

Original Article

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Diagnostic Accuracy of Focused Assessment with Sonography for Blunt Abdominal Trauma in Pediatric Patients Performed by Emergency Medicine Residents versus Radiology Residents

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Abstract

Introduction: Focused assessment with sonography for trauma (FAST) has been shown to be useful to detect intraperitoneal free fluid in patients with blunt abdominal trauma (BAT).

Objective: We compared the diagnostic accuracy of FAST performed by emergency medicine residents (EMRs) and radiology residents (RRs) in pediatric patients with BAT.

Method: In this prospective study, pediatric patients with BAT and high energy trauma who were referred to the emergency department (ED) at Al-Zahra and Kashani hospitals in Isfahan, Iran, were evaluated using FAST, first by EMRs and subsequently by RRs. The reports provided by the two resident groups were compared with the final outcome based on the results of the abdominal computed tomography (CT), operative exploration, and clinical observation.

Results: A total of 101 patients with a median age of 6.75 ± 3.2 years were enrolled in the study between January 2013 and May 2014. These patients were evaluated using FAST, first by EMRs and subsequently by RRs. A good diagnostic agreement was noted between the results of the FAST scans performed by EMRs and RRs ($\kappa = 0.865$, $P < 0.001$). The sensitivity, specificity, positive and negative predictive values, and accuracy in evaluating the intraperitoneal free fluid were 72.2%, 85.5%, 52%, 93.3%, and 83.2%, respectively, when FAST was performed by EMRs and 72.2%, 86.7%, 54.2%, 93.5%, and 84.2%, respectively, when FAST was performed by RRs. No significant differences were seen between the EMR- and RR-performed FAST.

Conclusion: In this study, FAST performed by EMRs had acceptable diagnostic value, similar to that performed by RRs, in patients with BAT.

Key words: Emergency medicine; Diagnostic imaging; Pediatrics; Ultrasonography; Wounds, Nonpenetrating

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INTRODUCTION

Children less than 15 years old account for almost 22% of all emergency department (ED) visits (1). Unintentional injuries are among the main causes of these visits which is the major leading cause of mortality and accounts for over 43% of deaths in children aged 1–19 years (2). Abdomen is one of the main body parts vulnerable to such injuries, and the commonest mechanism of abdominal injury in children is blunt trauma (3, 4).

Focused assessment with sonography for trauma (FAST) has frequently been used in adult patients to identify free fluid around the heart and three areas of the abdominal–pelvic cavity and assist in the triage of patients for further imaging or surgical intervention depending on the hemodynamic

stability (5–7). The role of FAST in pediatric trauma, however, remains controversial. Pediatric abdominal trauma management rarely requires surgery, but important decisions may depend on FAST results, such as the need for intensive care, determining the patient priority in case of multiple victims, and type and extent of resuscitation (8, 9). Most previous studies on FAST in children involved radiologists or sonographers performing the scan (8–10). This required the recall of off-site physicians or, sometimes, transport of a trauma patient to the radiology department. In teaching hospitals, emergency medicine residents (EMRs) are always present in the ED and are the first to meet the trauma patients. Therefore, EMRs can

save critical time by performing FAST, as compared with radiology residents (RRs) who may not be immediately accessible in the emergency settings. FAST is an operator-dependent technique. The operator's skill is very important for the correct diagnosis. Many studies have shown that trained non-radiologist physicians are capable of performing an expedient FAST as accurately as formally trained radiologists (11-15). The present study was conducted to compare the diagnostic accuracy of FAST performed by EMRs versus RRs in the detection of intraperitoneal free fluid in pediatric trauma patients admitted to the ED following blunt abdominal trauma (BAT).

METHODS

Study design

This was a diagnostic accuracy study comparing the results of FAST performed by EMRs versus RRs in the ED. This study was conducted between January 2013 and May 2014 in Al-Zahra and Kashani Educational Hospitals, Isfahan, Iran. The study protocol was approved by the Ethics Committee of Isfahan University of Medical Sciences (code: 392292). Informed consent was required for the enrolled subjects, so it was obtained from the parent or legal guardian.

