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**Original Research Article**

# ACCURACY OF ULTRASOUND VS. COMPUTED TOMOGRAPHY IN DIAGNOSING ACUTE ABDOMINAL CONDITIONS

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## Abstract

**Background**: Acute abdomen is a frequent occurrence in emergency department settings and often necessitates prompt diagnosis and urgent surgical intervention. Owing to the overlapping symptoms of many serious and benign intra-abdominal conditions, identifying life-threatening situations early in their progression can be challenging. The current study aimed to assess the diagnostic effectiveness of abdominal ultrasound in identifying common conditions presenting as an acute abdomen.

**Methods**: This prospective comparative study included patients presenting with an acute abdomen at the Emergency Department of CDSIMER. Clinical diagnoses were established, followed by abdominal ultrasound. Ultrasound findings were compared with intraoperative observations and histopathological results, or in cases in which surgery was not performed, based on CT scan findings. Various diagnostic performance parameters, including sensitivity, specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), and accuracy, were used for the statistical analysis.

**Results**: A total of 77 patients with acute abdominal pain were included in the study. Appendicitis was the most common diagnosis (33.77%), followed by cholecystitis (20.77%), pancreatitis (16.88%), intestinal obstruction (12.98%), and enteric perforation (15.58%). USG may have moderate accuracy for some conditions, such as appendicitis, acute intestinal obstruction, and acute cholecystitis, where it has shown acceptable sensitivity. CT scans are likely to have higher overall accuracy; across different conditions, CT scans are generally expected to be more accurate than USG for diagnosing acute abdominal conditions because of their ability to provide more detailed anatomical images.

**Conclusion**: Ultrasound is a highly effective imaging modality for accurate diagnosis of acute appendicitis, acute intestinal obstruction, and acute cholecystitis. Even in hospitals lacking highly advanced imaging facilities, clinical assessment combined with ultrasound results can provide reliable diagnostic accuracy.

**Keywords**: Acute Abdomen, Acute Appendicitis, Acute Intestinal Obstruction, Acute Intestinal Perforation, Acute Cholecystitis.

## Introduction

An acute abdomen manifests as abrupt and intense pain in the abdominal region. Often, it stems from a range of medical, surgical, and gynecological issues that necessitate urgent hospitalization, diagnostic procedures, treatment, and timely surgical measures [1]. Decisive action guided by thorough clinical assessment and comprehensive management strategies is imperative because of the potentially life-threatening nature of many conditions, where early surgical intervention significantly enhances prognosis. Conversely, certain cases may initially warrant conservative therapy, with the intervention being deferred until deemed necessary. Meticulous examination of patient history, comprehensive clinical evaluation, and judicious selection of diagnostic tests are pivotal for accurate diagnosis and effective management [2]. Sharp abdominal pain is the most frequent complaint upon presentation, constituting 5% of all visits to the emergency department [3]. Acute appendicitis is notably prevalent, with nearly 7% of individuals undergoing appendectomy at some point in their lives because of this diagnosis [4]. Several acute abdominal conditions can cause grave complications, including mortality. Therefore, achieving an early, precise diagnosis and timely treatment are crucial in such instances [5]. Abdominal pain may stem from various sources, including visceral pathologies, somatoparietal causes, or conditions that induce referred pain from systemic or local origins. Nevertheless, an acute abdomen can encompass a broad spectrum of conditions ranging from seemingly benign and self-resolving ailments to those necessitating immediate surgical intervention. The most frequent culprits are acute cholecystitis, appendicitis, bowel obstruction, enteric perforation, and pancreatitis [6]. Abdominal ultrasonography is the primary investigative tool requested by surgeons for patients with acute abdominal symptoms. Ultrasonography offers numerous advantages compared to alternative imaging techniques; it is easily accessible, cost-effective, portable, swift, non-invasive, requires minimal patient preparation, and is devoid of known side effects. Its sole drawback lies in its dependency on operator skills [7]. If ultrasonographic findings are inconclusive, Computed Tomography (CT) is the most valuable supplementary imaging modality [8]. This study aimed to assess and compare the diagnostic effectiveness of ultrasonography (US) and computed tomography (CT) in identifying acute abdominal conditions.

## Material and Methods

The current study was initiated at the Department of Radiology, Department of Radio-diagnosis Dr. Chandramma Dayananda Sagar Institute of Medical Education and Research, Devarakaggalahalli to evaluate and contrast the diagnostic efficacy of ultrasound (US) and computed tomography (CT) in diagnosing acute abdominal conditions. Ethical clearance was obtained from the institutional review board, and informed consent was obtained from all participants after a comprehensive explanation of the research protocol in the vernacular language.

