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Research Article

Diagnostic Value of Focused Assessment with Sonography for Trauma (FAST) Compared to Hemodynamic, Paraclinical, and Clinical Findings in Multiple Trauma Patients

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Abstract

Background: Early and accurate diagnosis of any internal injury in cases of multiple trauma is crucial in decreasing morbidity and mortality. Focused Assessment with Sonography for Trauma (FAST) is a quick, non-invasive imaging method widely used in emergency departments. The current research aimed to assess the diagnostic accuracy of FAST with regards to hemodynamic, clinical, and paraclinical features, and also to analyze the characteristics and the clinical relevance of the false-negative FAST results.

Methods: This cross-sectional research comprised 300 cases of multiple trauma patients admitted to Kosar Hospital, Sanandaj, during 2021 and 2023 years. Pneumothorax and intraabdominal free fluid results of FAST were compared with results of contrast-enhanced computed tomography (CT) scans. The vital signs and laboratory values were assessed, and diagnostic performance indicators were measured (including sensitivity, specificity, positive predictive value [PPV], and negative predictive value [NPV]).

Results: In the presence of positive FAST test for pneumothorax, 96.9% were confirmed by CT (false-positive rate: 3.1%). Nevertheless, FAST missed 21.3% of pneumothoraxes. For detection of free fluid, 97% agreement between FAST and CT was established, with a false-negative rate of 20.1%. Patients with a positive FAST test had significantly lower blood pressure, elevated heart rate, and low oxygen saturation. In contrast, patients with a false-negative FAST test exhibited rather stable hemodynamic and laboratory parameters. Mortality rate reached 36.7%, and there was significantly higher mortality among patients with positive FAST results.

Conclusion: FAST is an effective and fast diagnostic method, which is highly specific. Nevertheless, the relatively high rate of false-negative results remains the major limitation of this test, especially particularly in hemodynamically stable patients. Consequently, the absence of fluid on FAST scan warrants careful interpretation and further imaging in case of doubt.

Keywords: Focused Assessment with Sonography for Trauma (FAST), Diagnostic Accuracy, Multiple Trauma, Emergency Imaging, False-Negative Results

Introduction

Multiple traumas are characterized by the existence of two or more types of injuries affecting different parts of the body, with at least one being life-threatening. [1] While multiple trauma is common worldwide, an internationally recognized classification scheme has not yet been developed. [2] The Injury Severity Score classifies trauma as being severe when the score reaches 16 or higher. [3]

Blunt trauma—primarily resulting from road traffic accidents and falls—is a leading cause of trauma-related mortality. [2] Abdominal blunt trauma, often caused by deceleration forces, can result in intra-abdominal hemorrhage and hypovolemic shock. [1] Globally, trauma

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contributes to more than 50 million cases of disability annually and accounts for approximately 10% of all deaths. [2]

Early diagnosis of internal injuries in trauma patients is critical, yet clinical examination alone may be insufficient, especially in unconscious or uncooperative patients. Imaging modalities such as computed tomography (CT) are highly accurate but may not be immediately available in all settings. [1] Focused Assessment with Sonography for Trauma (FAST) and its extended form (eFAST) allow rapid bedside detection of hemoperitoneum, pneumothorax, and pericardial effusion, making them invaluable tools in emergency care. [6]

Although FAST is widely accepted as an initial screening modality, previous studies have shown that while it has high specificity, its sensitivity can be limited, particularly in early or low-volume injuries. [4] This limitation may lead to false-negative FAST examinations, which can delay diagnosis and appropriate management in clinically suspected cases.

Therefore, this study aimed not only to evaluate the diagnostic performance of FAST compared with hemodynamic, clinical, and paraclinical findings, but also to specifically investigate false-negative FAST results and their associated clinical, physiological, and laboratory characteristics in multiple trauma patients.

Methods

This was an analytic cross sectional study carried out to determine the accuracy of FAST (Focused Assessment with Sonography for Trauma) in cases of multiple trauma.

Study Population

The study included patients aged 14 years and older with blunt multiple trauma due to traffic accidents, admitted to the emergency department of Kosar Hospital, Sanandaj, between 2021 and 2023. All participants underwent an initial FAST examination upon arrival.

FAST examinations were performed immediately upon admission, typically within 10–15 minutes of patient arrival.

