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Accuracy of Focused Assessment with Sonography in Trauma (FAST) In Detecting Visceral Injury Following Blunt Trauma with Computed Tomography (Ct) as A Gold Standard

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ABSTRACT

Blunt abdominal trauma is one of the major causes of morbidity and mortality around the world. The prompt identification of visceral damage is crucial for effective management, and FAST is a proven, widely adopted first-line imaging tool. **Objectives:** To investigate the diagnostic value of FAST for ascertaining the presence of visceral injuries after blunt abdominal injury, keeping the CT scan as the reference measure. **Methods:** A cross-sectional study was implemented at the Department of Radiology, Aga Khan University Hospital, Karachi, from June 2025 to September 2025. A population of 103 patients meeting eligibility criteria with blunt abdominal trauma was selected by non-probability consecutive sampling. FAST was performed on all patients, with the findings subsequently correlated with subsequent CT scans. A 2x2 contingency table in which the CT scan served as the gold standard was used to estimate sensitivity, specificity, positive and negative predictive values of FAST, and its diagnostic accuracy. SPSS version 26.0 was used to analyze data using the Shapiro-Wilk test. **Results:** FAST had a sensitivity of 88.24% and a specificity of 81.16%. Total diagnostic accuracy was 83.50%. The PPV was 69.77% and the NPV 93.33%. FAST was noted to be highly efficient for detecting intra-abdominal injuries; however, some false positives were also reported. **Conclusions:** FAST is a non-invasive, diagnostic measure as a preliminary assessment of blunt abdominal trauma with a good sensitivity and NPV, and hence turns out to be a useful screening test, particularly in resource-limited and emergency settings.

INTRODUCTION

Traumatic injury is one of the major causes of death among people under the age of 45 years and plays a substantial role in disease burden worldwide. Trauma is mostly blunt in nature, with about 80% mortality resulting from hypovolemic shock. Accurate and timely detection of internal bleeding is therefore critical; however, it remains a challenge, giving rise to one of the most important gaps in knowledge in resource-limited environments, where the optimized imaging strategies are not yet developed. Computed tomography (CT) is considered to be the gold standard for evaluating abdominal visceral injury in blunt trauma [1]. It is sensitive in the detection of solid organ parenchymal laceration, intraparenchymal hematoma, and hollow viscus injuries. In addition, CT can be used to obtain grades of injury, provide treatment guidance for associated thoracic or pelvic trauma, and aid in surgical or interventional planning [2]. Its multiplanar and contrast-enhanced functions offer important anatomical details, which are cardinal for trauma assessments [3]. Nevertheless, CT has shortcomings in acute trauma

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settings. For instance, the transportation of patients to the CT suite can delay resuscitation in unstable patients, leading to deterioration of outcomes. Other issues include exposure to ionizing radiation and the necessity of using iodinated contrast media, especially in children, pregnant patients, and those affected by renal issues [4]. In addition, CT is quite costly, involves heavy infrastructure, and requires human resources. Hence, the use of CT as a first-line imaging modality for all patients with blunt trauma, particularly those with hemodynamic instability, is clinically debatable [5]. On the other hand, ultrasound has logistical and safety benefits as it is easy to carry around, repeatable, non-ionizing, and can be performed without disrupting resuscitation efforts [6]. The current ultrasound technology allows real-time evaluation of the dynamic movement of intraperitoneal or pericardial fluid. These qualities have contributed to the high rates of the implementation of Focused Assessment with Sonography in Trauma (FAST) in pre-hospital and emergency department settings. FAST is primarily aimed at identifying free intraperitoneal or pericardial fluid that is a sign of internal hemorrhage. In the setting of blunt abdominal trauma, this indicates hemoperitoneum resulting from solid visceral injury, hollow viscus perforation, or both [7]. The presence of such fluids can be detected to institute timely triage, such as emergency laparotomy, interventional radiological procedures, or additional imaging. In view of these, FAST is often criticized over diagnostic performance, as it is operator-specific and is dependent on the education, experience, and knowledge of the sonographer about the trauma protocols [8]. FAST is sensitive in the detection of moderate to large fluid accumulation but is insensitive to small-volume hemoperitoneum or isolated parenchymal injury in the absence of free fluid [9].