Inclusion Criteria: Our study included patients clinically diagnosed with acute appendicitis, acute intestinal obstruction, acute enteric perforation, acute pancreatitis, and acute cholecystitis. We enrolled both male and female individuals aged between 12 and 65 years.

Exclusion Criteria: Patients with traumatic injuries, female patients with obstetric or gynecological conditions, and individuals suffering from chronic abdominal conditions were excluded from the study.

Ultrasound examinations were conducted using Mindray resona I9 or GE Logiq α-200 machines equipped with 3.5 MHz sector or curvilinear probes. Computed tomography scans were performed utilizing GE 16 Slice Emotion third-generation spiral CT equipment. Non-ionic contrast agents (Iohexol) were administered during CT scans, with continuous monitoring of vital signs and hemodynamic parameters during the contrast injection procedure.

Seventy-seven cases presenting with symptoms indicative of acute abdomen were included in the study after excluding those with traumatic acute abdominal conditions. Abdominal ultrasound scans were performed for all enrolled patients, and clinical and demographic data were collected. CT scans were

performed using high-resolution GE Emotion scanners with patients positioned supine, arms raised above the head, and sections obtained at 6 mm to 8 mm intervals. Images were captured, and multiplanar reconstructions were generated as necessary. A pre-designed form was used to compile radiological findings, and statistical analysis was conducted using SPSS version 19.0 for Windows. The significance of the data was assessed using the chi-square test and Student's t-test, with a p-value of 0.05, which was considered statistically significant.

## Results

Table 1 shows the types of acute abdomen cases encountered in this study. Acute appendicitis is the most frequent diagnosis (26 cases, 33.77%). This is followed by acute cholecystitis (16 cases, 20.77%) and acute pancreatitis (13 cases, 16.88%). Less frequent diagnoses include acute enteric perforation (12 cases, 15.58%) and acute intestinal obstruction (10 cases, 12.98%). Gender Distribution: There seems to be a relatively even distribution of cases between males and females for most diagnoses. Age: The mean age ranges from 21.66 years (appendicitis) to 34.82 years (pancreatitis) with varying standard deviations. The specific reasons behind the prevalence of certain diagnoses were related to the referral patterns of the tertiary care hospital where the study was conducted.

Table 1: Showing the distribution of cases of acute abdomen included in the study

| Clinical diagnosis | Male | Female | Total (%) | Mean age ± SD |
|---|---|---|---|---|
| Acute appendicitis | 16 | 10 | 26 (33.77) | 21.66 ± 7.64 |
| Acute enteric perforation | 8 | 4 | 12 (15.58) | 30.15 ± 16.33 |
| Acute intestinal obstruction | 6 | 4 | 10 (12.98) | 32.20 ± 5.24 |
| Acute cholecystitis | 11 | 5 | 16 (20.77) | 33.61 ± 11.27 |
| Acute Pancreatitis | 8 | 5 | 13 (16.88) | 34.82 ± 13.64 |

Table 2 reveals the Sensitivity was 88.24% Specificity was 55.56%, Positive Predictive Value (PPV) = 78.95%, and Negative Predictive Value (NPV) was 71.43%. Sensitivity: USG has a good sensitivity (88.24%), it correctly identifies most cases of appendicitis. Specificity: The specificity (55.56%) is moderate, indicating a chance of false positives (USG suggests appendicitis when it's not present). PPV: The PPV (78.95%) suggests that a positive USG result has a good chance of being a true case of appendicitis. NPV: The NPV (71.43%) is somewhat positive, but not very high, meaning there's still a chance of appendicitis being missed with a negative USG result. USG shows good sensitivity for detecting appendicitis, but the moderate specificity suggests a possibility of false positives. This might lead to unnecessary investigations or procedures. The positive predictive value is encouraging, but the negative predictive value is not very high, highlighting the need for additional tests in some cases with negative USG results, particularly when clinical suspicion is high.