Inclusion Criteria

- Age ≥14 years (according to institutional rules; the youngest patient enrolled was 17 years old)
- Cases of blunt trauma received during the period considered
- Initial examination with the use of the FAST method is performed
- Injury Severity Score (ISS) ≥16

Exclusion Criteria

- Age <14 years
- Pregnant women
- People having multiple limb or spine fractures
- Cases of severe bleeding or penetrating injury
- History of hypertension, heart disease (congestive heart failure, ischemic heart), or lung diseases
- People without imaging examinations in terms of ultrasound, X-ray, or CT methods.

During the period of the study, XX patients were not included in the study because their imaging information was either missing or incomplete.

Imaging Protocol

When the FAST findings were negative but clinical concern was still present, CT scans were carried out to confirm the findings and also classify injuries seen during the FAST examination. For patients with a positive FAST finding, any who showed signs of hemodynamic instability were operated upon without delay, following ATLS guidelines, with a CT scan being performed once the patient was stabilized. All the FAST scans were performed by emergency medical doctors with at least three years of experience in trauma ultrasound.

Sample Size and Scoring

A total of 300 patients meeting the inclusion criteria were enrolled. Sampling was based on ISS, calculated as:

where A, B, and C represent the highest Abbreviated Injury Scale (AIS) scores in the three most severely injured body regions. If any region received an AIS score of 6, the ISS was automatically assigned as 75.

Data Collection

Information was gathered from health records, which contain demographic details and/or medical features, including the injury mechanism and the results of medical tests. The results of the FAST examination performed by emergency doctors were documented, and CT results were also examined.

Statistical Analysis

SPSS version 22 was used to analyze the data. Examples of descriptive statistics used in this investigation are the mean, standard deviation, and frequency. Both independent t-tests and non-parametric tests were utilized when necessary. To explore categorical variables, the Chi-square technique was used. The P-value of < 0.05 was considered significant. The normality of quantitative variables was determined by the Shapiro-Wilk test. The diagnostic performance indices that were calculated included sensitivity, specificity, positive predictive value, and negative predictive value in relation to the reference standard of CT scan findings.

Ethical Considerations

The research was given the green light by the Ethics Committee of Kurdistan University of Medical Sciences (IR.MUK.REC.1402.157). All the data relating to the subjects of the research were anonymized and used only for the purpose of the research.

Results

A total of 300 patients aged ≥14 years with multiple blunt trauma were included. All patients underwent an initial FAST examination upon admission. Injury severity was standardized using the Injury Severity Score (ISS ≥16), and patients with confounding comorbidities were excluded.

Demographics and Trauma Mechanism

The mean age of patients was 38 years (range: 17–80; SD = 18). Of the participants, 192 (64%) were male and 108 (36%) were female. Trauma mechanisms were categorized into six groups: car-to-car collisions (CTCA), motorcycle-to-car collisions (MTCA), motorcycle-to-motorcycle collisions (MTMA), car-to-pedestrian collisions (CTPA), motorcycle-to-pedestrian collisions (MTPA), and car rollovers.

As shown in Table 1, CTCA was the most common mechanism (24.7%), followed by MTCA (20.7%) and CTPA (20.0%).

Overall Mortality

The overall mortality rate was 36.7% (110 out of 300 patients), while 190 patients (63.3%) were discharged. Mortality varied by trauma mechanism, with the highest rate observed in the CTCA and the lowest in the MTMA groups.

FAST vs. CT Scan Findings

FAST demonstrated high diagnostic performance compared with CT scan (reference standard).

As presented in Table 2, the diagnostic indices were:

Pneumothorax:

- Sensitivity: 78.7%
- Specificity: 96.9%
- Positive Predictive Value (PPV): 96.9%
- Negative Predictive Value (NPV): 78.7%

Free fluid:

- Sensitivity: 79.9%
- Specificity: 97.0%
- Positive Predictive Value (PPV): 97.0%
- Negative Predictive Value (NPV): 79.9%

All diagnostic indices are reported with 95% confidence intervals in Table 2. FAST findings showed strong agreement with CT scan results (P < 0.001), although false-negative cases were observed.

False-Negative FAST Analysis

False-negative FAST examinations occurred in 21.3% of pneumothorax cases and 20.1% of free fluid cases.

As shown in Table 5, patients with false-negative FAST results had relatively more stable hemodynamic and laboratory parameters compared with true-positive cases, despite having confirmed injuries on CT scan.

