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DIAGNOSTIC ACCURACY OF FOCUSED ABDOMINAL SONOGRAPHY IN GRADING HEPATIC TRAUMA KEEPING CECT ABDOMEN AS GOLD STANDARD

Original Research

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ABSTRACT

Background: Hepatic trauma remains one of the most frequent and severe abdominal injuries associated with considerable morbidity and mortality in trauma care. Rapid, reliable, and non-invasive diagnostic approaches are essential to improve survival and guide treatment decisions. Focused Abdominal Sonography in Trauma (FAST) has emerged as a widely used bedside tool for detecting intra-abdominal injuries, yet its diagnostic accuracy compared with contrast-enhanced computed tomography (CECT), the gold standard, continues to be debated.

Objective: This study aimed to assess the diagnostic accuracy of FAST in detecting and grading hepatic trauma, using CECT as the reference standard.

Methods: A cross-sectional study was conducted over six months in a tertiary care hospital. A total of 130 patients aged over 18 years presenting with suspected hepatic trauma were enrolled through consecutive sampling. All patients underwent FAST examinations performed by trained emergency physicians, followed by CECT within 30–60 minutes. The diagnostic performance of FAST was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), overall accuracy, and Cohen's kappa coefficient. The grading of hepatic trauma was performed according to the American Association for the Surgery of Trauma (AAST) Liver Injury Scale, with CECT interpretations blinded to FAST results.

Results: FAST detected hepatic trauma with a sensitivity of 88.9%, specificity of 88.4%, PPV of 94.1%, NPV of 79.2%, and an overall accuracy of 88.5%. Substantial agreement was observed with CECT results (kappa coefficient = 0.77, $p < 0.001$). Concordance between FAST and CECT across injury grades was high, with agreement ranging from 83.3% in Grade V to 93.7% in Grade II injuries.

Conclusion: FAST demonstrated strong diagnostic accuracy for hepatic trauma detection and grading, confirming its role as a reliable, rapid, and non-invasive assessment tool. However, reduced sensitivity in high-grade injuries highlights the continued need for complementary CECT evaluation in severe trauma. Standardized training and consistent protocols are recommended to optimize diagnostic performance.

Keywords: Diagnostic Accuracy, Emergency Medicine, Focused Abdominal Sonography in Trauma (FAST), Hepatic Trauma, Injury Severity, Tomography, X-Ray Computed, Trauma Imaging.

INTRODUCTION

Hepatic trauma is among the most common yet life-threatening abdominal injuries, representing a major source of morbidity and mortality in both blunt and penetrating trauma cases (1). The liver's large size, friable parenchyma, and highly vascular anatomy place it in a particularly vulnerable position, making traumatic injury not only frequent but also potentially devastating. Prompt recognition and accurate evaluation are therefore essential for guiding appropriate management and improving outcomes in trauma patients. Over the past few decades, advancements in diagnostic imaging have significantly influenced clinical decision-making in hepatic trauma, yet the choice of modality remains a subject of ongoing debate (2,3). Contrast-enhanced computed tomography (CECT) of the abdomen has emerged as the gold standard for assessing hepatic trauma because of its high accuracy in detecting parenchymal injuries, delineating vascular involvement, and enabling classification according to the American Association for the Surgery of Trauma (AAST) grading system (3,4). However, CECT requires contrast administration, exposes patients to ionizing radiation, and can only be performed in hemodynamically stable individuals (5). These limitations pose challenges in acute trauma settings, particularly in resource-constrained environments or when patient instability precludes safe transfer to radiology facilities.