Table 2 Diagnostic accuracy of USG versus Intraoperative/CT Scan abdomen findings for acute appendicitis in n=26 cases

| USG | Acute appendicitis as confirmed by intraoperative finding (or by CT scan if the patient was not operated on) | Acute appendicitis not found intraoperatively (or on CT scan if the patient was not operated on) | Total |
|---|---|---|---|
| USG Acute appendicitis Present | 15 | 4 | 19 |
| USG appendicitis was not present but confirmed by CT scan | 2 | 5 | 7 |

Table 3 shows that the Sensitivity = 80%, specificity: Specificity cannot be calculated due to no

confirmed negative cases (TN=0). Positive Predictive Value (PPV) = 80, Negative Predictive Value (NPV): Negative Predictive Value cannot be calculated due to no confirmed negative cases (TN=0). Sensitivity: USG has a moderate sensitivity (80%), meaning it identifies some cases of perforation but misses others. Specificity and NPV: These cannot be reliably calculated due to the lack of confirmation. While USG might identify some cases of acute enteric perforation, the sensitivity is not very high. Therefore, using additional diagnostic tools like CT scans, especially when USG results are inconclusive.

Table 3: Diagnostic accuracy of USG versus intraoperative and CT findings for acute enteric perforation

| USG | Acute enteric perforation as confirmed by intraoperative finding or by CT scan | Acute enteric perforation not found intraoperatively or CT scan | Total |
|---|---|---|---|
| USG Acute Enteric Perforation Present | 8 | 2 | 10 |
| USG enteric perforation not present but confirmed by CT scan | 2 | 0 | 2 |

Based on Table 4, we can calculate the following USG performance measures for diagnosing acute intestinal obstruction. Sensitivity = 75%, Specificity = 50% PPV = 85.71% and NPV = 33.33%. USG shows some ability to detect acute intestinal obstruction, but the low specificity and NPV are concerning. This suggests that USG might be helpful in some cases, but it has a high risk of false positives and a high chance of missing obstructions. Relying solely on USG for diagnosis may be risky. Confirmation with other diagnostic techniques like CT scans, especially when USG results are inconclusive or clinical suspicion is high, is likely necessary.

Table 4: Diagnostic accuracy of USG versus intraoperative and CT findings for acute intestinal obstruction

| USG | Acute intestinal obstruction as confirmed by intraoperative finding or by CT scan | Acute intestinal obstruction not found intraoperatively or CT scan | Total |
|---|---|---|---|
| USG Acute intestinal obstruction Present | 6 | 1 | 7 |
| USG intestinal obstruction was not present but confirmed by CT scan | 2 | 1 | 3 |

Table 5 reveals the Sensitivity: USG has a high sensitivity (90.91%), Specificity: The specificity (60%) is lower. PPV: The PPV (83.33%) suggests that a positive USG result has a good chance of being a true case of cholecystitis. NPV: The NPV (75%) indicates that a negative USG result is not definitive, as there's still a chance of cholecystitis being missed. While USG shows good sensitivity for detecting cholecystitis, the lower specificity suggests a possibility of false positives. This might lead to unnecessary investigations or procedures. The positive predictive value is encouraging, but the negative predictive value is not very high, highlighting the need for additional tests in some cases with negative USG results, particularly when clinical suspicion is high.

Table 5: Diagnostic accuracy of USG versus intraoperative and CT findings for acute cholecystitis in n=13 cases

| USG | Acute cholecystitis as confirmed by intraoperative finding or by CT scan | Acute Cholecystitis not found intraoperatively or CT scan | Total |
|---|---|---|---|
| USG Acute cholecystitis is Present | 6 | 2 | 8 |

Table 6 shows that the USG has a sensitivity of 50%, specificity of 50%, positive predictive value (PPV) of 50%, and negative predictive value (NPV) of 50%. Sensitivity is low in this case, meaning that half of the patients with acute cholecystitis had a negative USG test. This could be due to several factors, such as the severity of the inflammation, or the presence of other conditions. Specificity is also low, meaning that half of the patients with a positive USG test did not have acute cholecystitis. This could be due to a number of factors, such as gallstones or other conditions that can mimic the symptoms of acute cholecystitis. Positive predictive value (PPV) is 50%, and Negative predictive value (NPV) is 50%. Overall, the accuracy of USG for diagnosing acute cholecystitis is not very good in this study. This means that USG should not be used as the sole diagnostic test for acute cholecystitis. Other tests, such as a CT scan, may be needed to confirm the diagnosis.