Study population

Pediatric patients 2–12 years of age with BAT who had trauma mechanisms associated with a high risk of injury were eligible. High-risk trauma mechanisms were chosen based on 2018 Up-to-date (table 1) (16, 17). Patients with abnormal pediatric age-adjusted shock index (heart rate/systolic blood pressure), Glasgow coma scale <15, and those who had sustained penetrating traumas were excluded. Figure 1 shows flow Diagram of the study process

Study protocol and data gathering

Trauma patients underwent a primary trauma survey in the ED by an emergency physician, and four standard views (Morrison's pouch, splenorenal space, retrovesical space, pleural and pericardial space) as recommended by the FAST consensus conference was performed first by previously trained EMRs. After that, RRs performed FAST using the same ultrasound machine within one hour of the first FAST exam performed by EMRs. Both EMRs and RRs were completely trained, and these training courses were part of their residents' curriculum.

The patients were evaluated in the supine position with arms abducted slightly or above the head. The goal of FAST in trauma patients is to detect

Table 1: Trauma mechanisms associated with a high risk of injury

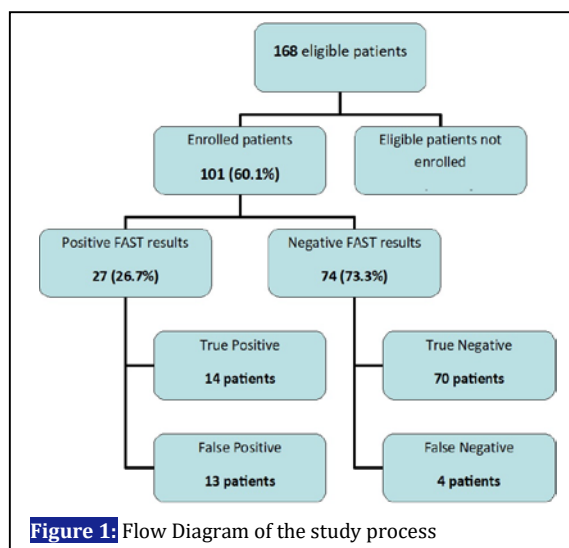
Motor vehicle collision

Ejection from the automobile
Death of another passenger in the same vehicle compartment
Vehicle rollover
High-speed automobile crash
• Initial speed > 64 kph
• Auto deformity > 50 cm
• Intrusion into passenger compartment >30 cm
Extrication time >20 minutes
Motorcycle crash > 32 kph or with separation of rider from the bike
Motor vehicle pedestrian injury
Pedestrian thrown or run over
Automobile-pedestrian injury with > 8 kph impact

Falls

Adult: > 6 m
Child: > 3 m or more than 2 to 3 times of patient's height
m, meters; kph: kilometers per hour

intraperitoneal free fluid. The absence of fluid in an ultrasound scan was considered as a negative scan. The presence of fluid regardless of the volume and location was defined as a positive scan; the presence of fluid in the pleural or pericardial space alone was not considered as a positive FAST result. Patients with positive or suspected FAST results in each resident group underwent abdominal CT scan to confirm the diagnosis if they were hemodynamically stable. Also, patients with negative FAST scan whose abdominal physical examination was suspicious or based on their clinical status and the decision of the treating surgeon also underwent abdominal CT scan. All RRs were blinded to the results of the previous FAST performed by EMRs. In addition, patients with negative FAST results were observed for 6–12



hours in the ED. Therefore, all patients regardless of negative or positive FAST results underwent further evaluation, including CT, laparotomy, or clinical observation, based on the decision of the in-charge physician.

We also collected demographic data (age and gender), mechanism of injury (motor vehicle collision, pedestrian struck, cyclist struck, fall down the stairs, fall from a height, assault), physical examination findings, FAST results, and abdominal CT findings.

Statistical analysis

The test characteristics such as sensitivity, specificity, positive and negative likelihood ratios, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated using statistical package of social sciences (SPSS) Version 20 software (SPSS, Chicago, IL, USA) and compared using chi-square analysis. Accuracy was defined as the percentage of FAST results that were consistent with the reference criterion. The diagnostic agreement between the FAST results of the two groups of residents was evaluated by analyzing the kappa score. The p-value less than 0.05 was considered statistically significant.

RESULTS

Of the 168 eligible patients, 101 (60.1%) patients with a mean age of 6.75 ± 3.2 years (range 2–12 years) were enrolled.

The baseline characteristics of the study patients are described in table 2. Sixty-nine patients (68.3%) were male. The most prevalent mechanism of injury was motor vehicle collision in 55 cases (54.5%).

