

Efficacy of Ultrasound as a Diagnostic Tool in Acute Abdominal Conditions: A Descriptive Study

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ABSTRACT

Introduction: Acute abdomen is a very common complaint for which a patient presents to the emergency department. It often requires immediate diagnosis and urgent surgical intervention. Since, many serious and benign intra-abdominal conditions share common symptoms, it is often difficult to identify life threatening conditions early in its course.

Aim: To evaluate the diagnostic efficacy of ultrasound abdomen in common conditions presenting as acute abdomen.

Materials and Methods: This was a descriptive study, which included the patients presented with acute abdomen to the Emergency Department of FH Medical College and Hospital from March 2017 to March 2020. Clinical diagnosis was made and ultrasound abdomen was done. Ultrasound diagnosis was compared with peroperative findings and histopathology or by CT scan, if patient was not operated. Diagnostic performance

markers such as sensitivity, specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV) and accuracy were used for statistical analysis.

Results: A total of 726 patients were studied which included clinically diagnosed cases of acute appendicitis (189), gastrointestinal perforation (87), acute intestinal obstruction (65), acute cholecystitis (202) and acute pancreatitis (183). In cases of acute appendicitis, ultrasound made correct diagnosis in 148 patients, with sensitivity of 97.36%, specificity of 40.54%, PPV of 87.05%, NPV of 78.94%. For enteric perforation, the sensitivity, specificity, PPV and NPV was 89.04%, 35.71%, 87.83%, and 38.46% respectively.

Conclusion: This study reflects that ultrasound scan has a high sensitivity, specificity and diagnostic accuracy for common acute abdominal conditions when executed by skilled hands.

Keywords: Abdominal pain, Emergency department, Urgent diagnosis

INTRODUCTION

An acute abdomen refers to a sudden, severe abdominal pain. In many cases, it arises due to various medical, surgical and gynaecological conditions, which require urgent hospitalisation, investigations, treatment and prompt surgical intervention [1]. A decision making through proper clinical examination and a thorough outline of management is must because many conditions are life threatening and require early surgical intervention which improves the prognosis of disease; other conditions require conservative treatment and intervention may be done later on if, required. A detailed history, full clinical examination and carefully selected investigations will lead to a correct diagnosis and management [2].

Acute abdominal pain is the most common presenting complaint, comprising 5% of all the emergency department visits [3]. Acute appendicitis is so common that almost 7% of people undergo appendectomy due to diagnosis of acute appendicitis during their lifetime [4]. Some acute abdominal conditions can have serious complications including mortality, hence, an early accurate diagnosis and prompt treatment is of paramount importance in these cases [5]. Abdominal pain may occur due to visceral pathologies, somato-parietal causes or conditions causing referred pain due to systemic and local causes. However, acute abdomen can represent a wide variety of conditions from a seemingly benign and self-limiting disease to a condition requiring prompt surgical intervention. More common causes are acute cholecystitis, acute appendicitis, bowel obstruction, enteric perforation and pancreatitis [6].

Today, ultrasonography of abdomen is the most commonly asked investigation by the surgeon in patients of acute abdomen. Ultrasonography enjoys many advantages over other imaging modalities, such as-it is readily available, cost-effective, portable, takes little time, no known side effects, non-invasive and requires

minimal patient preparation. Its only disadvantage is that it is user dependent [7]. If the sonographic examination is not conclusive, the most useful complementary imaging study is a Computed Tomography (CT) scan [8].

Not many studies are done in Indian set-up, especially in rural set-ups where only ultrasound is available and clinician is dependent over this modality only, hence present study was undertaken with an aim to determine the accuracy of ultrasound in common acute abdominal conditions presenting to emergency department. The ultrasound findings were compared with intraoperative findings and histopathology or CT scan, as the case may be.

MATERIALS AND METHODS

A descriptive cross-sectional study was performed in Emergency Department of FH Medical College and Hospital from March 2017 to March 2020. Before commencing the study, approval was taken from the Institutional Ethical Committee (FHMC/IEC/105/2020). We included all patients presenting to emergency department as acute abdomen having surgical causes. Written consent was also taken from all the participants.

Inclusion criteria: Patients who were clinically diagnosed as acute appendicitis, acute intestinal obstruction, acute enteric perforation, acute pancreatitis and acute cholecystitis were included in our study. We considered all males and females between 12-65 years of age.

