

# Diagnostic Accuracy of Focused Assessment With Sonography for Trauma in the Emergency Department

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## Abstract

**Background:** Trauma is currently the fourth leading cause of death in developed countries. One of the main objectives in abdominal trauma patients is to develop a rapid and accurate diagnosis. There is a tendency to use emergency abdominal ultrasound with abdominal trauma, therefore, it is recommended in some centers as a diagnostic tool and as a primary choice in abdominal trauma.

**Objectives:** The aim of this study was to determine the diagnostic accuracy of sonography for trauma by emergency medicine residents and radiology residents

**Patients and Methods:** This was a descriptive and analytical study performed on patients with abdominal blunt trauma who referred to the emergency ward. The diagnostic accuracy of sonography for trauma by emergency medicine residents and radiology residents was evaluated.

**Results:** Of the 380 patients, 296 were males and 84 were females. The mean ages of male and female patients were  $34.52 \pm 16.38$  years and  $41.19 \pm 21.38$  years, respectively ( $P = 0.009$ ). The sonographies performed by emergency residents were positive in 46 patients, with 22 of these confirmed by CT scans. The sensitivity and specificity of the sonography by emergency residents, as confirmed by CT scans, were 78.5% and 93.2%, respectively. The sonographies performed by radiology residents were positive in 38 patients, with 24 being confirmed by CT scans.

**Conclusions:** The sensitivity and specificity of the sonography by radiology residents, as confirmed by CT scans, were 85.7% and 96%, respectively. Sonographies performed by emergency residents were positive in 46 patients with 34 of these being confirmed by sonographies by radiology residents. The sensitivity and specificity of the sonographies by emergency residents, as confirmed by sonographies by radiology residents, were 89.5% and 96.5%, respectively

**Keywords:** Abdominal Trauma, Sonography, Emergency Medicine Resident, Radiology Resident, Abdominal CT scan

## 1. Background

Trauma is currently the fourth leading cause of death in developed countries (1). A large portion of these deaths are due to intra-abdominal hemorrhages via abdominal blunt trauma. Therefore, anything providing faster diagnoses of intra-abdominal hemorrhage would be more effective in saving patients' lives (2). Trauma is the most common cause of death among children, causing 10% of all deaths, and the third most common reason for death after cancer and cardiovascular diseases (1). The primary cause of death in the first four decades of life (1-44 years) is trauma. More than 150,000 deaths occur due to trauma annually in the United States. For every death, two to three people are permanently incapacitated, with a cost of approximately 400 billion dollars (2).

There has been a significant decrease in deaths from trauma over the past two decades. Undiagnosed injuries to the abdomen and its contents remain a preventable cause of death. Clinical studies on the symptoms, signs, and laboratory findings in the diagnosis of abdominal trauma and its control are often unreliable. The most common causes of blunt abdominal trauma are accidents (automobiles), falling from heights, and altercations (3).

Ultrasound has several advantages making it attractive for evaluation of abdominal trauma. The device is relatively inexpensive, portable, and it can safely identify fluid accumulations. Ultrasound is a fast tool that provides valuable information that can be easily obtained in a patient with unstable hemodynamic conditions. The benefits of ultrasound in the diagnosis of hemoprotein patients have been well documented with a sensitivity between 80% to

100% and a specificity close to 100% (4). Among the various diagnostic tests for intra-abdominal bleeding, abdominal imaging is important; ultrasound is the first step in the diagnostics, and one in which intra-abdominal hemorrhage presents as free fluid (1, 2).

In patients with an abdominal trauma diagnosis with probable intra-abdominal damage, prompt and proper treatment are of great importance (5). During the last decade, focused assessment with sonography for trauma has increasingly become the initial diagnostic modality of choice in trauma patients (2). In some cases, the physical examination of the abdomen was initially based on the patient complaining of abdominal pain, which may occur in patients with a decreased level of consciousness or lack of cooperation (5). This is often the case in head trauma patients, children, pregnant patients, and poisoned patients who may make it difficult to provide a proper clinical judgment of intra-abdominal lesions (6).