In acute blunt abdominal trauma, reliance on computed tomography as the primary diagnostic modality is often impractical in hemodynamically unstable patients and resource-limited settings, while the true diagnostic reliability of FAST remains uncertain. There is limited local evidence directly correlating positive FAST findings with CT-confirmed visceral injuries, highlighting the need for context-specific validation of FAST accuracy in blunt abdominal trauma. This study aimed to establish the accuracy of positive FAST as a method of identifying visceral injury in blunt abdominal trauma, keeping CT as the gold standard.

METHODS

This was a cross-sectional diagnostic accuracy study designed to determine the sensitivity of FAST in visceral damage following blunt abdominal trauma, using CT as a reference tool [10]. The study was conducted in the Department of Radiology, Aga Khan University Hospital, Karachi, Pakistan, a tertiary care hospital that manages a high volume of emergency patients and is equipped with advanced diagnostic imaging facilities. Clearance was obtained from IRB (ID 2025-11517-35095) with an exemption of informed consent as per protocol following approval of synopsis by the CPSP (Ref no: CPSP/REU/RAD-2021-175-3541). The duration of this study was six months (June 2025 to September 2025). Ultrasound examinations were performed by sonographers and residents with at least 1 year of experience. CT scans were conducted using a Toshiba Aquilion 640 scanner. Sensitivity and specificity with sample size (103) were calculated with the help of the WHO sample size calculatoras shown in the population pyramid (Figure 1).

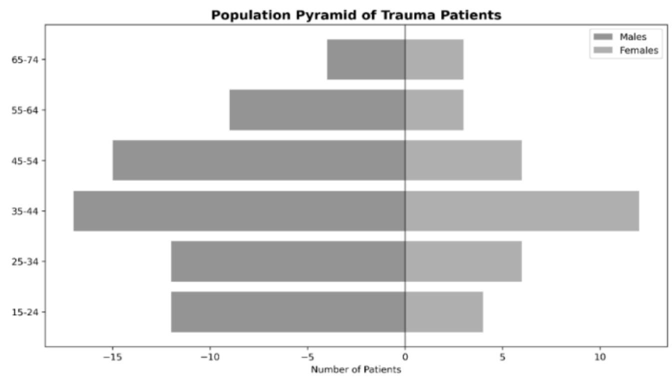

Figure 1: Population Pyramid of Trauma Patients

Prevalence of visceral injury in the study population was expected to be 20-40%, depending on the reported prevalence in general cohorts of blunt abdominal trauma. This is important because prevalence must be taken into account in estimating the numbers of diseased and non-diseased subjects. A few important terminologies and their definitions related to the study include diagnostic accuracy, which is the proportion of subjects correctly classified as having or not having the target condition. It is calculated as {TP + TN} / {TP + TN + FP + FN}. This measure is influenced by disease prevalence and is not independent of sensitivity and specificity. Blunt abdominal trauma is a non-penetrating injury of forceful impact, e.g., falls, vehicle accidents, or striking an object affecting the abdomen of a person. Positive CT refers to observations that confirm or validate positive FAST findings, i.e., presence of intra-abdominal injuries. Here, the outcomes can be segregated as: Sensitivity = TP / (TP + FN), Specificity = TN / (TN + FP), Positive Predictive Value (PPV) = TP / (TP + FP), Negative Predictive Value (NPV) = TN / (TN + FN). Patients who have had a history of blunt abdominal injuries and presented to the Emergency Room within one week of the insult, abdominal pain that persisted after blunt trauma, and all ages and genders of patients were included. Patients with a history of abdominal trauma, having known/pre-existing

