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# Diagnostic Use of Ultrasonography for Acute Appendicitis: A Single Centre Experiences

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**Abstract** **Original Research Article**

***Background:*** Acute appendicitis is a common and urgent surgical condition characterized by inflammation of the appendix. Rapid and accurate diagnosis is critical to prevent complications such as perforation. Ultrasonography has emerged as a valuable diagnostic tool due to its non-invasive nature, accessibility, and effectiveness in visualizing appendiceal inflammation. ***Aim of the study:*** This study aims to evaluate the effectiveness of ultrasonography in the diagnosis of appendicitis. ***Methods:*** This prospective observational study was conducted at 250 Beded general hospital Tangail, Bangladesh from 1/1/23 to 31/12/23. Ninety-five patients aged 15 to 60 years with acute appendicitis and right lower quadrant pain were included after obtaining informed consent. The hospital's review committee granted ethical approval. Data collection involved comprehensive clinical, radiological, and surgical evaluations using a standardized protocol. High-resolution abdominal ultrasonography was performed with the graded compression technique by experienced radiologists. Diagnostic accuracy was assessed through sensitivity, specificity, PPV, and NPV calculations. Data were analyzed using SPSS version 26.0, with significance at $p<0.05$. ***Result:*** The study included 95 participants, with a mean age of 28.57 years. Most were aged 15-20 (46.32%), and 58.95% were male. Pain was universally reported, with anorexia (85.26%), fever and nausea (65.26%), and vomiting (52.63%) being common. Peri-umbilical pain shifting to the right iliac fossa (RIF) was noted in 49.47%. Pain lasted 18-24 hours in 35.79% of cases. Pulse rate was ≤100/min in 75.79% of patients, with 61.05% having body temperatures between 98.6-100°F. Localized tenderness was present in 70.53% of patients. High-resolution ultrasonograms diagnosed acute appendicitis in 60% of cases with a sensitivity of 85.5% and specificity of 83.3%. ***Conclusion:*** High-resolution ultrasonography (HRUS) is an effective diagnostic tool for acute appendicitis, offering high sensitivity and specificity. Its non-invasive, cost-effective nature and real-time imaging make it valuable, especially in atypical pediatric and elderly cases. HRUS reduces unnecessary surgeries and improves outcomes, with a significant prevalence of appendicitis among younger males.

**Keywords:** Diagnosis, Ultrasonography and Acute Appendicitis.



## INTRODUCTION

The appendix is a small, tubular structure originating from the large intestine, specifically the posteromedial aspect of the cecum. It is often called the vermiform appendix due to its worm-like appearance [1]. In adults, the appendix is a slender, tube-like structure resembling the shape of a pencil. It is roughly 1.7 to 2.5 centimetres below the terminal portion of the ileum, forming a part of the gastrointestinal tract [2]. While the anatomical position of the appendix can vary, its origin and the ileal orifice are typically aligned with McBurney's point, a key anatomical landmark crucial for diagnosing appendicitis [3]. The appendix plays a vital role in supporting the gut's microbial balance by acting as a reservoir for beneficial microbes. Additionally, it is closely linked to gut-associated lymphoid tissue, particularly during the early stages of development, contributing to immune function [4]. Typical symptoms of appendicitis include right lower abdominal pain, nausea, and vomiting, often accompanied by tenderness and guarding in the right iliac fossa [5]. Appendicitis is widely recognized as more common in younger populations, affecting males and females at rates of 13%