Although diagnostic peritoneal lavage (DPL) and computed tomography (CT) have been identified as standard diagnostic methods for the evaluation of abdominal trauma (6), ultrasound is regarded as a primary diagnostic method in these patients. The advantages of abdominal ultrasound include dynamic diagnostics, its non-invasiveness, and it provides quick and easy access while remaining inexpensive.

Several important limitations prevent admissions for blunt trauma abdominal ultrasound as an imaging tool namely the fact that sonography of the abdomen and retroperitoneal area is more difficult due to skin wounds, broken bones, limiting the patient's status changes and excessive gas in the stomach or the intestine (3, 4).

One of the main goals of abdominal trauma treatment is to provide a fast and reliable diagnosis between patients with abdominal trauma needing immediate surgery, and patients who have received major damage but do not need surgery. The tendency to use ultrasound in emergency cases of abdominal trauma is such that, in some centers, it is recommended as a diagnostic tool and the primary choice in abdominal trauma (3, 7).

## 2. Objectives

In this study, we aimed to evaluate the results of abdominal sonography in blunt abdominal trauma patients by emergency residents and compare these results with sonography conducted by radiology residents. In doing so, we hoped to determine the degree of ultrasound accuracy conducted by emergency residents in diagnosing abdominal free fluid in patients with abdominal blunt trauma. A further aim of this study was to determine the diagnos-

tic accuracy of sonography for trauma by emergency residents and radiology residents.

## 3. Patients and Methods

This was an analytic study on patients with blunt trauma admitted to the emergency department. In this study, we determined the diagnostic accuracy of sonography for trauma and the recognition of intra-abdominal fluid and damage to the abdominal organs by emergency residents and radiology residents.

Patients with abdominal trauma who were admitted to the emergency department and were clinically stable were chosen as candidates for diagnostic abdominal sonography in the radiology department. The patients first underwent an abdominal ultrasound to measure intra-abdominal fluid by emergency residents. The results and patients were then sent to the radiology department for an abdominal ultrasound to assess the abdominal damage. The results of the sonography in terms of fluid amounts and abdominal organ damage were compared to the reports provided by the emergency residents. Inclusion criteria included patients with blunt abdominal trauma or multiple traumas, while the exclusion criteria was having an unstable clinical condition. Considering the prevalence of 5% and a diagnostic accuracy of 99%, the sample size of 380 patients was determined with a selection method of simple randomized sampling. Variables studied included age, sex, mechanism of trauma, sonography findings by emergency residents, sonography findings by radiology residents, results of abdominal scans, and DPL results that were performed when necessary.

All sonographies in the emergency ward were performed by third-year emergency medicine residents while third-year radiology residents performed sonographies in the Radiology Department. A radiology specialist supervised the results of this study. Abdominal CT scans were done in patients with a positive focused assessment with sonography for trauma (FAST).

The specificity and sensitivity of sonographic results were compared with abdominal CT scans, considered the gold standard.

### 3.1. Statistical Analysis

Sensitivity, specificity, positive and negative predictive values of ultrasonography performed by emergency medicine residents, and radiological detection of intraperitoneal fluid in patients with abdominal trauma were calculated. For comparisons, we used chi square and t-tests for quantitative and qualitative variables. P values < 0.05 were considered statistically significant.

#### 4. Results

Of the 380 patients, 296 were men with a mean age of  $34.52 \pm 16.38$  years, and 84 were women with a mean age of  $41.19 \pm 21.38$  years ( $P = 0.009$ ). The causes and mechanisms of trauma among patients, based on sex, are shown in Table 1. Ultrasounds performed by emergency medicine residents in 46 patients were positive. Results of abdominal sonographies performed by emergency medicine residents identified trauma in the hepatorenal area in 28 patients, the splenorenal area in 10 patients, and the paravesical area in 4 patients. In the same manner, ultrasound performed by radiology residents was positive in 38 patients. Abdominal sonographies performed by radiology residents reported trauma in the hepatorenal area in 26 patients, in the splenorenal area of 6 patients and in the paravesical region of 8 patients.