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ascites (that could invert the results of FAST), and patients who were positive in FAST examination but failed to receive further evaluation in CT in AKUH were excluded. The major quantitative information was collected by means of observation (FAST examination, CT imaging) and analysis of the medical records. For secondary data, demographics were collected from hospital records following the Declaration of Helsinki research [11]. The safety of the patients was assured by the administration of masked identification codes rather than IDs to patients [12]. A consultant radiologist applied the standard FAST protocol, and records of data were recorded in a pre-designed proforma, which included Demographics: age, gender, mechanism of injury, location of impact point, use of other conditions that may alter the interpretation of ultrasound, FAST results, and CT results. The categorical variables (gender, mechanism of impact, site of impact, FAST results, CT findings) were illustrated in the form of frequencies and percentages. Continuous variables (age) were tested according to Shapiro Wilk whether they follow a normal distribution or not [13]. FAST sensitivity was estimated by the use of the 95% intervals of the study population. Similarly, specificity, PPV, NPV, and diagnostic accuracy were defined with 95% CI to estimate the parameters of the population [14]. SPSS version 26.0 was used to conduct the statistical analysis. Shapiro-Wilk was used for testing the normality of quantitative variables [15-17].

RESULTS

Out of the 155 patients who were first enrolled under blunt abdominal trauma, 52 patients were dropped, and this left 103 patients to be analyzed. The final sample consisted of 69 male (67%) and 34 female (33%) whose ages were between 18 and 80 years (mean age 42.6 ± 16.3 years). All participants had undergone FAST and abdominal/pelvic CT during a hospital admission. Spleen (n=12) and liver (n=8) were the most commonly injured organs among the 34 CT-positive cases, followed by combined liver/spleen (n=6), kidney (n=4), pancreas (n=2), duodenum (n=1), and colon (n=1). FAST detected splenic (91.7%) and liver injuries (90.9%) more often than kidney injuries (71.4%, p=0.038), because retroperitoneal bleeding occurs in the retroperitoneal space, which is harder to see on standard FAST scans compared to intraperitoneal hemorrhage (Figure 2).

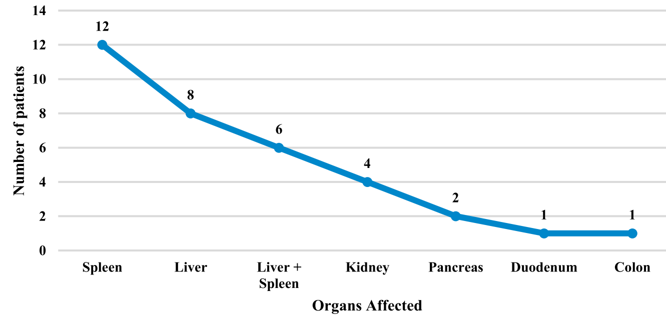

Figure 2: Distribution of Visceral Injuries in Blunt Abdominal Trauma

Diagnostic CT scan identified visceral injuries in 34 patients (33.0%) and no injuries in 69 patients (67.0%). FAST was positive in 43 patients (41.7%) and negative in 60 patients (58.3%). Using CT as the reference standard, FAST demonstrated 30 true positives, 56 true negatives, 13 false positives, and 4 false negatives. Figure 3 shows the breakdown of these diagnostic outcomes (Figure 3).

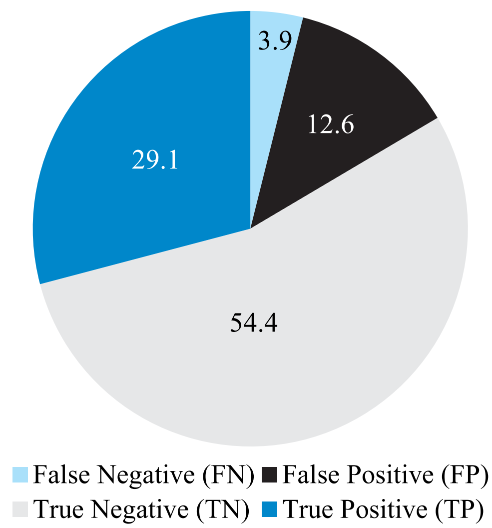

Figure 3: FAST Diagnostic Performance Breakdown

Diagnostic indices of FAST in the diagnosis of visceral injury were as follows: Sensitivity was 88.24% (95% CI: 74.2-95.8%), specificity was 81.16% (95% CI: ~70–89%), Positive Predictive Value (PPV) was 69.77%, Negative Predictive Value (NPV) was 93.33%, overall diagnostic accuracy was 83.50%, and F1 score was 77.78%. These findings suggest that FAST was sensitive in identifying most patients with CT-documented visceral injury and specific (excluding injury) (Table 1).