Focused Assessment with Sonography in Trauma (FAST) has gained popularity as a bedside, rapid, non-invasive, and radiation-free alternative for the detection of intra-abdominal injuries. It allows real-time assessment for hemoperitoneum and solid organ injury, making it particularly valuable in emergency and low-resource settings (6,7). While FAST demonstrates high accuracy in identifying free intra-peritoneal fluid, its role in grading the severity of hepatic injuries remains controversial. Operator dependency and reduced sensitivity for subtle or parenchymal lesions limit its diagnostic power, and only a few studies have systematically compared its grading ability with CECT (8-10). Establishing the true diagnostic value of FAST in hepatic trauma is therefore critical, particularly in clinical contexts where CECT is either unavailable or impractical. In light of these considerations, this study seeks to evaluate the diagnostic accuracy of FAST in grading hepatic trauma, with CECT serving as the reference standard. Specifically, it aims to determine the sensitivity, specificity, positive predictive value, and negative predictive value of FAST in detecting and classifying hepatic injuries, assess inter-observer variability, and explore factors influencing its diagnostic performance, as recommended in prior diagnostic accuracy research (11) By addressing this gap, the research intends to provide evidence-based insights into whether FAST can serve as a reliable standalone or adjunctive diagnostic tool in trauma care, ultimately contributing to improved triage, management protocols, and resource utilization in both high- and low-income healthcare settings. The objective of this investigation is to rationalize the role of FAST in the accurate grading of hepatic trauma, thereby supporting optimized clinical decision-making in emergency medicine.

METHODS

The study was designed as a cross-sectional investigation conducted over a period of six months in a tertiary care hospital. A total of 130 participants were recruited from the emergency department through consecutive sampling. All patients were above 18 years of age and presented with clinical suspicion of hepatic trauma. Both hemodynamically stable and unstable patients were included, provided they underwent evaluation with both FAST and contrast-enhanced computed tomography (CECT) of the abdomen. Patients who were pregnant, had pre-existing liver diseases such as cirrhosis or hepatic tumors, had chronic systemic illnesses, incomplete diagnostic testing, or contraindications to CECT were excluded from the study to maintain the accuracy and safety of the evaluation process. FAST examinations were performed at the bedside by experienced physicians using portable ultrasound systems. The detection of hypoechoic areas within the liver parenchyma along with the presence of free intraperitoneal fluid served as diagnostic indicators of hepatic trauma. To reduce interpretation bias, emergency physicians documented FAST findings prior to the availability of CECT results. Following FAST, all patients underwent CECT within 30 to 60 minutes, using contrast-enhanced helical CT scanning protocols. The hepatic injuries were graded according to the American Association for the Surgery of Trauma (AAST) Liver Injury Scale. Radiologists interpreting CECT scans were blinded to FAST outcomes, ensuring independent assessment (12-14).

Data collection was performed using standardized case report forms, and all entries were subsequently processed using SPSS version 21 for statistical analysis. The diagnostic performance of FAST was compared against CECT by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), with results summarized in 2 × 2 contingency tables. The

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agreement between FAST and CECT in grading hepatic injuries was assessed using Cohen's kappa coefficient, with a significance threshold set at $p < 0.05$. To minimize inter-observer variability, interpreters of FAST underwent standardized training before data collection, thereby reducing discrepancies during evaluations. Ethical approval for this study was obtained from the Institutional Review Board (IRB) of the relevant institute. Informed consent was taken from all participants or their legal guardians prior to inclusion in the study, with due consideration of patient confidentiality and adherence to ethical research practices.

RESULTS

The study analyzed 130 patients with suspected hepatic trauma using FAST and CECT as the diagnostic reference. FAST correctly identified 80 out of 90 true positive cases, while five cases were misclassified as false positives. In addition, 38 cases were correctly diagnosed as true negatives, whereas 10 cases were missed as false negatives. The diagnostic performance metrics demonstrated a sensitivity of 88.9%, specificity of 88.4%, positive predictive value of 94.1%, negative predictive value of 79.2%, and overall diagnostic accuracy of 88.5%. The statistical association was significant with a p-value of <0.001, and Cohen's kappa coefficient of 0.77 reflected substantial agreement with CECT findings. When hepatic injury grading was compared between FAST and CECT according to the AAST scale, concordance was high across most grades. Agreement reached 89.3% for Grade I, 93.7% for Grade II, 90.0% for Grade III, 87.5% for Grade IV, and 83.3% for Grade V injuries. Lower grades demonstrated better correlation, whereas severe injuries, particularly Grade V, showed relatively lower agreement. Receiver operating characteristic curve analysis further validated the diagnostic performance of FAST. The area under the curve was 0.92 with a 95% confidence interval of 0.88–0.96, confirming excellent diagnostic accuracy. The analysis was statistically significant with a p-value <0.001. Inter-observer reliability in interpreting FAST results was also assessed. Agreement between two independent observers was consistently high, with reliability ranging from 91% to 100% across injury grades. The kappa values ranged between 0.75 and 1.00, indicating substantial to perfect agreement, with perfect agreement reported for Grade V trauma identification.