and 25%, respectively [6]. It often presents unique challenges, where it is rare and often diagnosed late due to atypical symptoms and misdiagnoses such as gastroenteritis [7]. Delays in diagnosis are linked to increased complication rates, including perforation, which may result in significant morbidity [8]. Perforation rates are particularly elevated in young children, with estimates ranging from 57% to 100% in those under five years of age [9]. Despite significant advancements in diagnostic techniques, the diagnosis of appendicitis remains uncertain in approximately 30–40% of cases [10]. Clinical judgment, supported by laboratory tests such as leukocyte count, ESR, and CRP, is pivotal in reducing unnecessary surgeries and complications like appendix rupture [11]. Elevated leukocyte counts and increased C-reactive protein (CRP) levels are frequently observed in patients with appendicitis, serving as valuable indicators to support and confirm the diagnosis [12, 13]. Ultrasonography has emerged as a critical diagnostic tool for appendicitis due to its non-invasive nature, cost-effectiveness, and lack of ionizing radiation. Modern advancements in high-frequency transducers and real-time imaging have significantly improved ultrasonography's resolution and diagnostic accuracy for appendicular disorders [14]. Features such as a non-compressible tubular structure with a diameter greater than 5 mm and a target-like appearance on transverse views are hallmark findings in appendicitis [15]. Furthermore, it is particularly beneficial in pediatric and elderly populations, where clinical presentations are often atypical, and delays in diagnosis can result in severe complications [6, 16]. The role of ultrasonography in appendicitis management is thus indispensable in reducing morbidity and mortality rates across all age groups. This study aims to evaluate the effectiveness of ultrasonography in diagnosing appendicitis.

## METHODOLOGY & MATERIALS

This prospective observational study was conducted 250 Beded general hospital Tangail, Bangladesh from 1/1/23 to 31/12/23. A total of 95 patients were selected who presented with pain in the right lower quadrant of the abdomen and were referred for an ultrasound examination. Informed written consent was obtained from each patient or their legal guardian before participating in the study. The hospital's ethical review committee granted ethical approval for the study.

**Inclusion Criteria:**

- Patients aged 15 to 60 years of both genders.
- Patients with acute appendicitis.
- Patients presenting with pain in the right lower quadrant of the abdomen.
- Patients who consented to participate in the study.

**Exclusion Criteria:**

- Patients with urological, gynaecological, or other surgical conditions unrelated to appendicitis.
- Patients with a mass in the right iliac fossa.
- Patients are unable to answer the eligibility questions.
- Patients who did not have other relevant investigations conducted.

**Data Collection and Analysis**

Comprehensive clinical, radiological, and surgical data were collected using a standardized protocol. Clinical evaluation involves a detailed medical history and physical examination to assess symptoms and signs indicative of acute appendicitis. Laboratory investigations included haemoglobin levels, total and differential leukocyte counts, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) levels, and urine routine/microscopic examination. X-rays of the kidney, ureter, and bladder (KUB) were obtained when indicated. Experienced radiologists performed High-resolution abdomen ultrasonography using the graded compression technique to visualize the appendix. Ultrasonographic features suggestive of appendicitis included non-compressibility, an appendiceal diameter greater than 6 mm, wall thickening or hyperemia, and the presence of peri appendiceal fluid or abscess. The data as the outcome was the diagnostic accuracy of ultrasonography assessed by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

Data were analyzed using SPSS version 26.0. Continuous variables were summarized as mean ± standard deviation (SD) or median (interquartile range). Categorical variables were expressed as frequencies and percentages. A p-value $<0.05$ was considered statistically significant.

## RESULT

A total of 95 participants were included in the study, with a mean age of 28.571±1.202 years. The majority of participants were aged 15-20 years (46.32%), followed by 32.63% in the 21-30 years group. Males represented 58.95% of the study population, while females accounted for 41.05% (Table 1). Figure 1 illustrates the distribution of clinical presentations among the patients. Pain was reported by all patients, with anorexia (85.26%), fever and nausea (65.26%), and vomiting (52.63%) being the most common symptoms. Constipation and diarrhea were less frequent, affecting 25.26% and 12.63%, respectively. Regarding pain location, 49.47% reported peri-umbilical pain shifting to the right iliac fossa (RIF), while 30.53% had pain directly in the RIF. Epigastric pain shifting to the RIF was observed in 12.63%, and 7.37% experienced pain

