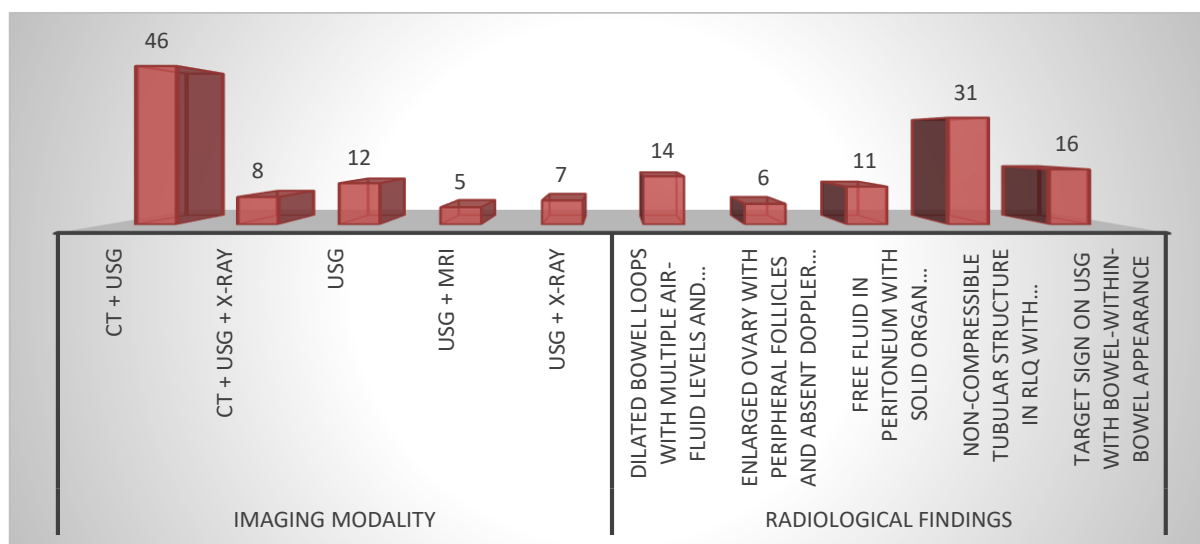


FIGURE 2: IMAGING MODALITIES AND RADIOLOGICAL FINDINGS

TABLE 3: FINAL DIAGNOSES AND CORRESPONDING SURGICAL FINDINGS

		Frequency (%)	P value
Final Diagnosis	Appendicitis	31 (39.7%)	< 0.0001
	Intussusception	30 (38.5%)	
	Ovarian torsion	6 (7.7%)	
	Solid organ injury due to blunt trauma	11 (14.1%)	
	Total	78 (100.0%)	
Surgical Findings	Classic intussusception with telescoping bowel segment	30 (38.5%)	< 0.0001
	Inflamed appendix with surrounding inflammatory changes	31 (39.7%)	
	Intra-abdominal fluid with solid organ laceration from trauma	11 (14.1%)	
	Enlarged ovary with absent blood flow consistent with torsion	6 (7.7%)	
	Total	78 (100.0%)	