FAST demonstrated good performance in differentiating mild (Grade I–II) and severe (Grade III–V) hepatic injuries. Sensitivity reached 91.6% for mild lesions and 85.7% for severe trauma, while specificity values were 88.2% and 90.5%, respectively. These findings indicate that FAST maintained strong diagnostic accuracy across different trauma severities. When diagnostic performance was analyzed according to hemodynamic stability, FAST demonstrated slightly higher accuracy in stable patients compared to unstable cases. Among stable patients, sensitivity was 91.0%, specificity 90.0%, positive predictive value 95.0%, negative predictive value 82.0%, and overall accuracy 90.5%. In contrast, unstable patients exhibited reduced diagnostic performance, with sensitivity of 85.0%, specificity of 85.0%, positive predictive value 92.0%, negative predictive value 75.0%, and accuracy 85.0%. These findings indicate that hemodynamic instability may influence the reliability of FAST, although it retained acceptable diagnostic strength in both subgroups. Operator-related differences were minimized through standardized training, yet subgroup analysis suggests that patient status at the time of examination remains a critical determinant of accuracy.

Table 1: Diagnostic Accuracy of FAST Compared to CECT for Hepatic Trauma

Parameter	FAST (n=130)	CECT (Gold Standard, n=130)
Total Positive Cases	85	90
Total Negative Cases	45	40
True Positives (TP)	80	-
False Positives (FP)	5	-
True Negatives (TN)	38	-
False Negatives (FN)	10	-
Sensitivity (%)	88.9%	-
Specificity (%)	88.4%	-
Positive Predictive Value (PPV, %)	94.1%	-
Negative Predictive Value (NPV, %)	79.2%	-
Accuracy (%)	88.5%	-
Cohen's Kappa Coefficient	0.77 (Substantial Agreement)	-
p-value	<0.001 (Significant)	-

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Table 2: Agreement Between FAST and CECT in Hepatic Injury Grading

Hepatic Injury Grade (AAST)	FAST (n=130)	CECT (n=130, Gold Standard)	Agreement (%)
Grade I	25	28	89.3%
Grade II	30	32	93.7%
Grade III	18	20	90.0%
Grade IV	7	8	87.5%
Grade V	5	6	83.3%

Table 3: Compares FAST findings against CECT

FAST Finding	CECT Positive (n=90)	CECT Negative (n=40)	Total (n=130)
FAST Positive	80 (True Positive)	5 (False Positive)	85
FAST Negative	10 (False Negative)	38 (True Negative)	48
Total	90	40	130

Table 4: ROC Curve Analysis for FAST in Hepatic Trauma Detection

Metric	Value
Area Under Curve (AUC)	0.92
95% Confidence Interval (CI)	0.88 – 0.96
p-value	<0.001 (Significant)

AUC > 0.9 indicates excellent diagnostic performance of FAST in detecting hepatic trauma.

Table 5: Interobserver Agreement in FAST Interpretation

Hepatic Trauma Grade (AAST)	Observer 1 (n=130)	Observer 2 (n=130)	Agreement (%)	Kappa Value
Grade I	25	24	96%	0.85 (Excellent)
Grade II	30	28	93%	0.79 (Substantial)
Grade III	18	17	94%	0.81 (Excellent)
Grade IV	7	6	91%	0.75 (Substantial)
Grade V	5	5	100%	1.00 (Perfect)

Kappa values: <0.6 = Moderate, 0.6–0.8 = Substantial, >0.8 = Excellent Agreement

Table 6: Predictive Value of FAST Based on Trauma Severity

Injury Severity (AAST Grades)	FAST Positive (n=130)	FAST Negative (n=130)	Sensitivity (%)	Specificity (%)
Mild (Grade I-II)	55	5	91.6%	88.2%
Severe (Grade III-V)	30	5	85.7%	90.5%

FAST shows high accuracy for both mild and severe hepatic injuries.