**Table 1.** The Causes of Trauma in Patients Based on Sex

Causes	Sex		Total
	Male	Female	
Car accident	80	29	109
Overturning vehicle	58	17	75
Pedestrian accident	50	16	66
Bicycle traffic accident	46	2	48
Overturning bike	20	2	22
Fall from a height	36	18	54
Dispute	6	0	6

Abdominal CT scans were positive in 28 cases and abdominal DPL results were also positive in 28 patients. Sonography by emergency residents was positive in 46 cases, and 22 cases were confirmed by CT using formulas to determine the sensitivity and specificity. The sensitivity and specificity of ultrasonography conducted by the emergency residents, as confirmed by CT scans, was 78.5% and 93.2%, respectively.

Sonography performed by radiology residents was positive in 38 cases and 24 cases were confirmed by CT using formulas to determine the sensitivity and specificity. The sensitivity and specificity of ultrasonography conducted by the radiology residents, as confirmed by CT scans, was 85.7% and 96%, respectively.

Sonography performed by emergency residents was positive in 46 cases and 34 of these cases were confirmed by ultrasound examinations conducted by radiology residents and by the use of formulas to determine the sensitivity and specificity. The sensitivity and specificity of ultrasound sonography performed by emergency residents, as

confirmed by radiology residents, was 89.5% and 96.5%, respectively. A comparison of the results of abdominal sonographies, which were performed by emergency medicine residents, with the results of abdominal sonographies by radiology residents in various parts of the abdomen are shown in Tables 2 - 4.

**Table 2.** Comparison of the Results of Abdominal Sonography by Radiology and Emergency Medicine Residents in the Hepatorenal Zone<sup>a</sup>

Sonography Results by Emergency Medicine Residents in the Hepatorenal Zone (Find of Injury or Bleeding)	Results <sup>b</sup>		Total
	Positive	Negative	
Positive	22	6	28
Negative	4	348	352
Total	26	354	380

<sup>a</sup>This tabulation shows the agreement between the results of the residents in the detection of free fluid in the hepatorenal zone.

<sup>b</sup>Results of sonography by radiology residents in the hepatorenal zone (find of injury or bleeding)

**Table 3.** Comparison of the Abdominal Sonography Results by Radiology and Emergency Medicine Residents in the Splenorenal Zone<sup>a</sup>

Sonography Results by Emergency Medicine Residents in the Splenorenal Zone (Find of Injury or Bleeding)	Results <sup>b</sup>		Total
	Positive	Negative	
Positive	4	6	10
Negative	2	368	370
Total	6	374	380

<sup>a</sup>This tabulation shows the agreement between the results of the residents in the detection of free fluid in the splenorenal zone.

<sup>b</sup>Results of sonography by radiology residents in the splenorenal zone (find of injury or bleeding).

**Table 4.** Comparison of the Abdominal Sonography Results by Radiology and Emergency Medicine Residents in the Paravesical Zone<sup>a</sup>

Sonography Results by Emergency Medicine Residents in the Paravesical Zone (Find of Injury or Bleeding)	Results <sup>b</sup>		Total
	Positive	Negative	
Positive	2	2	4
Negative	6	370	376
Total	8	272	380

<sup>a</sup>This tabulation shows the agreement between the results of the residents in the detection of free fluid in the paravesical zone.

<sup>b</sup>Results of sonography by radiology residents in the paravesical zone (find of injury or bleeding).

## 5. Discussion

Blunt trauma injuries are common problems following accidents, thus, approximately 25% of trauma patients require explorer (8) and many are also examined in other ways. Several studies have investigated the accuracy of methods in which the primary objective is to reduce the number of negative laparotomies as a first step and reduce non-therapeutic laparotomies as a second step. Commonly used methods include ultrasound, abdominal CT scans, DPL, and more recently, greater emphasis has been placed on the value and use of ultrasound (9-11).