Table 1: Contingency Table for Diagnostic Performance of FAST in Detecting Visceral Injury Secondary to Blunt Abdominal Trauma, Using CT as Gold Standard (n=103)

Variables	CT Positive, Frequency (%)	CT Negative, Frequency (%)	Total Number
FAST Positive	30/43 (9.7%) TP	13/43 (30.3%) FP	43
FAST Negative	4/60 (6.7%) FN	56/60 (93.3%) T	60
Total Number	34	69	103

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The high NPV indicates that a negative FAST result was unlikely to miss important visceral injury in this population. FP (n=13) were found mainly in the presence of minimal peritoneal fluid of non-traumatic origin. In the 13 FPs, 84.6% had peritoneal fluid (less than 50 mL). This fluid was subsequently found to be non-traumatic, like normal pelvic fluid, fluid that was already present as ascites (incidental and not known to the patient), or fluid that developed as a result of inflammation. A Fisher's exact test validated the existence of a close association between small fluid volume and FP outcomes (p=0.001, odds ratio=12.4, 95% CI=3.2-48.1). FN (n=4) was common in isolated and solitary solid organ injuries in the absence of massive hemoperitoneum or bleeding volumes, too small to be detectable by FAST. All FNs (n=4, 100%) were caused by isolated solid-organ injuries in the presence of low-volume hemoperitoneum (<200 mL). Chi-square test was done to show that the factor of no moderate-large free fluid in isolated injury showed a significant FN (p=0.012). It also demonstrated that FAST failure was closely associated with low-volume hemoperitoneum (p=0.003). Sensitivity of 88.24% means that FAST missed approximately 12% of cases with visceral injury, while the specificity of 81.16% indicates a moderate rate of FP (Figure 4).

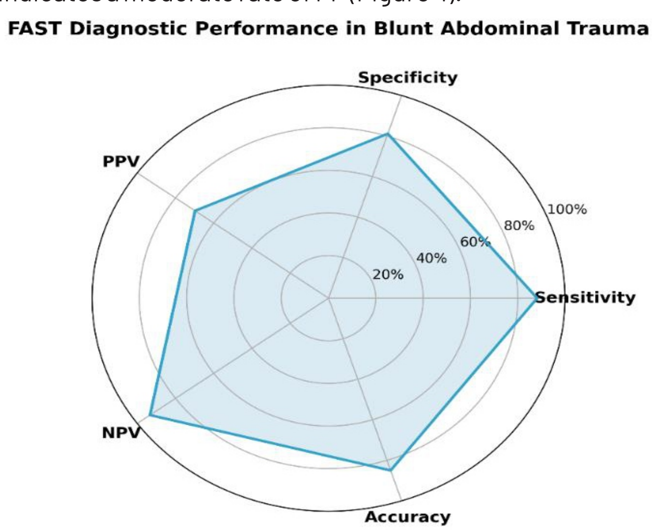

Figure 4: FAST Diagnostic Performance in Blunt Abdominal Trauma

Out of significance is the NPV 93.33% (95% CI: 84.2-97.4%), which meant that a negative FAST essentially eliminated any significant visceral injury in over 9 out of 10 cases. This large NPV favors the clinical utility of FAST as a high-speed screening tool in unstable trauma patients in the absence of urgent CT. However, the moderate PPV of 69.77% (95% CI: 55.2–81.3%), in turn, highlights the importance of confirmatory CT with positive FAST results to avoid unnecessary surgery or intervention. The sensitivity of 88.24% observed is higher than the benchmark of 80%. No statistically significant difference was detected in one-sample proportion testing (p=0.089), which may be because of the lack of sufficient data (n=34 true positives). However, the statistics validate that FAST has the lowest acceptable sensitivity limits, which means it can be used clinically.