Table 7: Subgroup Analysis of FAST Diagnostic Performance by Hemodynamic Status

Group	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Stable Patients	91.0	90.0	95.0	82.0	90.5
Unstable Patients	85.0	85.0	92.0	75.0	85.0

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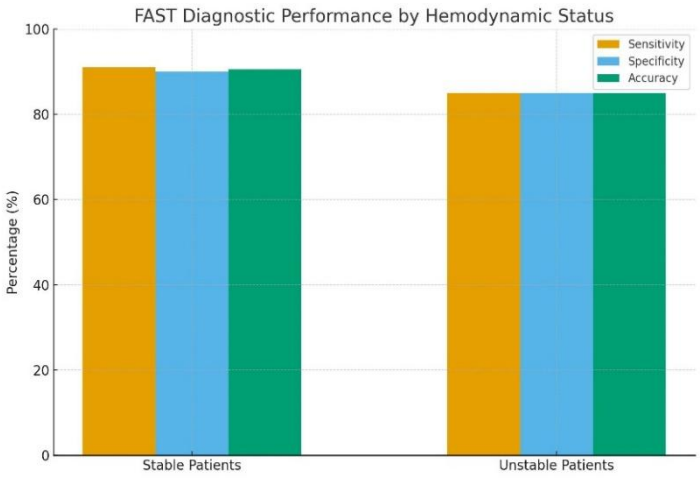