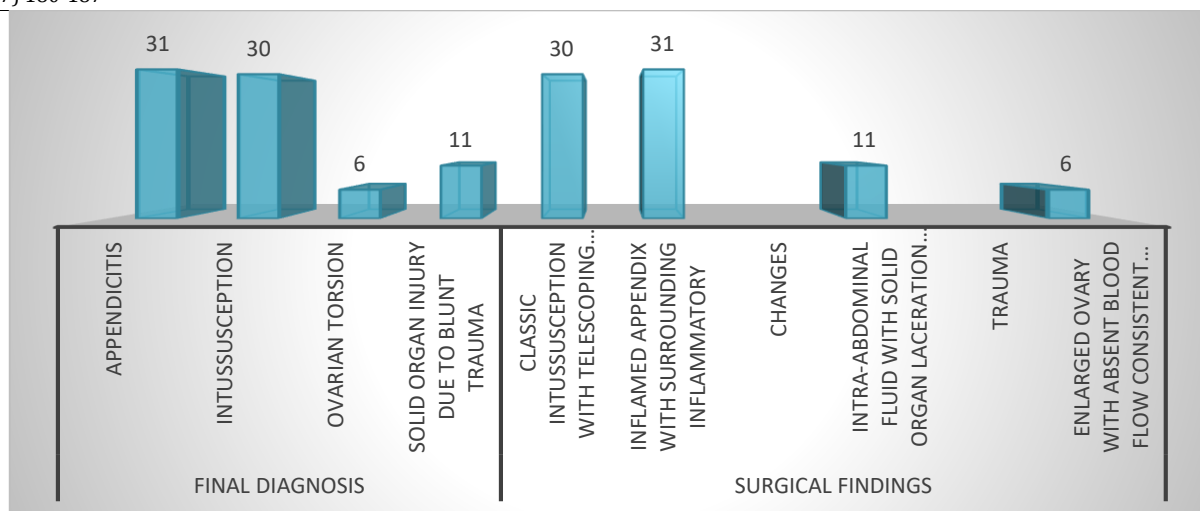


FIGURE 3: FINAL DIAGNOSES AND CORRESPONDING SURGICAL FINDINGS

TABLE 4: CLINICAL OUTCOMES OF STUDY PARTICIPANTS

Outcome	Frequency (%)	P value
Complication	2 (2.6%)	< 0.0001
Recovered	76 (97.4%)	
Total	78 (100.0%)	

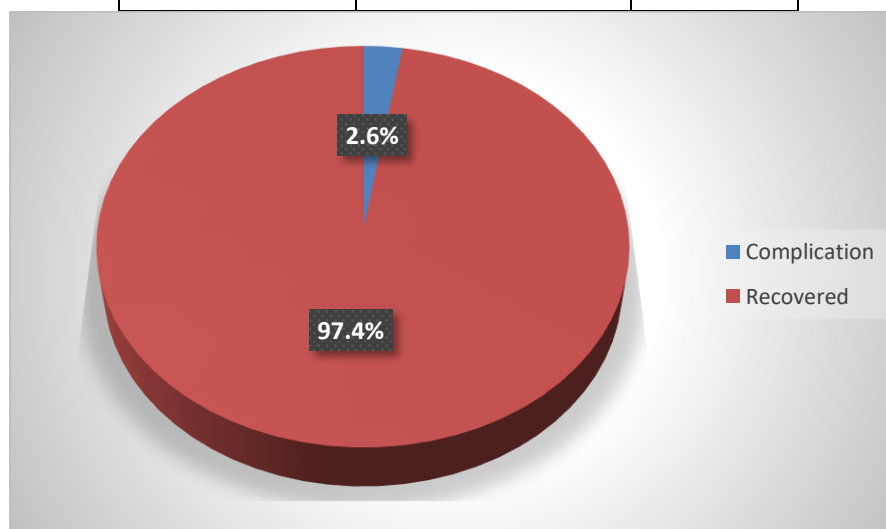


FIGURE 4: CLINICAL OUTCOMES OF STUDY PARTICIPANTS

A total of 78 children were included in the study. The majority of patients belonged to the 5–10 years age group, comprising 38 patients (48.7%), followed by 22 patients (28.2%) aged less than 5 years and 18 patients (23.1%) aged 10–12 years. The distribution of patients across different age groups was statistically significant ($p = 0.013$). Regarding sex distribution, 43 patients (55.1%) were female and 35 patients (44.9%) were male. The difference in sex distribution was not statistically significant ($p = 0.364$).

Among the 78 children included in the study, the most commonly utilized imaging modality was the combination of CT and ultrasonography (USG), performed in 46 patients (59.0%). This was followed by USG alone in 12 patients (15.4%), CT + USG + X-ray in 8 patients (10.3%), USG + X-ray in 7 patients (9.0%), and USG + MRI in 5 patients (6.4%). The distribution of imaging modalities was statistically significant ($p < 0.0001$). Regarding radiological findings, the most frequent finding was a non-compressible tubular structure in the right lower quadrant with inflammatory changes, observed in 31 patients (39.7%). Other findings included target sign on ultrasonography with bowel-within-bowel appearance in 16

patients (20.5%), dilated bowel loops with multiple air-fluid levels and target sign in 14 patients (17.9%), free fluid in the peritoneum with solid organ laceration in 11 patients (14.1%), and an enlarged ovary with peripheral follicles and absent