throughout the abdomen. Most participants (35.79%) had pain lasting 18-24 hours, with 27.37% reporting pain for 24-48 hours (Table 2). Table 3 indicated that 75.79% of patients had a pulse rate of ≤100/min, while 24.21% had a pulse rate exceeding 100/min. Body temperature was 98.6-100°F in 61.05% of patients, and 24.21% had temperatures above 100°F. In 70.53% of patients, localised tenderness was observed, with muscle guarding in 64.21%. Positive findings for pointing signs, rebound tenderness, and Rovsing's signs were noted in 82.11%, 75.79%, and 70.53% of cases, respectively. The psoas test was positive in 60% of patients, and 43.16% showed a positive obturator test. Figure 2 showed that the retrocaecal position was the most common, found in 68.42% of cases, followed by the pelvic position in 27.37%. The remaining positions, including paracaecal (1.05%), subcecal (2.11%), and postileal (1.05%), were much less frequent. High-resolution Ultra sonograms diagnosed acute appendicitis in 60% of patients, abscesses or collections in 25.26%, and unremarkable results in 14.74%. The diagnostic accuracy of the High-resolution Ultra sonogram was demonstrated by a true positive rate of 71, a false positive rate of 2, a false negative rate of 12, and a true negative rate of 10. HRUS showed a sensitivity of 85.5%, specificity of 83.3%, positive predictive value of 97.3%, and negative predictive value of 45.5% (Table 4).

**Table 1: Demographic characteristics of the study population (n=95)**

| Variables | Frequency (n) | Percentage (%) |
|---|---|---|
| **Age** | | |
| 15-20 | 44 | 46.32 |
| 21-30 | 31 | 32.63 |
| 32-40 | 11 | 11.58 |
| 41-50 | 6 | 6.32 |
| 51-60 | 3 | 3.16 |
| Mean±SD | 28.57±1.2 | |
| **Gender** | | |
| Male | 56 | 58.95 |
| Female | 39 | 41.05 |

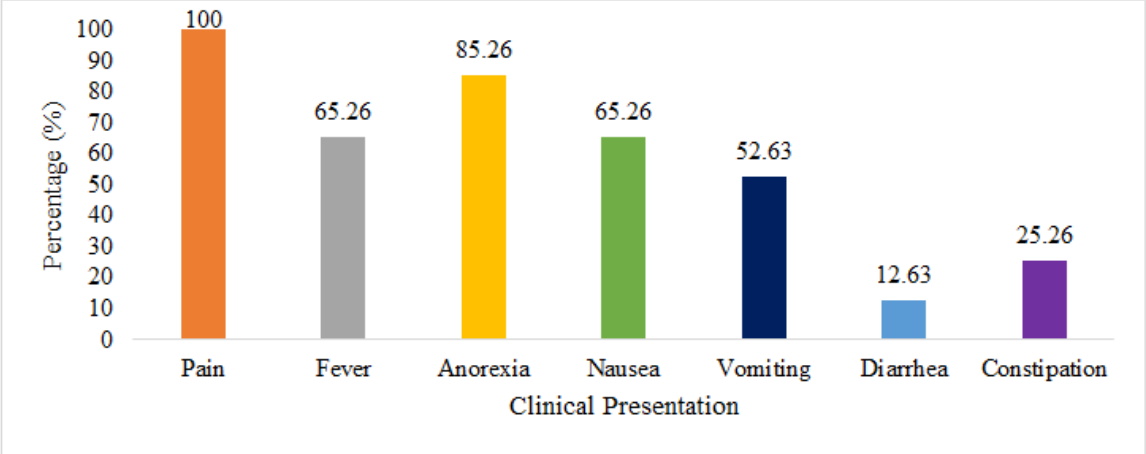


**Figure 1: Distribution of patients according to clinical presentation (n=95)**

**Table 2: Characteristics of the pain among study population (n=95)**

| The original site of pain | Frequency (n) | Percentage (%) |
|---|---|---|
| Peri-umbilical pain shifts of RIF | 47 | 49.47 |
| Right iliac fossa | 29 | 30.53 |
| Epigastric pain shifted to RIF | 12 | 12.63 |
| Whole abdomen | 7 | 7.37 |
| **Duration of the pain** | | |
| <6 hours | 5 | 5.26 |
| 6-12 hours | 9 | 9.47 |
| 12-18 hours | 10 | 10.53 |
| 18-24 hours | 34 | 35.79 |
| 24-48 hours | 26 | 27.37 |
| >48 hours | 11 | 11.58 |