Blunt abdominal trauma is one of the most controversial issues in the trauma field. Many efforts have been made to replace non-therapeutic, negative laparotomies with less invasive and expensive procedures, and yet, positive cases have been identified with a high sensitivity (12, 13). In a study by Boulanger et al., the sensitivity and specificity of ultrasound in abdominal trauma cases in the emergency department were 82% and 94%, respectively (14). However, in a study by Rozycki et al., the sensitivity and specificity of ultrasound in abdominal trauma patients in the emergency department was 81% and 99%, respectively (15). In the current investigation, the sensitivity and specificity of sonography conducted by emergency residents were compared to abdominal CT scans and resulted in a 78.5% sensitivity and a specificity of 93.2%. The sonography sensitivity performed by emergency residents compared to sonography by radiology residents was 89.5% with a specificity of 96.5%. In a study by Shams et al. in 2012 on patients with blunt abdominal trauma, they stated that the sensitivity of ultrasonography for detection of intraperitoneal fluid in Morison's atmosphere was 88% and the accuracy for emergency medicine residents was 82% (16).

A 2004 study by Soudack et al. on 313 patients with a mean age of 7 years found that the sensitivity, specificity, and accuracy of FAST were 92.5%, 97.2%, and 95.5%, respectively. Thus, they reported that FAST is a possible screening method in children with blunt abdominal trauma (17). Miller et al. (2003) conducted a study on 359 patients with blunt abdominal trauma and reported that in the detection of free fluid, the sensitivity, specificity, and positive and negative predictive values in the FAST method are 42%, 98%, 67%, and 93%, respectively (18). Furthermore, in a 2003 prospective study by Richards et al. on 3,264 patients with closed abdominal trauma, sonography was used for the detection of abdominal free fluid. They reported that determining the existence of free fluid by ultrasound alone has 60% of the susceptibility, a 98% specificity, and an 82% positive predictive value, while the negative predictive value was 95% with a 94% accuracy in the diagnosis of intra-abdominal contents (7). A study by Emery et al. (2001) on

the use of ultrasound in 160 children showed that the accuracy of ultrasonography in the diagnosis of intraperitoneal free fluid in comparison to CT scans was 76% and the negative predictive value was 81% (19). In a study by Bode et al., which was conducted on 1,671 patients, stated that the sensitivity of ultrasonography to reveal intra-abdominal injuries was 88% with a specificity of 100% and an accuracy of 99% (20).

Shojaee et al. (21) demonstrated that emergency medicine residents can perform FAST with a high degree of accuracy and specificity in patients with blunt abdominal trauma. They found that these results were similar to those seen with radiology residents. Arhami Dolatabadi and colleagues further demonstrated that emergency medicine residents can perform sonography on trauma patients as successfully as radiology residents (22).

In most studies, the role of ultrasound in the diagnosis of abdominal lesions due to trauma has been emphasized as the primary diagnostic method. The reason behind this is because this method is rapid, accurate, and inexpensive.

### 5.1. Conclusion

Ultrasonography performed by emergency medicine residents was positive in 46 cases, 22 cases of which were confirmed by CT scans, and the sensitivity and specificity of ultrasonography conducted by the emergency department residents compared to abdominal CT scans was 78.5% and 93.2%, respectively.

Sonographies performed by radiology residents were positive in 38 cases and 24 cases were confirmed by CT scans and the sensitivity and specificity, the ratio of sensitivity of sonography by radiology residents to abdominal CT scans was 85.7% with a specificity of 96%.

Ultrasonographies done by emergency medicine residents were positive in 46 cases, and 34 cases were confirmed by ultrasound examinations conducted by radiology residents and the sensitivity and specificity of emergency medicine residents compared to radiology residents resulted in a sensitivity of 89.5% with a specificity of 96.5%.

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### Footnote

**Authors' Contribution:** Alireza Ala, study design; Samad Shams Vahdati, analysis and critical editing; Hourieh Arjomandi, data gathering; Mahboob Pouraghaei, writing and

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