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DIAGNOSTIC ACCURACY OF FOCUSED ASSESSMENT WITH SONOGRAPHY IN TRAUMA PERFORMED BY EMERGENCY MEDICINE VERSUS RADIOLOGY RESIDENTS IN BLUNT ABDOMINAL TRAUMA

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Abstract

Objective: *To compare the diagnostic accuracy of FAST performed by emergency medicine residents (EMRs) and radiology residents (RRs) for detecting intraperitoneal free fluid in blunt abdominal trauma.*

Study Design: *Comparative cross-sectional diagnostic-accuracy study.*

Settings: *Accident and Emergency Department, Jinnah Postgraduate Medical Centre, Karachi.*

Period: *Four months from January 2025 to April 2025.*

Material & Methods: *Independent, blind FAST examinations by an Emergency Medicine Resident (EMR) and a Radiology Resident (RR) were performed on 276 patients, aged 16-65 years, before a contrast-enhanced computed tomography (CECT) scan scheduled to occur within 6 hours. For each assessment, sensitivity, specificity, predictive values, and accuracy were considered. The exact McNemar test was used to compare paired accuracy, and descriptions of agreement were assessed with Cohen's Kappa.*

Results: *CECT was positive for free fluid in 49/276 patients (17.8%). EMR-FAST identified 44 true positives (TP), 224 true negatives (TN), 3 false positives (FP), and 5 false negatives (FN). Sensitivities, specificities and accuracy for EMR-FAST were 89.8%, 98.7% and 97.1%, respectively. RR-FAST identified 47 TL, 225 TN, 2 FP and 2 FN. Sensitivities, specificities and accuracy for RR-FAST were 95.9%, 99.1% and 98.6%, respectively. The difference in accuracy, 1.4%, was not significant (exact McNemar p = 0.388). The inter-operator agreement was 95.7% with a kappa score of 0.849.*

Conclusion: *Based on the findings, the accuracy of the EMR-FAST was high, and agreement with the RR-FAST was substantial. For EMR-FAST, the negative predictive value was also high, but FAST should not be considered a replacement for CECT in the presence of a high clinical index of suspicion.*

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INTRODUCTION

The greatest burden of road traffic injury is on low- and middle-income countries. Trauma causes a great deal of avoidable morbidity and mortality.[1] Blunt abdominal trauma in particular can be very dangerous, as significant hemorrhage can be occult. Contemporary studies and reports from Pakistan, especially from Jinnah Post-Graduate Medical Centre (JPMC), show a significant burden of visceral injury and the necessity for time-sensitive and organized diagnostic pathways.[2,3] The modern trauma management integrates the continuum of resuscitation, bedside assessment, CT, interventional radiology, and surgery along the continuum of the patient's hemodynamic status.[4]

Focused assessment with sonography in trauma (FAST) is a rapid and repeatable scan that is free of ionizing radiation and can be used to identify free fluid within the abdominal, cardiac, and thoracic cavities.[5] Focused assessment with sonography in trauma has high specificity, but variable sensitivity depending on multiple factors including the volume and the pattern of the injury, the timing of the exam, patient habitus, operator experience, and quality of the equipment.[6,7] A 2023 individual participant data meta-analysis of prehospital FAST has shown that a positive FAST scan would be a sufficient reason to transport the patient to the hospital; whereas a negative FAST scan should not be used to rule out injury.[8] Trauma ultrasound is included as one of the main applications of emergency point-of-care ultrasound by the American College of Emergency Physicians.[9]

With the traditional reliance on radiology to perform FAST, this has delayed many bedside decisions in trauma care. There is limited local evidence either to support (or oppose) the use of CECT as a FAST scan replacement in the local Emergency Medicine and Radiology practice.[10-12] At JPMC, FAST has traditionally depended on radiology availability, which may delay bedside decision-making during crowded trauma care. Local evidence directly comparing emergency medicine and radiology residents against the same CECT reference standard is limited. The study aimed to assess and compare sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy and agreement of the EMR and RR performed FAST in blunt abdominal trauma patients.

MATERIAL & METHODS

Study design: Comparative cross-sectional diagnostic-accuracy study with two paired index tests and a common reference standard.

Setting and period: The Accident and Emergency Department of Jinnah Postgraduate Medical Centre, Karachi, over a four-month study period from January 2025 to April 2025.

Sample size and sampling: The required sample size was 276, using a 95% confidence level, expected sensitivity of 85.7%, expected prevalence of free fluids of 17.4%, and 10% absolute precision. Non-probability consecutive sampling was employed for participant enrollment.