Table 6: Diagnostic accuracy of USG versus intraoperative and CT findings for acute cholecystitis in n=16 cases

| USG | Acute Pancreatitis as confirmed by intraoperative finding or by CT scan | Acute Pancreatitis not found intraoperatively or CT scan | Total |
|---|---|---|---|
| USG Acute Pancreatitis is Present | 10 | 2 | 12 |
| USG Acute Pancreatitis not present but confirmed by CT scan | 1 | 3 | 4 |

## Discussion

Abdominal pain remains a significant presenting complaint among patients seeking admission to the emergency ward, accounting for 5-10% of all admissions [5]. Many of these cases involve potentially life-threatening conditions, highlighting the importance of early diagnosis and management to improve patient outcomes and prognosis. Our study focused on assessing the effectiveness of ultrasound in diagnosing common acute abdominal conditions encountered in emergency departments. We clinically evaluated all patients presenting with an acute abdomen for treatment upon arrival at the emergency ward. Subsequently, ultrasound examinations were conducted for all patients, supplemented

by routine biochemical investigations and additional imaging modalities, as deemed necessary. Previous studies have demonstrated comparable findings, acknowledging the influence of operator skill and patient-related factors, such as obesity and increased bowel gas [9- 11]. Prasad H et al. [12] employed graded compression sonography as a widely available and highly accurate technique for confirming or excluding acute appendicitis, reporting detection rates of 60-83% of the vermiform appendix and sensitivities and specificities exceeding 90% in suspected cases [13]. Our study demonstrated a positive predictive value (PPV) of 78.95%, which is consistent with the literature [10,11]. Confirmed cases underwent emergency surgical intervention with intraoperative findings compared to preoperative assessments. In cases where ultrasound yielded inconclusive results despite clinical suspicion, computed tomography (CT) scans were performed for further evaluation, and the results were compared with those of ultrasound [14]. Additionally, in cases of acute cholecystitis and acute pancreatitis, where emergency surgery was not initially planned, ultrasound findings were compared with those of CT scans for comprehensive assessment.

In a study conducted by Ashaolu et al. [5] the sensitivity and specificity of ultrasound in diagnosing acute appendicitis were reported as 83.3% and 100%, respectively. Similarly, Pintado-Garrido R et al. [15] found the sensitivity and specificity of ultrasound for acute appendicitis diagnosis to be 83.7% and 97.4%, respectively. These findings align closely with the results of our current study with a sensitivity of 80.24% and specificity of 55.56%. Ashaolu BA et al. also observed a sensitivity of 100% and specificity of 97.5% for ultrasound in diagnosing acute intestinal obstruction [5]. In a comparative study by Bree et al., [16] ultrasound sensitivity and specificity for acute cholecystitis were reported as 93% and 53%, respectively, in this study we found a sensitivity of 90.91% and Specificity of 60%. Acute appendicitis stands out as a predominant cause of acute abdomen requiring surgical intervention. Despite its prevalence, diagnosing acute appendicitis remains challenging due to its clinical resemblance to various other conditions [16]. Skilled practitioners can recognize characteristic sonographic features of acute appendicitis, such as a non-compressible tubular structure with a target sign, diameter exceeding 6 mm at the base, presence of intra-peritoneal fluid, thickened omentum, distorted irregular mucosa, and the presence of a fecolith [17].

In our study, 26 patients received a clinical diagnosis of acute appendicitis. Among them, 15 patients were confirmed to have acute appendicitis based on ultrasound findings. The remaining 16 patients underwent CT scans, with 2 ultimately diagnosed with acute appendicitis. Patients with normal CT findings were managed conservatively and discharged with follow-up instructions. In various research papers, the accuracy of the graded compression technique in ultrasonography for diagnosing acute appendicitis varies considerably, with sensitivity ranging from 44% to 100% and specificity ranging from 47% to 99%. These variations can be attributed to multiple factors. Ultrasound demonstrates superior sensitivity in detecting free intra-peritoneal air compared to abdominal X-rays (86% vs. 76%). Sonographic signs of intra-peritoneal air include the enhanced peritoneal stripe sign, peritoneal stripe reverberations, and focal air collections visualized as ring-down artifacts. The mobility of free intra- peritoneal air with changes in patient position, known as the shifting phenomenon, can also aid in diagnosis. However, ultrasound is unable to localize the site and cause of perforation.

Ultrasound is a sensitive tool for diagnosing bowel obstruction, with a reported accuracy of approximately 75%. Fluid-filled loops are readily visualized, allowing differentiation between mechanical obstruction and paralytic ileus by observing peristaltic movements. Ultrasound features of acute cholecystitis include gallbladder wall thickness exceeding 3 mm, peri- cholecystic fluid, sonographic Murphy sign, distended gallbladder, and incarcerated gallstones in the gallbladder infundibulum. Computed tomography signs of acute cholecystitis are similar, with gallbladder wall thickness exceeding 3 mm, peri-cholecystic fluid, distended gallbladder, and peri-cholecystic fat stranding. The reported sensitivity of ultrasound for acute cholecystitis varies widely, ranging from 27% to 95%, but typically falls within the 70%-85% range in published literature.

