

# DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY IN ACUTE ABDOMEN TAKING OPERATIVE FINDINGS AS GOLD STANDARD

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## ABSTRACT

**INTRODUCTION:** Ultrasonography (USG) of abdomen is common investigations asked by the surgeon in acute abdominal conditions. USG supercedes other radiological imaging modalities as it is easily available, cost effective, portable, no known side effects, noninvasive and requires minimal patient preparation. Aim of this study was to determine the diagnostic accuracy of ultrasonography in acute abdomen considering diagnoses of acute appendicitis, Pneumoperitoneum secondary to gut perforation and acute cholecystitis, taking operative findings as gold standard. It is a Cross-sectional validation study conducted at the Armed Forces Institute of Radiology and Imaging, (AFIRI) Rawalpindi, Pakistan from 17<sup>th</sup> May 2022 to 16<sup>th</sup> November 2022. **MATERIALS & METHODS:** A total of 342 patients with acute abdomen of duration of symptoms  $\leq$  48 hours were included. Patients with pregnancy, Patients with gynecological causes of acute abdomen, renal tract colic presenting as acute abdomen, acute pancreatitis, gastric or duodenal ulcers and known neoplasm were excluded. After this, ultrasound was performed using ultrasound machine with live 2-D mode (rapid B-mode) and transducer frequencies between 3 - 11 MHz and findings were noted. After this patient that are operated or underwent laparotomy on the basis of USG findings were selected and their findings were compared with USG findings. **RESULTS:** In my study, overall sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of ultrasonography in acute abdomen considering diagnoses of acute appendicitis, Pneumoperitoneum secondary to gut perforation and acute cholecystitis, taking operative findings as gold standard was 91.67%, 84.78%, 89.90%, 87.31% and 88.89% respectively. **CONCLUSION:** This study concluded that diagnostic accuracy of ultrasonography in acute abdomen is quite high.

**Keywords:** Acute abdomen, Ultrasonography, Ultrasonography.

## Introduction

Approximately 10% of the patients have complaints of acute abdominal pain among all the patients presenting to the emergency department.<sup>1</sup> Acute abdominal pain can occur in many conditions. Formerly the

patients who were presented with acute abdomen, surgery was indicated. But nowadays, not all of the patients with acute abdominal pain undergo surgery.<sup>2</sup> Diagnostic imaging is currently used in the work-up

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of patients with acute abdominal pain. Ultrasound and computed tomography (CT) are frequently used on top of clinical and laboratory evaluation.<sup>3,4</sup>

Abdominal ultrasound is one of the most frequent investigations asked by the surgeon in acute abdominal conditions. USG supercedes other radiological imaging modalities as it is easily available, cost effective, portable, no known side effects, noninvasive and requires minimal patient preparation.<sup>5</sup> Ultrasonography is a valuable imaging tool in patients who present with specific gastrointestinal diseases, such as acute appendicitis or diverticulitis.<sup>2</sup> The abdominal ultrasound evaluation should include visible gas and fluid, the peri enteric soft tissues and the GI tract itself. Extraluminal free gas may be intraperitoneal or retroperitoneal, and when present, it should suggest either hollow viscus perforation or infection with gas-forming organisms.<sup>6,7</sup>

A study conducted by Gathwal CK et al showed that the overall sensitivity of ultrasound in detection of acute abdomen was 90.71%, positive predictive value 100%, false positive rate 0%, false negative rate 9.28% and diagnostic accuracy 90.71%.<sup>8</sup> It shows that ultrasound findings can be straightforward and can become crucial for increasing the diagnostic yield of bedside scan in cases of the acute abdomen. Also practitioners should familiarize themselves with the findings and techniques required to make the diagnosis with confidence. If its diagnostic accuracy will be found high, then an easily available, economical and non-invasive imaging modality can be provided to these particular patients for early diagnosis and thus taking proper management protocol.

## Objective

To determine the diagnostic accuracy of ultrasonography in acute abdomen considering diagnoses of acute appendicitis, Pneumoperitoneum secondary to gut perforation and acute cholecystitis, taking operative findings as gold standard.

## Methodology

The study was conducted at Armed Forces Institute of Radiology and Imaging (AFIRI), Rawalpindi from

17<sup>th</sup> May 2022 to 16<sup>th</sup> November 2022. After approval from institutional ethical review committee (IERB approval certificate No. 0026). Sample size was calculated by using open epi calculator and having 95 % confidence level. 342 patients with mean age of 41 + 6.75 years (age ranging from 15 - 65 years) presenting to AFIRI, Rawalpindi, fulfilling the inclusion criteria were selected by non-probability, consecutive sampling. Informed consent was taken from each patient. Prevalence of acute appendicitis is 22.86% with 10 % desired precision for sensitivity and specificity of ultrasound in diagnosing acute appendicitis is 71.80 % and 59.10 % respectively.