**Table 3: Clinical findings of the study patients (n=95)**

| Variables | Frequency (n) | Percentage (%) |
|---|---|---|
| **Pulse** | | |
| ≤100/min | 72 | 75.79 |
| >100min | 23 | 24.21 |
| **Temperature** | | |
| <98.6°F | 14 | 14.74 |
| 98.6-100°F | 58 | 61.05 |
| >100°F | 23 | 24.21 |
| **Tenderness** | | |
| Localized | 67 | 70.53 |
| Diffuse | 28 | 29.47 |
| **Muscel guard** | | |
| Present | 61 | 64.21 |
| Absent | 34 | 35.79 |
| **Pointing sign** | | |
| Present | 78 | 82.11 |
| Absent | 17 | 17.89 |
| **Rebound tenderness** | | |
| Positive | 72 | 75.79 |
| Negative | 23 | 24.21 |
| **Rovsing's sign** | | |
| Positive | 67 | 70.53 |
| Negative | 28 | 29.47 |
| **Psoas test** | | |
| Positive | 57 | 60.00 |
| Negative | 38 | 40.00 |
| **Obturator** | | |
| Positive | 41 | 43.16 |
| Negative | 54 | 56.84 |

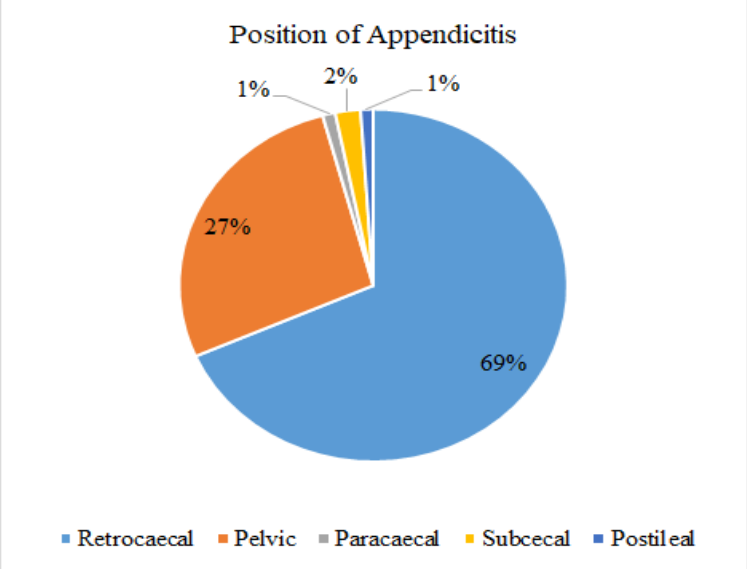


**Figure 2: Distribution of the patient based on the position of the appendix (n=95)**

**Table 4: Outcome of the study among patients (n=95)**

| High-resolution Ultra sonogram diagnosis | Frequency (n) | Percentage (%) |
|---|---|---|
| Acute Appendicitis | 57 | 60.00 |
| Abscess/collection | 24 | 25.26 |

| High-resolution Ultra sonogram diagnosis | Frequency (n) | Percentage (%) |
|---|---|---|
| Unremarkable | 14 | 14.74 |
| Overall Quality | Positive | Negative |
| Positive | 71 (TP) | 2 (FP) |
| Negative | 12 (FN) | 10 (TN) |
| Sensitivity | 85.50% | |
| Specificity | 83.30% | |
| Positive Predictive Value | 97.30% | |
| Negative Predictive Value | 45.50% | |