Doppler flow in 6 patients (7.7%). The distribution of radiological findings was also statistically significant ($p < 0.0001$). Among the 78 children studied, appendicitis was the most common final diagnosis, identified in 31 patients (39.7%), followed closely by intussusception in 30 patients (38.5%). Solid organ injury due to blunt abdominal trauma was diagnosed in 11 patients (14.1%), while ovarian torsion was observed in 6 patients (7.7%). The distribution of final diagnoses was statistically significant ($p < 0.0001$). Correspondingly, surgical findings revealed an inflamed appendix with surrounding inflammatory changes in 31 patients (39.7%), classic intussusception with a telescoping bowel segment in 30 patients (38.5%), intra-abdominal fluid with solid organ laceration secondary to trauma in 11 patients (14.1%), and an enlarged ovary with absent blood flow consistent with torsion in 6 patients (7.7%). The distribution of surgical findings was also statistically significant ($p < 0.0001$).

Among the 78 children included in the study, the overall outcome was favorable in the vast majority of cases. A total of 76 patients (97.4%) recovered successfully following appropriate surgical management, while complications were observed in only 2 patients (2.6%). The difference in outcome distribution was statistically significant ($p < 0.0001$), indicating a high rate of successful recovery and a low incidence of postoperative complications among the study population.

DISCUSSION

The present study included 78 children presenting with surgical abdominal emergencies. The highest proportion of patients was observed in the 5–10 years age group, accounting for 38 patients (48.7%), followed by children younger than 5 years comprising 22 patients (28.2%) and those aged 10–12 years comprising 18 patients (23.1%). The predominance of school-aged children is consistent with previous studies reporting a higher incidence of conditions such as appendicitis and intussusception in this age group, likely due to the age-related distribution of these surgical pathologies. The age-wise distribution was statistically significant ($p = 0.013$), suggesting that abdominal surgical emergencies are not uniformly distributed across pediatric age groups. With regard to sex distribution, females constituted a slightly higher proportion with 43 patients (55.1%), while males accounted for 35 patients (44.9%). However, the difference was not statistically significant ($p = 0.364$), indicating that the occurrence of surgical abdominal emergencies in the study population was comparable between both sexes. Similar observations have been reported in pediatric surgical literature, where sex distribution often varies depending on the underlying diagnosis but does not consistently demonstrate a significant overall gender predilection. The age distribution observed in the present study is comparable to the findings of Memon et al., who evaluated 240 pediatric patients with acute surgical abdomen and reported that the majority of cases occurred in the 6–10 years age group (27.5%), followed by younger children and adolescents. The authors attributed this predominance to the increased occurrence of acquired surgical conditions such as acute appendicitis in school-aged children. [11]

The present study demonstrated that combined CT and ultrasonography (USG) was the most frequently employed imaging modality, utilized in 46 patients (59.0%), highlighting the complementary role of cross-sectional and sonographic imaging in the evaluation of pediatric abdominal emergencies. USG alone was

sufficient in 12 patients (15.4%), while CT + USG + X-ray, USG + X-ray, and USG + MRI were used in 8 patients (10.3%), 7 patients (9.0%), and 5 patients (6.4%), respectively. The statistically significant distribution of imaging modalities ($p < 0.0001$) reflects the tailored use of imaging based on the suspected pathology and clinical presentation. Among radiological findings, a non-compressible tubular structure in the right lower quadrant with surrounding inflammatory changes was the most common finding, observed in 31 patients (39.7%), corresponding to acute appendicitis.