After this, ultrasound was performed using ultrasound machine with live 2-D mode (rapid B-mode) and transducer frequencies between 3-11 MHz and findings were noted. After this patient that are operated or underwent laparotomy on the basis of USG findings were selected and their findings were compared with USG findings. All this data (age, gender, duration of symptoms, positive findings on USG and operation) was recorded on a specially designed proforma. Data was collected analyzed through SPSS 25.0. Duration of symptoms and age were presented as mean and standard deviation. Frequency and percentages were calculated to describe results.

### Inclusion Criteria:

All patients with acute abdomen (as per-operational definition) of duration of symptoms  $\leq$  48 hours.

Age 15-65 years.

Both genders.

### Exclusion Criteria:

Patients with penetrating abdominal injuries.

Female patients with gynecological causes of acute abdomen.

Patients with renal tract colic presenting as acute abdomen.

Patients with acute pancreatitis, gastric or duodenal ulcers.

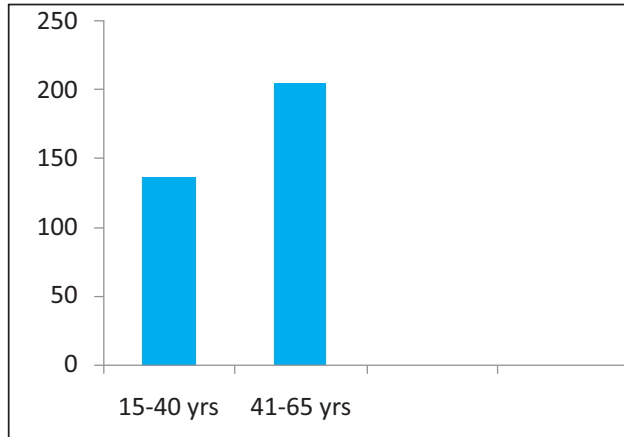
Patients with known neoplasm.

Patients who are not willing for admission.

## Results

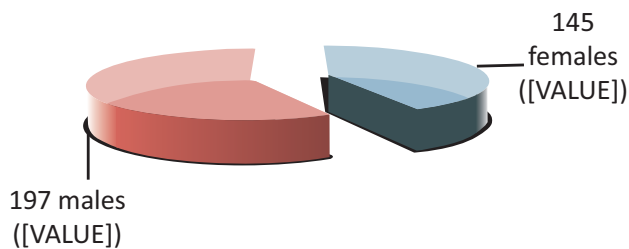
342 patients with age range in this study was from 15-65 years with mean age of 41.23 – 6.75 years.

Majority of the patients 205 (59.94%) were 41-65 years of age as shown in (Fig.1). Out of these 342 patients, 145 (42.40%) were female and 197 (57.60%) were males with ratio of 1:1.4 (Fig.2).



Mean – SD = 41.23 – 6.75 years

**Figure 1:** Distribution of patients according to Age.



**Figure 2:** Distribution of patients according to Gender (n=342).

In USG positive patients, 187 were true positive and 21 were false positive. Among 134 USG negative patients, 17 were false negative whereas 117 were true negative as shown in (Tab.1). Overall sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of ultrasonography in acute abdomen considering diagnoses of acute appendicitis, Pneumoperitoneum secondary to gut

	Positive result on operation	Negative result on operation	P-value
Positive on USG	187 (TP)	21 (FP)	0.0001
Negative on USG	17 (FN)	117 (TN)	

Sensitivity: 91.67% Specificity: 84.78% Positive Predictive Value (PPV): 89.90% Negative Predictive Value (NPV): 87.31% Diagnostic Accuracy: 88.89%

**Table 1:** Diagnostic accuracy of ultrasonography in acute abdomen, taking operative findings as gold standard.

perforation and acute cholecystitis, taking operative findings as gold standard was 91.67%, 84.78%, 89.90%, 87.31% and 88.89% respectively.

Stratification of diagnostic accuracy with respect to cause of acute abdomen is shown in (Tab.2,3&4) respectively.