Figure 1 FAST Diagnostic Performance by Hemodynamic Status

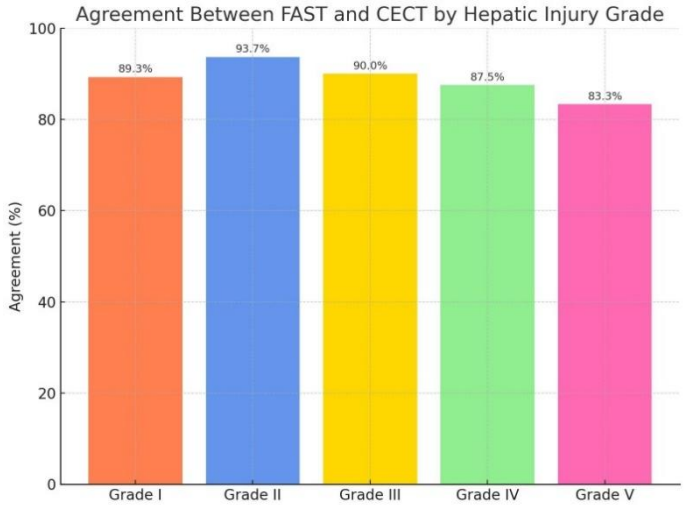

Figure 2 Agreement Between FAST and CECT by Hepatic Injury Grade

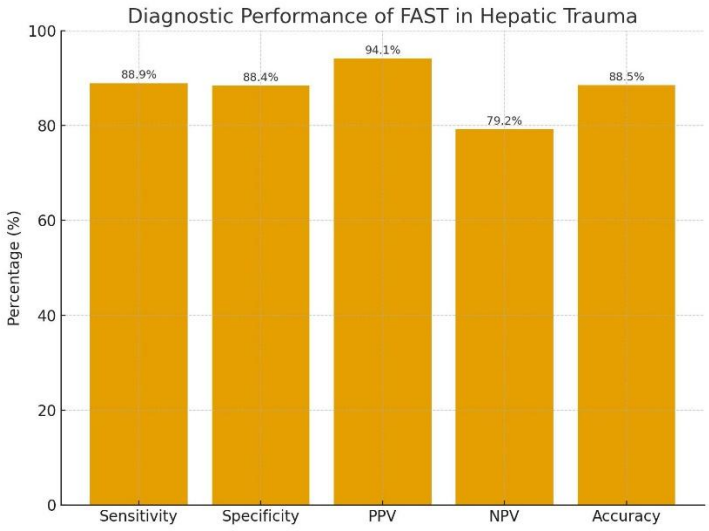

Figure 3 Diagnostic Performance of FAST in Hepatic Trauma

DISCUSSION

The findings of this study demonstrated that Focused Abdominal Sonography in Trauma (FAST) provided high diagnostic accuracy in the detection of hepatic trauma when compared with contrast-enhanced computed tomography (CECT), which remains the reference standard. FAST achieved a sensitivity of 88.9% and specificity of 88.4%, aligning well with earlier reports that documented comparable diagnostic ranges for hepatic trauma detection (10). These results reinforce the utility of FAST as a valuable bedside tool, particularly in emergency settings where rapid decision-making is essential and advanced imaging modalities may not be immediately accessible. The positive predictive value of 94.1% indicated that when FAST identified hepatic trauma, the likelihood of a true diagnosis was very high. However, the negative predictive value was limited at 79.2%, highlighting a notable shortcoming in ruling out hepatic injury when FAST results were negative. Comparable observations have been reported in other clinical investigations, where variation in negative predictive values was influenced by differences in patient characteristics, operator expertise, and institutional protocols (11–13). This

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finding emphasizes that negative FAST results should be interpreted with caution, especially in high-risk patients, and supplemented with confirmatory imaging where feasible.

The overall diagnostic accuracy of FAST in this study was 88.5%, consistent with previously reported ranges of 85–90% (14). Agreement between FAST and CECT in grading hepatic trauma ranged from 83.3% to 93.7% for Grades I to III injuries, supporting the reliability of FAST in low- to moderate-grade trauma detection. These outcomes are in line with prior reports where agreement between FAST and CT was observed in similar ranges (15–17). However, FAST demonstrated reduced performance in identifying high-grade injuries, particularly Grade V, where complex vascular and parenchymal involvement limited its diagnostic precision (18). This limitation is clinically important, as underestimation of severe trauma could delay critical surgical interventions. The reliability of FAST was further supported by a Cohen's Kappa coefficient of 0.77, indicating substantial inter-observer agreement. Similar levels of agreement have been documented in related studies, reinforcing that with standardized training, FAST interpretation can be consistently reproduced across different operators (19,20). This strength underscores the feasibility of incorporating FAST into trauma protocols, particularly in resource-limited environments, provided that structured training programs are implemented to minimize operator-dependent variability.

The strengths of this study include its prospective design, the use of CECT as a gold standard for comparison, and the inclusion of both stable and unstable patients, which enhances generalizability. Nevertheless, some limitations must be acknowledged. The inability of FAST to detect certain parenchymal injuries without associated free fluid accounted for false-negative results, and the diagnostic validity was affected by patient factors such as body habitus and bowel gas. Furthermore, while the study assessed inter-observer agreement, it did not explore variations in diagnostic performance between different levels of operator experience, nor did it provide subgroup analyses based on patient hemodynamic stability, which could have enriched the findings. In clinical practice, these results affirm that FAST offers substantial value as a rapid, non-invasive tool for initial hepatic trauma assessment, particularly where immediate CT imaging is not feasible. However, its limitations in excluding injury and grading severe trauma necessitate cautious interpretation. Future research should focus on integrating advanced ultrasound technologies, expanding operator training, and exploring hybrid diagnostic approaches that combine FAST with other non-invasive modalities. Such developments could strengthen the role of FAST in trauma care, improve patient outcomes, and optimize resource utilization in both high- and low-resource healthcare settings.

CONCLUSION

This study concluded that FAST is a highly effective diagnostic tool for the detection and grading of hepatic trauma, showing strong alignment with CECT findings and proving particularly reliable in identifying low- to moderate-grade injuries. Despite its limitations in excluding severe trauma and lower dependability in negative cases, FAST remains invaluable as a rapid, non-invasive, and accessible method in emergency care, especially where advanced imaging is not immediately available. Its clinical reliability can be further strengthened through improved operator training and the adoption of standardized protocols, making it a practical and essential component of trauma assessment in diverse healthcare settings.

AUTHOR CONTRIBUTION

Author	Contribution
Mamoon Rasheed*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Sayed Farrukh Nadeem	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Saira Ahmed	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published

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Author	Contribution
Alia Shaheen	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Moeen Iqbal	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Qamar Mehboob	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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