## DISCUSSION

Acute appendicitis is a prevalent surgical emergency worldwide, making accurate diagnosis essential for effective management. High-resolution ultrasonography has proven to be a valuable diagnostic tool due to its non-invasive nature, cost-effectiveness, and ability to provide real-time imaging [14]. In this study, the mean age of participants was 28.57 years, with the highest prevalence of acute appendicitis observed among individuals aged 15–20 years (46.32%). This aligns with previous research and suggests that younger populations are more susceptible, possibly due to higher rates of lymphoid hyperplasia in this age group [17]. Additionally, the male-to-female ratio of 1.43:1 reflects earlier findings, indicating a higher incidence in males likely driven by anatomical and hormonal factors [18]. The most common clinical presentations included anorexia (85.26%), nausea (65.26%), and fever (65.26%), consistent with hallmark symptoms described in earlier studies [18]. Pain initially localized to the peri-umbilical region and later migrating to the right iliac fossa was noted in 49.47% of cases, mirroring the classic migratory pain pattern described in the literature [19]. Localized and rebound tenderness were observed in 70.53% and 75.79% of patients, respectively, highlighting their diagnostic relevance. Supporting studies by Craig *et al*., and Kazarian *et al*., also identified abdominal pain in the right lower quadrant as a predominant symptom [21]. Regarding pain characteristics, peri-umbilical pain shifting to the right iliac fossa (49.47%) was the most common pattern, reflecting the classical migratory pain pattern in appendicitis. The progression of pain over 18-24 hours in 35.79% of patients further supports the temporal evolution of inflammation, as reported in earlier studies [22]. Our findings on clinical signs, including localized tenderness (70.53%), rebound tenderness (75.79%), and positive Rovsing's sign (70.53%), further validate the diagnostic criteria for appendicitis. Additionally, the retrocaecal position of the appendix, observed in 68.42% of cases, highlights anatomical variations that may influence symptom presentation and diagnostic accuracy. A related study by Khan *et al*., reported additional clinical observations, including a pulse rate ≤90/min in 85% of patients and >90/min in 15%, temperatures around 100°F in 90%, rebound tenderness in 76%, and a positive Rovsing's sign in 78% of cases [23]. Regarding diagnostic outcomes, high-resolution ultrasonography demonstrated excellent sensitivity (85.50%) and specificity (83.30%), with a positive predictive value of 97.30%. These metrics underscore its reliability as a primary imaging modality for appendicitis, consistent with findings by Alelyani *et al*., (2021), who reported comparable diagnostic performance [24]. These results align with the findings of Rud *et al*., (2019) *et al*., who reported a sensitivity of 69% % and a specificity of 81% for ultrasound in their study [25].

**Limitations of the study:**

The study on the diagnostic use of ultrasonography for acute appendicitis has several limitations. Ultrasonography's accuracy can be operator-dependent, and variations in skill and experience among radiologists might influence the diagnostic outcomes. The study did not compare ultrasonography with other imaging modalities like CT or MRI, which may offer higher diagnostic accuracy in some cases.

## CONCLUSION

High-resolution ultrasonography (HRUS) proves to be an effective diagnostic tool for acute appendicitis, offering high sensitivity (85.5%) and specificity (83.3%). Its non-invasive, cost-effective nature and real-time imaging capabilities make it particularly valuable, especially in atypical cases involving pediatric and elderly populations. This study highlights the prevalence of acute appendicitis among younger individuals, with a significant male predominance. Clinical presentations, such as migratory pain to the right iliac fossa and localized tenderness, align with established diagnostic criteria. HRUS, with a positive predictive value of 97.3%, reinforces its role in reducing unnecessary surgeries and improving patient outcomes.

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**Conflict of interest:** None declared

**Ethical approval:** The study was approved by the Institutional Ethics Committee.

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