Exclusion criteria: Patients having traumatic injury or female patients with obstetric and gynaecological conditions were excluded. Patients suffering from chronic abdominal ailments were also excluded.

After initial resuscitation patients, were clinically examined. Proper history was taken in detail. Then thorough examination was done in all cases. All relevant findings such as abdominal tenderness,

guarding, rigidity, presence or absence of bowel sounds, abdominal lump, ascites etc., were noted.

Relevant investigations and ultrasound abdomen were done as initial workup, as it was not possible for a single radiologist to do all the scans because many scans were done on emergency basis due to varied time of presentation. All efforts were taken so that ultrasound were done by an experienced sonologist in all the cases. In patients undergoing surgery, the relevant intraoperative findings were noted and the specimen was sent for histopathology. The USG findings were then compared with intraoperative and histopathology findings. In other patients in whom surgery was not done, CT scan of the abdomen was done and the findings were correlated with ultrasound findings.

STATISTICAL ANALYSIS

Statistical Package for Social Sciences (SPSS) for windows version 16.0 (SPSS Inc.) was used to analyse the data using the appropriate Descriptive and Inferential statistical methods and displayed by means of varied statistical presentations. Results were reported as percentages for categorical variables. Sensitivity, Specificity, PPV and NPV was determined.

RESULTS

A total of 726 subjects were studied in which acute appendicitis was seen in 189 [Table/Fig-1]. All of them underwent USG scan. A diagnosis of acute appendicitis was confirmed in 170 patients on USG scan. Out of these 170 patients, 148 were found to have acute appendicitis on intraoperative finding. Twenty two patients were not found to have appendicitis on intraoperative finding.

Clinical diagnosis	Male (n)	Female (n)	Total	%	Mean age at presentation (years)	SD
Acute appendicitis	102	87	189	26.03	26.44	10.01
Acute enteric perforation	62	25	87	11.98	33.67	38.93
Acute intestinal obstruction	43	22	65	08.95	34.33	04.28
Acute cholecystitis	45	157	202	27.82	34.09	25.90
Acute pancreatitis	122	61	183	25.20	34.26	27.20

[Table/Fig-1]: Distribution of study subjects as per clinical diagnosis.

Of the rest 19 patients in whom USG did not confirmed a diagnosis of acute appendicitis four patients had appendicitis which was proved on CT scan. Fifteen patients did not have appendicitis on CT scan also [Table/Fig-2]. From the above table a sensitivity of 97.36%, specificity of 40.54%, PPV of 87.05%, NPV of 78.94% and accuracy of 86.24% was obtained.

USG	Acute appendicitis as confirmed by intraoperative finding (or by CT scan if patient was not operated)	Acute appendicitis not found intraoperatively (or on CT scan if patient was not operated)	Total
USG appendicitis present	148	22	170
USG appendicitis not present (but confirmed by CT scan)	04	15	19

[Table/Fig-2]: Diagnostic accuracy of USG versus intraoperative/CT abdomen findings for acute appendicitis (N=189).

Clinical diagnosis of acute enteric perforation was made in a total of 87 patients and usg scan was done in all the patients. A diagnosis of enteric perforation was made in 74 patients on USG scan. Of them, 65 patients had enteric perforation identified intraoperatively who underwent surgery. In nine patients, enteric perforation was not found intraoperatively.

In 13 patients, USG finding did not suggest an enteric perforation. Of them eight had perforation which five patients did not have which was confirmed on CT scan of abdomen [Table/Fig-3]. From the above table, a sensitivity of 89.04%, specificity of 35.71%, PPV of 87.83%, NPV of 38.46% and accuracy of 80.45% was obtained.

USG	Acute enteric perforation confirmed by intraoperative finding or CT scan	Acute enteric perforation not found intraoperatively or CT scan	Total
USG perforation present	65	09	74
USG perforation not present	08 (confirmed by CT scan)	05 (confirmed by CT scan)	13

[Table/Fig-3]: Diagnostic accuracy of USG versus intraoperative and CT findings for acute enteric perforation (N=87).

Clinical diagnosis of acute intestinal obstruction was made in total of 65 patients and all of them had underwent USG abdomen. A diagnosis of acute intestinal obstruction was made on USG in 56 patients. Of them 53 patients were found to have obstruction. In three patients obstruction was not present intraoperatively.