In 62 cases with positive or suspected results of FAST, due to the abdominal physical examination

Table 2: Description of the study patients' baseline characteristics (n = 101)

Variable	Number (%)
Age (in years)	
2–5	27 (26.8)
6–9	45 (44.6)
10–12	29 (28.6)
Sex	
Male	69 (68.3)
Female	
Mechanism of injury	
Motor vehicle collision	55 (54.5)
Pedestrian struck	15 (14.9)
Cyclist struck	6 (5.9)
Fall down the stairs	7 (6.9)
Fall from a height	9 (8.9)
Assault	2 (2.0)
Other	6 (5.9)

Table 3: Comparison of the ultrasound reports and CT findings in the studied patients

CT scan findings	Ultrasound findings			
	EMRs		RRs	
	Positive n=25	Negative n=76	Positive n=24	Negative n=77
Positive	13	5	13	5
Negative	12	71	11	72

EMRs, emergency medicine residents; RRs, radiology residents

findings or the decision of the in-charge surgeon, abdominal CT scan with intravenous contrast was performed. All patients who did not undergo a CT scan were discharged. They had no problem during the clinical observation period and two weeks follow-up period.

Only 18 (17.8%) cases had positive findings on abdominal CT scans including bladder injury and severe bleeding (1 patient, 5.5%), liver injury (8 patients, 44.4%), renal injury (5 patients, 27.8%), splenic injury (5 patients, 27.8%), pancreatic injury (2 patients, 11.1%), and injury to gastrointestinal tract (1 patient, 5.5%). Four patients had more than one injured organ.

Table 3 shows the comparison between the ultrasound reports and CT findings in the studied patients. Based on the findings of this table, the sensitivity, specificity, PPV, and NPV for FAST performed by EMRs and RRs were calculated. The results of FASTs performed by EMRs and RRs in comparison with the final outcome based on the findings of the abdominal CT scans and clinical follow-up are shown in figure 2. There was no

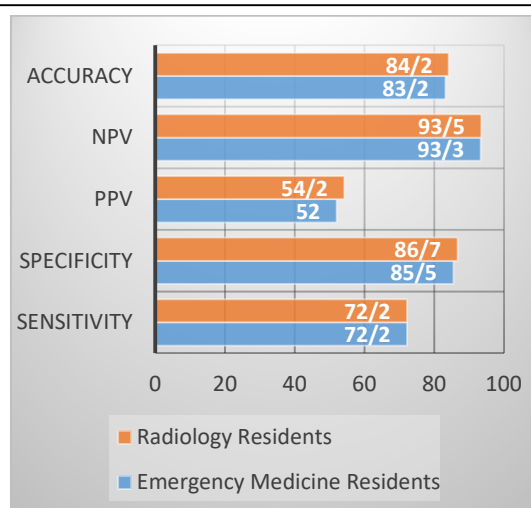


Figure 2: Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of FAST performed by two resident groups

Table 4: Agreement between the FAST results performed by emergency medicine residents and radiology residents (Kappa = 0.865, $P < 0.001$)

EMR-performed FAST	RR-performed FAST		Total
	Positive	Negative	
Positive	22	3	25
Negative	2	74	76
Total	24	77	101

EMRs, emergency medicine residents; RRs, radiology residents

statistically significant difference between FASTs performed by EMRs and RRs ($p = 0.845$).

The agreement between the FAST results performed by EMRs and RRs is reported in table 4. The FAST results significantly correlated between the two resident groups; a good diagnostic agreement was noted between the results of the FAST scans performed by EMRs and RRs ($\kappa = 0.865$, $P < 0.001$).

DISCUSSION

This study represents one of the prospective evaluations of EMR-performed FAST in children. We compared the diagnostic accuracy of the FAST scan performed by RRs and EMRs and found no significant difference regarding the sensitivity, specificity, PPV, NPV, and accuracy.

FAST has been used since the 1980s for the detection of intraperitoneal free fluid. It has been more extensively used since the 1990s, particularly in adult trauma centers (8, 18). Previous reports on the use of FAST in children were mostly based on the scans performed by radiologists or sonographers (8-10).

