

# A Comparative Analysis of Diagnostic Accuracy of Focused Assessment With Sonography for Trauma Performed by Emergency Medicine and Radiology Residents

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## Abstract

**Background:** Focused assessment with sonography in trauma (FAST) is a method for prompt detection of the abdominal free fluid in patients with abdominal trauma.

**Objectives:** This study was conducted to compare the diagnostic accuracy of FAST performed by emergency medicine residents (EMR) and radiology residents (RRs) in detecting peritoneal free fluids.

**Patients and Methods:** Patients triaged in the emergency department with blunt abdominal trauma, high energy trauma, and multiple traumas underwent a FAST examination by EMRs and RRs with the same techniques to obtain the standard views. Ultrasound findings for free fluid in peritoneal cavity for each patient (positive/negative) were compared with the results of computed tomography, operative exploration, or observation as the final outcome.

**Results:** A total of 138 patients were included in the final analysis. Good diagnostic agreement was noted between the results of FAST scans performed by EMRs and RRs ( $\kappa = 0.701$ ,  $P < 0.001$ ), also between the results of RRs-performed FAST and the final outcome ( $\kappa = 0.830$ ,  $P < 0.0010$ ), and finally between the results of EMRs-performed FAST and final outcome ( $\kappa = 0.795$ ,  $P < 0.001$ ). No significant differences were noted between EMRs- and RRs-performed FASTs regarding sensitivity (89.9% vs 84.6%), specificity (98.4% vs 97.6%), positive predictive value (84.6% vs 84.6%), and negative predictive value (98.4% vs 98.4%).

**Conclusions:** Trained EMRs like their fellow RRs have the ability to perform FAST scan with high diagnostic value in patients with blunt abdominal trauma.

**Keywords:** Comparative, Diagnostic, Sonography, Emergency Medicine, Radiology Residents

## 1. Background

Focused assessment with sonography in trauma (FAST) is a modality to rapidly detect free fluid (usually blood) in the peritoneal, pleural, and pleural spaces in trauma patients (1). It can be performed in the emergency department (ED) to provide noteworthy information in a short span of time. Therefore, FAST exam is applied in blunt trauma algorithms as an initial evaluation procedure. It is performed immediately after the primary survey of the Advanced Trauma Life Support (ATLS) protocol and is the basis for immediate decisions for further evaluation and management of the patient (2).

Interest and experience with FAST grew among surgeons and emergency physicians during the early 1990s, when it was no longer exclusively performed by radiologists (3-5). In 2001, American college of emergency physicians (ACEP) published the first formal comprehensive

guidelines ultrasound use in emergency medicine that contained the application of FAST as a core application (6). In 2008, the ACEP offered recommendations for the training of FAST by emergency physicians (3).

As an ultrasound imaging method, FAST is an operator-dependent technique, i.e. the skill of the operator is critically important for correct diagnosis. Many studies have shown that trained nonradiologist physicians are capable of performing an expedient FAST as accurately as formally trained radiologists (7-9). Nonetheless, some radiologists believe that a high level of knowledge and experience is needed to perform an accurate and reliable FAST in trauma patients (10).

## 2. Objectives

The present study was conducted to compare the diag-

nostic accuracy of FAST performed by emergency medicine and radiology residents for the detection of peritoneal free fluid in trauma patients.

### 3. Patients and Methods

This prospective observational study was conducted between November 2012 and November 2013 in Al-Zahra educational hospital (Isfahan, Iran) of Isfahan university of medical sciences. The study protocol was approved by the ethics committee of the university.

Patients of any age or sex admitted to the emergency department (ED) of hospital for blunt abdominal trauma, high energy trauma (Box 1) (11), and multiple trauma were deemed eligible for participation in the study.