	Positive result on operation	Negative result on operation	P-value
Positive on USG	112 (TP)	14 (FP)	0.001
Negative on USG	13 (FN)	66 (TN)	

Sensitivity: 89.60%, specificity: 82.50%, positive predictive value (PPV): 88.89%, negative predictive value (NPV): 83.54%, diagnostic accuracy: 86.83%

**Table 2:** Stratification of USG diagnostic accuracy with respect to acute appendicitis (n=205).

	Positive result on operation	Negative result on operation	P-value
Positive on USG	34 (TP)	04 (FP)	0.001
Negative on USG	02 (FN)	27 (TN)	

Sensitivity: 94.44%, specificity: 87.10%, positive predictive value (PPV): 89.47%, negative predictive value (NPV): 93.10%, diagnostic accuracy: 91.04%

**Table 3:** Stratification of USG diagnostic accuracy with respect to acute cholecystitis (n=67).

	Positive result on operation	Negative result on operation	P-value
Positive on USG	41 (TP)	03 (FP)	0.001
Negative on USG	02 (FN)	24 (TN)	

Sensitivity: 95.35%, specificity: 88.89%, positive predictive value (PPV): 93.18%, negative predictive value (NPV): 92.31%, diagnostic accuracy: 92.86%

**Table 4:** Stratification of USG diagnostic accuracy with respect to pneumoperitoneum (n=70).

## Discussion

Ultrasound is a valuable imaging tool in patients presenting with specific gastrointestinal disease, such as acute appendicitis or diverticulitis.<sup>2</sup> The abdominal ultrasound evaluation should include visible gas and fluid (to determine their luminal or extraluminal location), the peri enteric soft tissues, and the GI tract itself. Extraluminal gas may be intraperitoneal or retroperitoneal, and its presence should suggest either hollow viscus perforation or infection with gas-forming organisms.<sup>6,7</sup>

I have conducted this study to determine the diagnostic

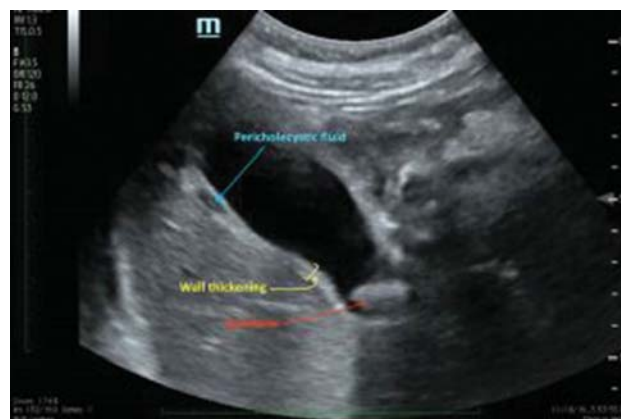
accuracy of ultrasound in acute abdomen accuracy of ultrasound in acute abdomen considering diagnoses of acute appendicitis, Pneumoperitoneum secondary to gut perforation and acute cholecystitis, taking operative findings as gold standard. In our study, sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of ultrasonography in acute abdomen considering diagnoses of acute appendicitis, Pneumoperitoneum secondary to gut perforation and acute cholecystitis, taking operative findings as gold standard was 91.67%, 84.78%, 89.90%, 87.31% and 88.89% respectively. In a study conducted by Gathwal CK et al, they found the overall sensitivity of ultrasound in detection of acute abdomen was 90.71%, positive predictive value 100%, false positive rate 0%, false negative rate 9.28% and diagnostic accuracy 90.71%.<sup>9</sup>

In a local study, diagnostic accuracy of USG for acute appendicitis was low with sensitivity of 71.8% and specificity of 59.1% when compared with operative findings. For acute perforation (peritonitis) it was again low with sensitivity of 42.9% and specificity of 66.7% when compared with operative findings. It was very good for acute intestinal obstruction with sensitivity of 90.9% and specificity of 83.3%.<sup>9</sup> In a study conducted by AyoolaAshaolu et al, conducted on 150 patients who presented with non-traumatic abdominal pain, include 66 patients of acute appendicitis, yielded a sensitivity of 83.3% and specificity of 100%.<sup>10</sup> In my study, sensitivity of ultrasound in diagnosing acute appendicitis was 89.60% and specificity was 82.50%. In a study done by Pintado-Garrido et al, the sensitivity and specificity for appendicitis were 83.7% and 97.4% respectively.<sup>11</sup> The study done for role of ultrasound in non-traumatic acute abdomen by Prasad et al, showed sensitivity and specificity of 66.6% and 100% respectively.<sup>12</sup> In another study by Stoker et al, sensitivity of 92% and a specificity of 53% have been reported for the detection of gut perforation with US.<sup>13</sup> Chen et al, studied 132 patients for use of ultrasonography in detection of pneumoperitoneum and it demonstrated a sensitivity of 93%, a specificity of 64%, a positive predictive value of 97%, a negative predictive value of 44%.<sup>14</sup> In my study the sensitivity, specificity, positive predictive value and negative predictive value of ultrasound in diagnosing pneumoperitoneum was 95.35%, 88.89%, 93.18% and 92.86% respectively.