Raz et al. showed that the sensitivity, specificity, and PPV of ultrasound were 59%, 41%, and 48%, respectively (19), and Kim et al. reported these to be 61.3%, 96.3%, and 89.1%, respectively (20). Tobias et al. showed that the accuracy of FAST in the diagnosis of abdominal and pelvic traumas was more than 97%, which is higher than the accuracy reported in our study (21).

In the current study, there was no significant difference between FASTs performed by EMRs and RRs. The reports of FASTs significantly correlated between the two resident groups; a good diagnostic agreement was noted between the results of FAST scans performed by EMRs and RRs. Several previous studies have compared the accuracy of FAST performed by radiologists and non-radiologists. The results of these studies demonstrated a sensitivity of 52%–100% and specificity of 96%–99% for FAST performed by non-radiologists (22, 23). Buzzas et al. compared the accuracy of surgeon-performed FAST and radiologist-performed FAST. They reported a

sensitivity of 73% and specificity of 97% for FAST performed by surgery residents and sensitivity of 79% and specificity of 99% for FAST performed by radiologists (24). Bhoi et al. evaluated the accuracy of FAST done by non-radiologists and compared it with radiologist-performed FAST in the ED of a trauma center in India. The sensitivity values of FAST performed by non-radiologists and radiologists were 100% and 95.6%, respectively, and specificity was 97.5% in both groups (12). Emergency physicians with training can interpret ultrasound with relatively high sensitivity, specificity, and accuracy in both pediatric and adult patients with BAT (19-23).

In the present study, FAST performed by RRs and EMRs had equal overall sensitivity, specificity, accuracy, PPV, and NPV. The level of agreement between the two groups was good. Following training, EMRs were able to perform FAST with high accuracy for patients with BAT.

Dolatabadi et al. showed that the sensitivity, specificity, PPV, NPV, and accuracy in evaluating free intraperitoneal fluid were 80%, 95%, 57%, 98%, and 94% for ER-performed FAST and 86%, 95%, 59%, 98%, and 94% for RR-performed FAST, respectively. The level of agreement between the FAST results reported by the EMRs and RRs was moderate ($k = 0.525$). This shows that EMRs can perform sonography on trauma patients as successfully as RRs (13). Shojaei et al. reported that, following training, emergency residents could perform FAST with high accuracy and specificity, similar to RR residents, in patients with BAT. They showed that EMR-performed FASTs had 90% sensitivity and 98.5% specificity in comparison with RR-performed sonography. Furthermore, EMR-performed FASTs had 96.5% accuracy in relation to the final outcome (14). Kakaei et al. evaluated the role of FAST in assessing the injured people in the 2012 earthquake in Iran and reported that the sensitivity of FAST did not change when it was performed by RRs in comparison with EMRs or surgery residents, but its specificity increased (25). Ghafouri et al. showed that sensitivity and specificity for EMR-performed FAST were 93.1 and 93.4%, respectively. As for the tests performed by

RRs, the sensitivity was a bit higher (96.5%) with lower specificity (92.3%) (26).

It has been suggested by most investigators that sensitivity and specificity begin to plateau after 25 to 50 FAST exams (24, 27), whereas some others have recommended 200 examinations with a minimum 8-h training course, with 4-h theoretical and 4-h practical periods (28). After the end of the first year of residency, EMRs can perform FAST with high accuracy and specificity, similar to RRs, in patients with BAT.

Emergency medicine physicians and EMRs, unlike radiologists or RRs, are available 24 hours a day. The similarity between the EMRs and RRs performance in the present study indicates that using trained EMRs instead of radiologists or RRs to diagnose trauma patients can save critical time, decrease costs, and increase efficiency.

Limitations

EMRs performed FAST just after the patients' arrival to the ED, during the primary survey, and the patients were transferred to the radiology department after the primary evaluations in the ED. This could have affected the result of the FAST scan. Further studies with larger samples and separate subjects for each group of residents or doing serial FASTs on patients will allow us to

better compare the results of FASTs performed by EMRs and RRs in trauma patients.

CONCLUSIONS

FAST performed by EMRs in this study had acceptable diagnostic values. It is likely that EMRs sufficiently trained to perform such scans can perform FAST with high diagnostic value, similar to RRs, in patients with BAT.

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AUTHORS' CONTRIBUTION

All the authors met the standards of authorship based on the recommendations of the International Committee of Medical Journal Editors.

CONFLICT OF INTEREST

None declared.

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