#### Box 1. Evidence of High-Energy Impact

##### Evidence

##### Falls

Adults: > 6.09 meter

Children: > 3.04 meter or 2 to 3 times the height of the child

##### High-risk auto crash

Extrusion: > 0.3 meter, occupant site: >0.45 meter, any site

Ejection (partial or complete) from automobile

Death in same passenger compartment

Vehicle telemetry data consistent with high risk of injury

##### Auto pedestrian/bicyclist thrown, run over, or with significant (> 32 km/h) impact

##### Motorcycle crash > 32 km/h

After arrival in ED and a primary trauma survey, FAST was carried out by previously trained residents. Simultaneously, other necessary measures were taken for the patient. Patients on whom performing FAST would potentially delay emergency procedures, those with penetrating abdominal trauma and preexisting peritoneal fluid, and pregnant women were excluded from the study.

The patients were evaluated in supine position with arms abducted slightly or above the head. All scans were done by the same ultrasound machine (DC-7, Mindray Medical Ltd., China) in ED, while a low frequency (5 - 2 MHz) curved array transducer was selected with a focused depth based on the patient's body. In pediatric patients, a higher-frequency linear array transducer was selected to produce sound waves with adequate depth penetration to obtain better resolution (12).

A typical FAST examination was performed to obtain the 4 standard views (subxiphoid (pericardial) 4-chamber view, right coronal and intercostal oblique view, left coronal and intercostal oblique view, and suprapubic (pelvic) view) to examine 4 specific areas of the thoracoabdominal region (13).

History and physical examination findings were noted and FAST scan findings (negative or positive for abdominal free fluid) were collected and documented on a data

sheet for each case. Any amount of free fluid in any of the 3 windows (hepatorenal, splenorenal, suprapubic) was considered positive for abdominal free fluid (haemoperitoneum). Patients with pericardial effusion were excluded and managed separately. After FAST was completed by EMRs, the patients were transferred to radiology department and underwent FAST by radiology residents (second year radiology residents) using the same technique and machine as EMRs. All FAST scans were completed within 4 minutes. For the patients whose transfer to RD was dangerous, impossible and those who were hemodynamically unstable, bedside FAST scan was down by EMRs and RRs. Ultrasound findings for each patient were compared with the results of computed tomography (reported by the attending radiologist), operative exploration, or observation.

For definitive imaging of the abdomen in positive or suspected reports of each resident group a CT scan of the abdomen and pelvis with intravenous contrast was performed. In addition, patients with negative FAST results were observed for 2 hours in the emergency department. Patients with negative FAST scan whose abdominal physical examination was suspicious, underwent CT scan of the abdomen and pelvis at the request of the senior EM resident or attending emergency physician. Patients with positive FAST scan who were hemodynamically unstable and did not respond to 2 L IV fluid administration while no other source was found for the instability, underwent exploratory laparotomy without further imaging (14).

All statistical analyses were performed using the statistical package of social sciences (SPSS) version 19.0 (SPSS, Chicago, IL, USA). To evaluate the diagnostic agreement between the results of the two groups of residents and also between FAST results and final diagnostic method, kappa score analysis was run. Sensitivity, specificity, positive, and negative predictive values of FAST performed by EMRs and RRs were calculated and compared using Chi-square analysis. P value less than 0.05 was considered statistically significant.

### 4. Results

One hundred and forty participants with a mean age of  $28.5 \pm 13.8$  years (range 4 - 65 years) were included in this study. About 71% of patients were male. Sonography was performed on all of the patients.

Two patients expired and were excluded from the final analysis. Of remaining 138 patients, 17 patients had positive FAST scan by one or both resident groups. Five patients (with positive FAST scan from both groups) had moderate or greater amount of intraperitoneal free fluid in FAST and underwent operation without having other diagnostic modalities and laparotomy proved the presence of haemoperitoneum in all cases. In 6 patients with negative FAST, the abdominal examination was suspicious; therefore, CT scan was performed.