In nine patients a diagnosis of obstruction was not made on USG; of them five patients had obstruction which was identified on CT scan. Four patients did not have obstruction identified on CT scan [Table/Fig-4]. From the above table a sensitivity of 91.37%, specificity of 57.14%, PPV of 94.64%, NPV of 44.44% and accuracy of 87.69% was obtained.

USG	Acute intestinal obstruction confirmed intraoperatively (or on CT scan)	Acute intestinal obstruction not found intraoperatively (or on CT scan)	Total
USG obstruction present	53	03	56
USG obstruction not present	05 (confirmed by CT scan)	04 (confirmed by CT scan)	09

[Table/Fig-4]: Diagnostic accuracy of USG versus intraoperative/CT findings for acute intestinal obstruction (N=65).

Clinical diagnosis of acute cholecystitis was made in total of 202 patients. All of them underwent USG scan followed by CT abdomen in all patients. Acute cholecystitis was identified in total of 168 patients. Of them, 151 patients were identified on CT scan as having acute cholecystitis. Seventeen patients did not have acute cholecystitis on CT scan.

In 34 patients, a diagnosis of acute cholecystitis could not be made on USG. Of them, five patients were identified as acute cholecystitis on CT scan abdomen. In 29 patients, a diagnosis of acute cholecystitis could not be made on CT scan [Table/Fig-5]. From the above table, a sensitivity of 96.79%, specificity of 63.04%, PPV of 89.88%, NPV of 85.29% and an accuracy of 89.1% was obtained.

USG	Acute cholecystitis present on CT scan	Acute cholecystitis not present on CT scan	Total
USG acute cholecystitis present	151	17	168
USG acute cholecystitis not present	05	29	34

[Table/Fig-5]: Diagnostic accuracy of USG versus CT findings for acute cholecystitis (N=202).

[Table/Fig-6] reflects diagnostic accuracy of ultrasound abdomen when compared with CT abdomen findings in 183 patients of acute pancreatitis. All patients underwent an abdominal ultrasound followed by CT abdomen. On comparing ultrasound findings with that of CT abdomen, a sensitivity of 73.75%, specificity of 34.78%, PPV of 88.72%, NPV of 16% and accuracy of 68.85% was obtained.

USG	Pancreatitis present on CT scan	Pancreatitis not present on CT scan	Total
USG acute pancreatitis present	118	15	133
USG acute pancreatitis not present	42	08	50

[Table/Fig-6]: Diagnostic accuracy of USG versus CT findings for acute pancreatitis (N=183).

DISCUSSION

Abdominal pain remains one of the major presentations of patients admitting into the emergency ward. It consists of 5-10% of all admissions [5]. Many of these patients are having life threatening

conditions, and early diagnosis and management of these patients improves patient's outcome and prognosis. Our study revolves around evaluating the efficacy of ultrasound in diagnosing common acute abdominal conditions presenting in the emergency department. We made a clinical diagnosis of all patients coming to emergency ward with acute abdomen for treatment. Ultrasound examination was done in all patients with other regular biochemical investigations and other imaging modalities if as required. Various similar studies done in the past are comparable with our study as shown in [Table/Fig-7] [5,9-13].

Authors	Acute appendicitis	Intestinal obstruction	Gastro-intestinal perforation	Acute cholecystitis	Pancreatitis
Ashaolu BA et al., [5]	Sensitivity-83.3 Specificity-100	Sensitivity-100 Specificity-97.5	Sensitivity-60 Specificity-90.2	Sensitivity-100 Specificity-100	
Lam SH et al., [9]	Sensitivity-100 Specificity-85 PPV-72 NPV-100				
Scruggs W et al., [10]				Sensitivity-88 Specificity-87 PPV-91 NPV-83	
Khan MAB et al., [11]		Sensitivity-95 Specificity-84			
Hong JJ et al., [12]	Sensitivity-100 Specificity-75				
Bree RL et al., [13]				Sensitivity-93 Specificity-53	
Present study	Sensitivity-97.36 Specificity-40.54	Sensitivity-91.37 Specificity-57.14	Sensitivity-89.04 Specificity-35.71	Sensitivity-96.79 Specificity-63.04	Sensitivity-73.75 Specificity-34.78

[Table/Fig-7]: Sensitivity, specificity values of various similar studies in the past [5,9-13].