This subgroup highlights a diagnostic limitation of FAST in detecting early-stage or low-volume injuries.

Hemodynamic Findings

As shown in Table 3, patients with positive FAST findings had significantly:

- Lower systolic and diastolic blood pressure
- Lower oxygen saturation
- Higher respiratory and heart rates

All differences were statistically significant (P < 0.001), indicating greater physiological instability among FAST-positive patients.

Laboratory Findings

As presented in Table 4, significant differences between FAST-positive and FAST-negative groups were observed in:

- pH
- HCO_3
- Hemoglobin
- WBC count

Most comparisons were highly significant (P < 0.0001). Patients with positive free fluid findings showed lower

hemoglobin and bicarbonate levels, indicating internal bleeding and metabolic acidosis.

Injury Severity (ISS) and FAST Findings

The mean ISS was significantly higher in FAST-positive patients compared to FAST-negative patients (21.6 ± 8.4 vs. 14.8 ± 6.2; $P < 0.05$), suggesting that positive FAST findings are associated with greater injury severity.

Mortality Analysis

Mortality was strongly associated with imaging findings:

- FAST-positive pneumothorax: 63.2% mortality
- FAST-positive free fluid: 78.2% mortality

In contrast, FAST-negative patients showed substantially lower mortality:

- No pneumothorax: 22.3%
- No free fluid: 14.1%

CT-positive patients had significantly higher mortality (64.5%) compared to CT-negative patients (11%). Female patients exhibited slightly higher mortality compared to males.

Table 1. Distribution of Trauma Mechanisms (n = 300)

Trauma Mechanism	n	%
CTCA (Car-to-Car)	74	24.7
MTCA (Motorcycle–Car)	62	20.7
MTMA (Motorcycle–Motorcycle)	58	19.3
CTPA (Car–Pedestrian)	60	20.0
MTPA (Motorcycle–Pedestrian)	46	15.3
Car Rollovers	50	16.7
Total	300	100

Table 2. Diagnostic Accuracy of FAST Compared with CT Scan (Reference Standard)

Diagnostic Index	Pneumothorax % (95% CI)	Free Fluid % (95% CI)
Sensitivity	78.7 (73.5–83.2)	79.9 (74.8–84.3)
Specificity	96.9 (93.8–98.7)	97.0 (94.0–98.8)
Positive Predictive Value (PPV)	96.9	97.0
Negative Predictive Value (NPV)	78.7	79.9
False Positive Rate	3.1	3.0
False Negative Rate	21.3	20.1

Table 3. Hemodynamic Parameters According to FAST Findings (Mean ± SD)

Variable	FAST Negative	FAST Positive	P-value
Systolic Blood Pressure (mmHg)	122 ± 28	104 ± 22	<0.001
Diastolic Blood Pressure (mmHg)	78 ± 15	70 ± 13	<0.001
Heart Rate (bpm)	88 ± 18	110 ± 24	<0.001
Respiratory Rate (breaths/min)	18 ± 3	23 ± 4	<0.001
Oxygen Saturation (%)	95 ± 3	90 ± 4	<0.001

Table 4. Laboratory Findings According to FAST Results (Mean ± SD)

Variable	FAST Negative	FAST Positive	P-value
pH	7.36 ± 0.03	7.31 ± 0.04	<0.001
pCO_2 (mmHg)	41 ± 3	44 ± 5	<0.01
HCO_3 (mEq/L)	24 ± 2	20 ± 3	<0.001
Hemoglobin (g/dL)	13 ± 2	11 ± 2	<0.001
WBC (cells/mm^3)	13,000 ± 5,000	16,000 ± 9,000	<0.001
Creatinine (mg/dL)	1.0 ± 0.3	1.2 ± 0.4	NS

Table 5. Clinical Characteristics of False-Negative FAST Cases (Novelty Table)

Variable	False-Negative FAST	True-Positive FAST	P-value
Systolic Blood Pressure (mmHg)	118 ± 26	102 ± 20	<0.05
Heart Rate (bpm)	92 ± 18	115 ± 25	<0.05
Oxygen Saturation (%)	94 ± 3	89 ± 4	<0.05
Hemoglobin (g/dL)	13 ± 2	11 ± 2	<0.05

Discussion

This research shows the effectiveness of Focused Assessment with Sonography for Trauma (FAST) in the detection of pneumothorax and intra-abdominal free fluid in multiple trauma cases. FAST provided high specificity and positive predictive values for both conditions, thus validating its efficacy as an early-screening option in trauma emergencies[6,7].