Finally, FAST scan findings were compared to the results

of surgical exploration in 5 patients (3.62%), to CT scan in 18 patients (13.04%), and to clinical observation in the remaining 115 patients (83.33%).

Good diagnostic agreement was noted between the results of FAST scans performed by EMRs and RRs ( $\kappa = 0.701$ ,  $P < 0.001$ ), also between the results of EMRs-performed FAST and the final outcome ( $\kappa = 0.830$ ,  $P < 0.0010$ ), and finally between the results of RRs-performed FAST and the final outcome ( $\kappa = 0.795$ ,  $P < 0.001$ ), (complete agreement would be equal to a  $\kappa$  of 1, and chance agreement would be equal to 0) (Table 1).

Sensitivity, specificity, positive, and negative predictive values of FAST scans done by EMRs and RRs are presented in Table 2. There were no differences in these parameters between FAST scans performed by EMRs and RRs (Figure 1).

**Table 1.** Agreement Between the Results of FAST Performed by Emergency Medicine Residents and Radiology Residents<sup>a,b</sup>

EMRs Performed FAST	RRs Performed FAST		
	Positive	Negative	Total
Positive	11	3	14
Negative	5	121	126
Total	16	124	140

<sup>a</sup>Abbreviations: EMRs, Emergency medicine residents; RRs, Radiology residents.

<sup>b</sup>Kappa = 0.701 and  $P < 0.001$ .

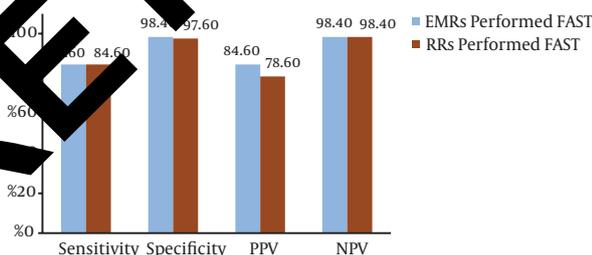
**Table 2.** Agreement Between the Results of FAST Performed by Two Groups of Residents and Final Outcome<sup>a,b</sup>

Final outcome	EMRs Performed FAST		RRs Performed FAST	
	Positive	Negative	Positive	Negative
Positive	11	2	11	1
Negative	2	123	3	122
Total	13	125	14	124

<sup>a</sup>Abbreviations: EMRs, Emergency medicine residents; RRs, Radiology residents.

<sup>b</sup>Between EMRs-performed fast and final outcome, Kappa = 0.830 and  $P < 0.001$ . between RRs-performed fast and final outcome, Kappa = 0.830 and  $P < 0.001$ .

**Figure 1.** Sensitivity, Specificity, Positive Predictive Value (PPV) and Negative Predictive Value (NPV) of FAST Performed by Two Resident Groups (t-test)



EMRs, Emergency medicine residents; RRs, Radiology residents. P value in comparison of specificities = 0.651. P value in comparison of PPVs = 0.686.

## 5. Discussion

In this study, we compared the diagnostic value of FAST scan between RRs and EMRs. This investigation showed that ER-performed sonography had an acceptable diagnostic value in comparison to RR-performed FAST.

Rapid detection of intraperitoneal fluid in patients with blunt abdominal trauma to select an appropriate approach is highly critical in reducing mortality and improving the outcome. Diagnostic peritoneal lavage (DPL), CT imaging, and FAST are the main paraclinical modalities to evaluate patients with blunt abdominal trauma. CT scan is the gold standard and provides the evidence of bleeding plus detailed information of injured organ. It has a sensitivity of 88% and specificity of 98% (13). However, it is time consuming and not appropriate for unstable patients. DPL is sensitive in the detection of abdominal bleeding (16) but is invasive and time consuming and may bring about some complications to patients (17). FAST is a noninvasive, simple method. Although it cannot replace CT scan, it is highly valuable in the initial evaluation of patients with abdominal trauma and could save the time and provide highly valuable information to make decisions about the further management of patients in ED (13). Therefore, it is very important for physicians working in ED to be able to do an accurate and reliable FAST.