DISCUSSION

This study presented a sensitivity of 88.24% (95%, CI: 73.4-95.4%), specificity of 81.16% (95%, CI: 70.4-88.7%), which demonstrates that FAST proves effective in the detection of visceral injuries and can be considered a valid triage assessment in resource-constrained environments where CT is not available. High sensitivity provides a high-level of detection of most patients with visceral injuries, which can be addressed by a timely surgical or interventional response. The study has a good range of sensitivity and specificity in relation to recent studies. Glia and Hamir and Rofananda *et al.* had greater sensitivity (98.3%) as they had highly trained operators and controlled conditions, though it appears that their specificity is low, indicating they over-interpret some results [18, 19]. Conversely, Jabbar *et al.* attained greater specificity (97.8%) due to optimized protocols in fixed cohorts [20]. Current findings are mirrored in studies by Glia and Hamir and Rashid *et al.* which indicate moderate-to-high performance that can be replicated in other similar clinical settings [18, 21]. The negative predictive value of 93.33% (95%, CI:84.1-97.4%) means that negative FAST predicts the absence of any significant visceral injury with a high degree of reliability in over 93% of patients. This large NPV is comparable to Rofananda *et al.* (91.2%) and higher than Salah *et al.* (88.5%), which confirms the validity of FAST in the emergency triage [19, 17]. Observation protocols are safe in hemodynamically stable patients with a negative FAST, without unnecessary radiation and costs, in case of the unavailability of urgent CT. The high NPV 93.33% (95% CI: 84.1-97.4%) indicates that clinicians can be sure that there is no serious visceral injury in hemodynamically unstable patients with a negative FAST, allowing clinicians to promptly focus on extra-abdominal sources of hemorrhage or to begin observation protocol even before a CT scan. Nevertheless, the FN rate was 6.7%, which requires serial tests and constant clinical follow-up. The positive predictive value of 69.77% implies that nearly 30% of positive FAST outcomes could be false. Our PPV is similar to Jabbar *et al.* [20] (72.4 %), but lower than Rashid *et al.* (85.3%) [21]. The FP (n=13) was primarily because of non-traumatic peritoneal fluid, like physiologic ascites or pelvic fluid, and this is why confirmatory CT of a stable patient with positive FAST is necessary to help avoid unnecessary surgery. FN (12% of real injuries) were primarily due to isolated solid organ injuries that did not have extensive hemoperitoneum. These instances illustrate that FAST is not able to detect

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smaller volumes of bleeding or lack of free fluid parenchymal injuries. This has clinical implications for serial FAST examination and close observation for trauma patients who are persistently abdominally tender even after the early negative FAST. The strengths of the study included prospective data collection, standardization of FAST protocols, and CT confirmation in each and every case, which gave high diagnostic accuracy. The clinical practice environment of the emergency department in the real-world setting increases the applicability of the results to other tertiary hospitals with resource constraints in the same area.

There are certain limitations, such as the variability of operators, since FAST exams were conducted by different radiologists and emergency physicians without standardized proficiency evaluation. Omission of penetrating injuries and cases without follow-up CT is a risk of biasing the sample to the hemodynamically stable cases. The sample size (n=103) is small for estimates with high accuracy, particularly in subgroups. Future studies should test longer FAST (E-FAST) protocols to diagnose pneumothorax and retroperitoneal trauma, adopt standardized operator training, and consider artificially intelligent assisted estimations as reported by computer scientists to lessen variability introduced by operators and enhance the accuracy of diagnosis in the Emergency Department.

CONCLUSIONS

FAST is a valid and quick screening method for identifying blunt intra-abdominal visceral injuries. The study supports its application in emergency and resource-constrained environments. Confirmatory CT is necessary for detailed assessment and characterization of injuries to guide subsequent management. FAST and CT are complementary methods that maximize the diagnostic accuracy, patient outcomes, and resource usage.

Authors' Contribution

Conceptualization: SSQ
Methodology: SSQ, DBK, NZ
Formal analysis: SSQ, DBK, NZ
Writing and Drafting: SSQ, DBK, NZ, SS, MS
Review and Editing: SSQ, DBK, NZ, SS, MS

All authors approved the final manuscript and take responsibility for the integrity of the work.

Conflicts of Interest

All the authors declare no conflict of interest.

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