NPV: Negative Predictive Value; PPV: Positive Predictive Value

Confirmed cases were then operated in emergency operation theatre and results were compared to that of preoperative findings. CT scan was done in patients who were clinically positive, with no positive finding on ultrasound scan and results of CT scan were also compared with ultrasound results [14]. In acute cholecystitis and acute pancreatitis, the ultrasound findings were compared with CT scan results, as they were not planned for emergency surgery.

In a similar study done by Ashaolu BA et al., sensitivity and specificity of ultrasound in diagnosing acute appendicitis was found to be 83.3% and 100%, respectively [5]. In another study done by Pintado-Garrido R et al., the sensitivity and specificity of ultrasound in diagnosing acute appendicitis was 83.7% and 97.4%, respectively [15]. The results of these studies are comparable to the results of present study. In study done by Ashaolu BA et al., the sensitivity and specificity of ultrasound in diagnosing acute intestinal obstruction was 100% and 97.5%, respectively which is comparable to the results of our study [5].

In a comparative study done by Bree RL et al., the sensitivity and specificity of ultrasound in diagnosing acute cholecystitis was 93% and 53%, which is comparable to the results of our study [13]. Acute appendicitis is one of the most common aetiology of acute abdomen that leads to operation [16]. Although it is a very common pathology but its diagnosis still remains a challenge because it mimics many other conditions clinically [16]. In experienced hands, sonographic features of acute appendicitis includes non-compressible tubular structure with a target sign having a diameter of >6 mm at the base, intra peritoneal fluid, thickened omentum, distorted irregular mucosa, presence of a fecolith [17].

In our study, 189 patients were diagnosed as acute appendicitis on clinical grounds. Out of these 170 patients were diagnosed as having acute appendicitis on ultrasound scan. In remaining 19 patients, four were ultimately proved on CT scan as having acute appendicitis. Patients with normal CT scans were managed conservatively and discharged with advice of follow-up.

In various research papers, the graded compression technique of ultrasonography in acute appendicitis has a very variable accuracy in diagnosis, sensitivity ranging from 44% to 100% and specificity range of 47% to 99% which can be attributed to many factors such

as variability in operator skill and factors related to patients such as obesity, increased bowel gas [18-20].

Prasad H et al., [7] have used graded compression sonography as a widely available and highly accurate technique for confirming or excluding acute appendicitis in patients suspected of having acute appendicitis; detection rates of 60-83% of the vermiform appendix and sensitivities and specificities of more than 90% in patients suspected of having acute appendicitis have been reported [21]. Our PPV is 87.05% which is comparable to that of literature [18,19].

The sensitivity of detecting free intra-peritoneal air by ultrasound is superior to an abdominal X-ray (86% compared with 76%) [22]. The sonographic signs of intra-peritoneal air includes: (a) enhanced peritoneal stripe sign; (b) peritoneal stripe reverberations; and (c) focal air collections visualised as ring down artefacts. The free intra-peritoneal air can move while changing the patient's position (Shifting phenomenon) [23,24,25]. It is not possible to localise the site and cause of perforation on ultrasound scan.

Ultrasound is a sensitive tool for diagnosing bowel obstruction with reported accuracy of about 85% [26,27]. Fluid filled loops are easily visualised at ultrasonography and one can easily differentiate between a mechanical obstruction and paralytic ileus by visualising peristaltic movements [24,26,27]. Ultrasound signs of Acute Cholecystitis are gallbladder wall thickness >3 mm, peri-cholecystic fluid, sonographic Murphy sign, distended gallbladder, and incarcerated gallstone in the gallbladder infundibulum [28,29].

Computed tomography signs of acute cholecystitis are gallbladder wall thickness >3 mm, peri-cholecystic fluid, distended gallbladder, and peri-cholecystic fat stranding [30]. The sensitivity of US for acute cholecystitis has been reported to be anywhere between 27% and 95%, but generally in the 70%-85% range in published literature [28,29,30].

Limitation(s)

Main limitation of our study was that ultrasound scans were done by different radiologists as per the departmental rotational duties in the emergency department and also it was sometimes difficult to perform ultrasound scan in an irritable patient. This study was done in one geographical region and more such studies are required from other regions to generalise it.

CONCLUSION(S)

In our study, ultrasound was found to be very good imaging modality in accurately diagnosing acute appendicitis, acute intestinal obstruction, acute cholecystitis with high sensitivity. In the hospitals where highly advanced imaging facility is not available, there also we can rely on clinical and ultrasound results with reasonable accuracy.

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