In one study by Ralls et al, sonographic findings in 497 patients with suspected acute cholecystitis were analysed prospectively which shows positive predictive values of 95 % for stones combined with wall thickening as shown in (Fig.3).<sup>15</sup>

Another study conducted by Rosen et al showed the sensitivity of bedside ultrasonography for detecting acute cholecystitis of 91% Specificity 66%, positive predictive value 70% and negative predictive value 90%.<sup>16</sup> In my study, the sensitivity of bedside ultrasonography for detecting acute cholecystitis was 94.44%, specificity 87.1%, positive predictive value 89.47% and negative predictive value 93.10%.

Moriwaki et al, conducted a study that included 289 patients with blunt abdominal trauma. All the patients were evaluated with ultrasonography for the presence of gastrointestinal perforation (by detecting pneumoperitoneum). The confirmation of GI perforation was done by intraoperative findings (gold standard). The sensitivity, specificity and accuracy for the diagnosis of gastrointestinal perforation by US were 85.7%, 99.6% and 98.9% respectively.<sup>17</sup>

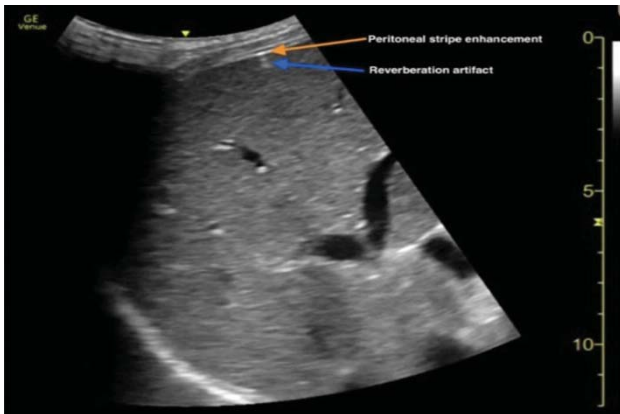


**Figure 3:** Ultrasound of gall bladder in acute cholecystitis showing thickened walls and a calculus with peri-cholecystic fluid

The sonographic findings of pneumoperitoneum were first identified in 1984 showing stripe sign as shown in (Fig.4).<sup>18</sup> This was followed up by a 2007 study, which determined that ultrasound is a more sensitive modality than plain radiography for detecting free air in the abdomen. The study found that plain radiography had a sensitivity of 79%, specificity of 64% and a positive predictive value of 96% for detecting pneumoperitoneum. Ultrasound imaging proved superior in terms of sensitivity at 93% and was at least comparable in terms of specificity at 64% and positive

predictive value at 97%.<sup>19</sup>

A study conducted by Braccini et al, showed the sensitivity, specificity, positive predictive value and negative predictive value of ultrasound for diagnosing pneumoperitoneum 86%, 83.5%, 87% and 83.5% respectively.<sup>20</sup>



**Figure 4:** Pneumoperitoneum on ultrasound as evident by gas bubbles abutting the liver and anterior abdominal wall

A large, single center study found that USG has a high rate of sensitivity and specificity (98.5% and 98%, respectively) for diagnosing acute appendicitis.<sup>21</sup> (Fig.5) In a study conducted by Pipal DK at Mahatma Gandhi Medical College and Hospital, Jaipur, India, USG had shown the sensitivity of 94.4% and specificity of 80% for diagnosing acute appendicitis.<sup>22</sup> While in another study, ultrasonography had 88.6% and 66.6% respectively.<sup>23</sup>



**Figure 5:** Acute appendicitis on ultrasound showing dilated appendix

## Conclusion

This study concluded that diagnostic accuracy of ultrasonography in acute abdomen is quite high. So, we concluded that USG is inexpensive, prospectively highly accurate, non-invasive, rapid, and requires no patient preparation or contrast material administration and there is no radiation exposure, so it must be performed in all cases for early diagnosis and thus taking proper management protocol.

**Conflict of interest:** No institutional or financial conflict of interest is declared by authors.

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