## Conclusion

Our study revealed ultrasound as a highly effective imaging modality for accurately diagnosing acute appendicitis, acute intestinal obstruction, and acute cholecystitis, exhibiting high sensitivity. Even in hospitals lacking highly advanced imaging facilities, clinical assessment combined with ultrasound results can provide reliable diagnostic accuracy.

## References

1. Patterson JW, Kashyap S, Dominique E. Acute Abdomen. [Updated 2023 Jul 10]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan. Available from: https://www.ncbi.nlm.nih.gov/books/NBK459328/ [Accessed on Feb 21 2024]
2. Mistry J, Heneghan NR, Noblet T, Falla D, Rushton A. Diagnostic utility of patient history, clinical examination and screening tool data to identify neuropathic pain in low back-related leg pain: protocol for a systematic review. BMJ Open. 2019 Nov 24;9(11):e033187.
3. Kamin RA, Nowicki TA, Courtney DS, Powers RD. Pearls and pitfalls in the emergency department evaluation of abdominal pain. Emerg Med Clin North Am. 2003; 21:61-72.
4. Flum DR, Morris A, Koepsell T, Dellinger EP. Has misdiagnosis of appendicitis decreased over time? A population-based analysis. JAMA. 2001;286(14):1748-53.
5. Ashaolu BA, Asaleye MC, Adetiloye AV, Alatise IO. The spectrum of diseases and diagnostic values of ultrasound in adult patients with nontraumatic acute abdomen in a Nigerian tertiary health facility. Niger J Surg. 2015; 21:06-12.
6. Cartwright SL, Knudson MP. Evaluation of acute abdominal pain in adults. Am Fam Physician. 2008;77(7):971-78.
7. Kristensen MS, Teoh WH, Graumann O, Laursen CB. Ultrasonography for clinical decision-making and intervention in airway management: from the mouth to the lungs and pleurae. Insights Imaging. 2014 Apr;5(2):253-79.
8. Smajerova M, Petrasova H, Little J, Ovesna P, Andrasina T, Valek V, Nemcova E, Miklosova B. Contrast-enhanced ultrasonography in the evaluation of incidental focal liver lesions: A cost-effectiveness analysis. World J Gastroenterol. 2016 Oct 14;22(38):8605-14.
9. Yilmaz M, Akbulut S, Kutluturk K, Sahin N, Arabaci E, Ara C, et al. Unusual histopathological findings in appendectomy specimens from patients with suspected acute appendicitis. World J Gastroenterol. 2013;19(25):4015-22.
10. Pinto F, Pinto A, Russo A, Coppolino F, Bracale R, Fonio P, et al. Accuracy of ultrasonography in the diagnosis of acute appendicitis in adult patients: Review of the literature. Crit Ultrasound J. 2013;5; S2.
11. Javidi Parsijani P, Pourhabibi Zarandi N, Paydar S, Abbasi HR, Bolandparvaz S. Accuracy of ultrasonography in diagnosing acute appendicitis. Bull Emerg Trauma. 2013;1(4):158-63.
12. Prasad H, Rodrigues G, Shenoy R. Role of ultrasonography in a nontraumatic acute abdomen. Int J Radiol. 2007; 5:02-07.
13. Lee JH, Jeong YK, Hwang JC, Ham SY, Yang SO. Graded compression sonography with adjuvant use of a posterior manual compression technique in the sonographic diagnosis of acute appendicitis. AJR. 2002; 178:863-68.
14. Caglayan K, Günerhan Y, Koç A, Uzun MA, Altınlı E, Köksal N. The role of computerized tomography in the diagnosis of acute appendicitis in patients with negative ultrasonography findings and a low Alvarado score. Ulus Travma Acil Cerrahi Derg. 2010;16(5):445-48.
15. Pintado-Garrido R, Moyadelacalle M, Sanchez-Ramon S, Castro Villamor MA, Plaza Lomos S, Mendo Gonzalez M. Indication and usefulness of ultrasonography for suspected acute appendicitis at the emergency department. Emergencias 2008; 20:81-86.
16. Bree RL. Further observations on the usefulness of the sonographic Murphy sign in the evaluation of suspected acute cholecystitis. J Clin Ultrasound. 1995; 23:169-72.
17. Elghany EA, Ali GG. Multi-detector row helical CT and US in diagnosing appendicitis. The

Egyptian Journal of Radiology and Nuclear Medicine. 2011;42(2):139-45.