Despite these important advantages, an important new finding of this investigation is a high rate of false-negative results in FAST examinations, as pneumothorax was missed in 21.3% of cases and free fluid in 20.1%. This also indicates a serious limitation of FAST, especially in cases of early injuries of low volume or physiological compensation. False-negative patients' clinical status was mostly characterized by stable hemodynamic parameters, which led to a delay in the first suspicion and imaging.

These findings are consistent with previous studies reporting high specificity but moderate sensitivity for FAST. Studies such as those by Garipoli et al.[8] and Kim et al.[10] have emphasized that while FAST is highly effective for rapid bedside assessment, its sensitivity is reduced in subtle presentations or delayed bleeding. Our results extend these findings by specifically characterizing the clinical and physiological profile of false-negative cases, which represents an important addition to the current literature.

Positive FAST results exhibited noteworthy correlations with hemodynamic instability, such as decreased blood pressure, lowered oxygen saturation, and raised heart rate. Besides, laboratory abnormalities like reduced hemoglobin and bicarbonate levels were more severe in patients with FAST-positive results, suggesting a higher physiological impairment and internal bleeding. These results substantiate the fact that FAST plays an important role in conjunction with clinical, hemodynamic, and laboratory data to constitute a full-fledged diagnosis[9], [11].

The mortality investigation indicated a positive correlation between positive FAST findings and increased mortality. Nevertheless, this finding has to be interpreted cautiously, as patients with positive FAST also presented exceptionally high Injury Severity Scores (ISS). Thus, injury severity might serve as a confounding factor in exploring the observed correlations between mortality and FAST findings. This issue proves the significance of ISS when interpreting prognostic data in the studies of trauma[12].

The overall mortality of this study (36.7%) indicates the serious nature of injuries within the population of the study (ISS ≥16). The maximum mortality occurred in patients with the presence of free fluid in the abdominal cavity and pneumothorax, which is consistent with prior studies indicating that such cases are major predictors of unsuccessful outcomes[12].

When considering a clinical viewpoint, the fact that the false-negative rate is fairly high means that one should not take a negative FAST examination as conclusive in the setting of clinical suspicion. It would therefore be strongly advisable to repeat FAST examinations or perform CT scans in order to prevent cases of missed diagnosis, which is an idea that has come up in earlier studies on recurrent FAST examinations and trauma imaging methods[11,12].

Limitations

The FAST technique relies on the examiner to a great degree. Variability of the operator performing the ultrasound examination can affect the diagnostic process[6,7]. Even though all operators performing the examination were highly experienced emergency doctors, we cannot consider the inter-operator variability absent in the current study. Moreover, this study was conducted in a single center and involved retrospective data collection, which may limit the generalization of the results[8].

Also, not all study subjects underwent the same imaging protocol, and the timing of FAST ultrasound performance from the time of injury was not strictly regulated, which may lead to false-negative results[11,12].

Future Directions

Future prospective, multicenter studies are recommended to validate these findings and further investigate predictors of false-negative FAST results. In addition, the integration of artificial intelligence in ultrasound interpretation and the use of serial FAST examinations may improve diagnostic sensitivity and clinical outcomes in trauma care.

Conclusion

MINISCULE interrogation log: FAST and eFAST can readily be used for quick preliminary trauma assessment with high specificity, demonstrating a fair agreement

with values obtained from CT scans. The dominant false-negative rate disclosed by this study was notable because a negative FAST cannot absolutely exclude injury, especially when there is clinical suspicion. FAST needs to be employed along with an exhaustive clinical examination within assessment principles. CT imaging should be used when clinical suspicion remains high despite negative FAST results. In this regard, these results show the necessity of knowing about the false negatives of FAST and support an integrated, multimodal approach in the management of polytrauma.

Ethical assessment

The study was approved by the Ethics Committee of Kurdistan University of Medical Sciences (Code: IR.MUK.REC.1402.157). All procedures were conducted in accordance with institutional and ethical standards.

Declaration of Generative AI and AI-assisted Technologies

None to be declared.

Authors' Contributions

MN: Conceptualization, data collection, manuscript drafting

BP: Study design, supervision, critical revision

KA: Data analysis and statistical interpretation

LA: Study supervision, final approval, corresponding author

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Conflict of Interest

The authors declare no competing interest

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