Several previous studies have compared the accuracy of FAST performed by radiologists and nonradiologists. The results of these studies demonstrated a sensitivity of 78%-100% and specificity of 96%-99% for FAST performed by nonradiologists (18-20). Some studies have shown that the ability to detect haemoperitoneum using the FAST method is equally accurate if it is performed by nonradiologists (NR) and radiologists alike (9, 14). Our results are consistent with these studies. Buzzas et al. (10) compared the accuracy of FAST performed by surgery residents and radiologists. They reported a sensitivity of 73% and specificity of 97% for surgeon-performed FAST and sensitivity of 79% and specificity of 99% for radiologist-performed FAST. Bhoi et al. evaluated the accuracy of FAST done by nonradiologists and compared it to radiologists-performed FAST in the emergency department of a trauma center in India. Sensitivity values of FAST done by NR and RR were 100% and 95.6% and specificity was 97.5% in both groups (8).

The results of our study suggest that the accuracy of FAST performed by trained EMRs is comparable to RRs performed FAST. Some studies have specifically evaluated FAST performed by EMRs or emergency physicians. Brenchley et al. reported a sensitivity of 78% and specificity of 99% for FAST performed by UK emergency physicians (7). Ingeman et al. reported that FAST performed by emergency physicians had a sensitivity of 75%, a specificity of 96% and an accuracy of 91% (19). In our study, EMRs-performed FASTs had 84% sensitivity and 98% specificity. Sensitivity and specificity for RRs-performed FAST were

84% and 97%, respectively. Currently, FAST is being done by residents and specialists of radiology, emergency medicine, and surgery in Iran. Shojaee et al. evaluated the accuracy of FASTs performed by EMRs with respect to the detection of abdominal free fluid following blunt trauma and compared it to RRs performed FASTs. Both RRs- and EMRs-performed FASTs had about 60% sensitivity and 99% specificity in comparison to the final outcome based on the findings of abdominal CT scans and clinical follow-up (21). Kakaei et al. evaluated the role of FAST in assessing injured people in Iran 2012 earthquake and reported that sensitivity of FAST did not change when it was performed by RRs, but its specificity increased (compared to EM and surgery residents) (22).

Therefore, the results of our study are comparable with previous studies conducted in Iran and other countries. All EMRs in hospitals affiliated to Isfahan university of medical sciences have substantial training in FAST as a part of residency training programs, including didactic sessions and practical examinations, each with at least 200 FAST examinations at the end of the first year of residency (according to the log book). It has been suggested by most investigators that sensitivity and specificity begin to plateau after 25 to 50 FAST exams (23-25), while some others have recommended 200 examinations (26). In addition, during the second year of residency training they are required to complete 1 month training in an emergency radiology rotation. Hence, it is no surprise that EMRs of this center provide accurate FAST exams.

There were some limitations in this study. First, EMRs were more involved with the patients and had more information about them which could affect their performance in FAST. Second, we could not perform a CT scan as gold standard for all patients. Additionally, the timing of FAST performed by each group of residents is different in this study. EMRs performed FAST just after patients' arrival to ED (after primary survey) and the patients were transferred to RD after primary evaluations in the ED. Regarding the role of time in free fluid accumulation it could affect the result of FAST scan. Although the patients were transferred to radiology department as soon as possible to eliminate this effect, this limitation is inevitable when we decide to perform the FAST scan on the same subjects by both groups of residents. Further studies with separate subjects for each group of residents or doing serial FAST on patients may practically eliminate the effect of time on the performance of each group.

We conclude that, trained EMRs have the ability to perform FAST scan with high diagnostic value (specificity, sensitivity, PPV, and NPV), similar to RRs for the detection of haemoperitoneum in patients with blunt abdominal trauma.

## Footnotes

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