This was followed by the target sign with bowel-within-bowel appearance in 16 patients (20.5%) and dilated bowel loops with multiple air-fluid levels and target sign in 14 patients (17.9%), both characteristic of intussusception. Free intraperitoneal fluid associated with solid organ laceration was identified in 11 patients (14.1%), while an enlarged ovary with peripheral follicles and absent Doppler flow suggestive of ovarian torsion was seen in 6 patients (7.7%). The significant distribution of radiological findings ($p < 0.0001$) emphasizes the crucial role of imaging in accurately diagnosing the underlying surgical cause of abdominal emergencies in children and facilitating timely intervention. The findings of the present study are consistent with those reported by Doria et al., who conducted a systematic review comparing ultrasonography and computed tomography in the diagnosis of acute appendicitis in children and adults. The authors demonstrated that ultrasonography serves as an excellent first-line imaging modality in pediatric patients because of its lack of ionizing radiation, while CT provides higher diagnostic accuracy in equivocal cases. [12]

The findings of the present study revealed that appendicitis was the most common surgical cause of abdominal emergency, diagnosed in 31 patients (39.7%), closely followed by intussusception in 30 patients (38.5%). This observation is in agreement with previous pediatric surgical studies reporting acute appendicitis as

the leading cause of emergency abdominal surgery in older children, while intussusception remains a major cause of acute abdomen in younger age groups. Solid organ injury due to blunt abdominal trauma was identified in 11 patients (14.1%), reflecting the importance of trauma as a significant contributor to pediatric abdominal emergencies. Ovarian torsion accounted for 6 patients (7.7%), emphasizing the need to consider gynecological causes in female children presenting with acute abdominal pain. The statistically significant distribution of final diagnoses ($p < 0.0001$) indicates a distinct pattern of disease occurrence within the study population. Surgical findings closely corresponded with the preoperative diagnoses, with an inflamed appendix and surrounding inflammatory changes observed in 31 patients (39.7%), classic intussusception with a telescoping bowel segment in 30 patients (38.5%), intra-abdominal fluid associated with solid organ laceration in 11 patients (14.1%), and an enlarged ovary with absent blood flow consistent with torsion in 6 patients (7.7%). The significant association of surgical findings ($p < 0.0001$) demonstrates the high diagnostic accuracy of radiological evaluation and underscores its essential role in guiding appropriate surgical management in pediatric abdominal emergencies. The findings of the present study are comparable to those reported by Stringer et al., who reviewed the spectrum of acute abdominal emergencies in children and found that acute appendicitis was the most common cause of surgical acute abdomen, particularly among school-aged children and adolescents. [13]

The outcome analysis of the present study demonstrated an excellent prognosis among children with surgical abdominal emergencies when timely diagnosis and appropriate surgical intervention were provided. A total of 76 patients (97.4%) recovered successfully, whereas complications occurred in only 2 patients (2.6%). The statistically significant distribution of outcomes ($p < 0.0001$) highlights the effectiveness of early radiological assessment and prompt surgical management in improving patient outcomes. The high recovery rate observed in this study is comparable to findings from previous pediatric surgical series, which have reported favorable outcomes when abdominal emergencies are recognized and treated without delay. The low complication rate further emphasizes the value of accurate preoperative imaging, appropriate surgical planning, and multidisciplinary care in minimizing morbidity. These findings support the crucial role of radiological evaluation in facilitating early diagnosis, guiding surgical decision-making, and ultimately contributing to successful recovery in children presenting with acute abdominal surgical conditions. The favorable outcomes observed in the present study are consistent with the findings reported by Bhatt et al., who evaluated children presenting with acute abdominal surgical emergencies and demonstrated that early diagnosis, timely radiological assessment, and prompt

surgical intervention were associated with excellent postoperative recovery and low complication rates.[14]

CONCLUSION

The current study emphasises the critical role of radiological imaging in the diagnosis and management of paediatric surgical abdominal emergencies. Ultrasound emerged as the primary imaging modality owing to its availability, safety, and high diagnostic accuracy. Radiography and computed tomography provided valuable complementary information in selected cases. Acute appendicitis was identified as the most common surgical emergency, followed by intestinal obstruction, intussusception, and solid organ injury due to blunt abdominal trauma. Early and accurate radiological assessment facilitated timely surgical intervention, resulting in a high recovery rate and a low incidence of complications. Radiological evaluation therefore remains indispensable in improving diagnostic precision, guiding management decisions, and enhancing clinical outcomes in paediatric abdominal emergencies.

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