Inclusion criteria: All patients, male or female, aged 16 to 65 years, who presented within 24 hours of blunt abdominal trauma, were either stable or had been stabilized following initial resuscitation, were then able to undergo CECT, and signed the informed consent form.

Exclusion criteria: Patients with penetrating abdominal trauma; unstable patients who required an immediate laparotomy; patients with pregnancy, chronic ascites, peritoneal dialysis, or other conditions that may cause free abdominal fluid, or patients who had a contraindication to intravenous contrast, or patients who did not give their consent to the examination, or paired examinations which were of low quality, or which were of diagnostic value.

Index tests and reference standard: Following the standard trauma survey, an EMR performed a 4-window FAST exam with a 3.5-5 MHz curvilinear transducer. This was followed by an RR who was blinded to the EMR result. The EMRs completed a structured 2-day point-of-care ultrasound (POCUS) workshop and at least 25 supervised FAST exams; RRs were in their 2nd year of training or more. Each operator recorded the subxiphoid, RUQ, LUQ, and suprapubic views. Any anechoic stripe

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consistent with free fluid in at least 1 window was considered a positive FAST exam. All subjects underwent a CT scan of the abdomen and pelvis with contrast within 6 hours, and it was reported by a consultant radiologist who was blinded to both FAST exam results. Any free fluid in the abdomen and pelvis on CECT was considered a positive reference standard.

Data collection: Age, sex, body mass index, injury mechanism, time from injury, initial vital signs, Glasgow Coma Scale score, haemodynamic status, both FAST results, CECT result, organ injury and emergency-department disposition were recorded on a structured proforma using a unique study identifier.

Statistical analysis: Data were analyzed using SPSS version 26. Continuous variables were represented as mean ± standard deviation and minimum-maximum; categorical variables as count and percentage. Separate 2 x 2 tables were constructed for EMR-FAST and RR-FAST against CECT. 95% Wilson confidence intervals were used to report sensitivity, specificity, PPV, NPV, and overall test accuracy. Exact McNemar tests were used to compare paired correctness and paired positive proportions. Cohen's kappa was used to measure the agreement of EMR-CECT, RR-CECT, and EMR-RR; 95% confidence intervals of kappa and the paired accuracy difference were assessed by paired bootstrap resampling. A two-sided p-value of less than 0.05 was considered statistically significant.

Ethical approval: The study was granted ethical approval by the JPMC Institutional Review Board (IRB# F.2-81/2025-GENL/226/JPMC). Written informed consent was obtained, routine trauma care was not delayed, and only de-identified data were analyzed.

RESULTS

All 276 enrolled patients had complete paired FAST and CECT results. Mean age was 40.63 ± 14.39 years. 148 (53.6%) were male. The most frequent recorded mechanisms of injury were falls (22.5%), assaults and other (20.3% each), road traffic injuries (19.6%), and crush injuries (17.4%). Baseline characteristics are summarized in Table I.

Table-I: Baseline demographic and clinical characteristics (n=276)

Characteristic	Value	Range / distribution
Age (years)	40.63 ± 14.39	16-65
Male sex	148 (53.6%)	Female: 128 (46.4%)
Body mass index (kg/m²)	25.93 ± 6.10	14.6-41.5
Time since injury (hours)	11.73 ± 6.77	0.7-24.0
Mechanism	Fall: 62 (22.5%)	Other: 56 (20.3%); Assault: 56 (20.3%); RTC: 54 (19.6%); Crush: 48 (17.4%)
Haemodynamic status	Stable: 140 (50.7%)	Stabilized after resuscitation: 136 (49.3%)
Systolic blood pressure (mmHg)	113.76 ± 14.65	90-140
Pulse (beats/min)	91.90 ± 18.06	60-120
Respiratory rate (breaths/min)	19.95 ± 4.92	12-28
SpO_2 (%)	95.88 ± 2.60	92-100
Glasgow Coma Scale	13.46 ± 1.12	12-15

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CECT detected intraperitoneal free fluid in 49 patients (17.8%; 95% CI: 13.7, 22.7%). Among these patients, documented organ injury included the liver in 14 (28.6%), the spleen in 11 (22.4%), the kidney in 11 (22.4%), and other organs in 13 (26.5%). A total of 155 (56.2%) patients were admitted to a ward, 23 (8.3%) patients were admitted to intensive care, and 98 (35.5%) patients were discharged from the emergency department.

EMR-FAST was positive in 47 patients; among these, 44 CECT-positive individuals were identified with three false positives and five false negatives. RR-FAST was positive in 49 patients; among these, 47 CECT-positive individuals were identified with two false positives and two false negatives (Table-II).

Table-II: FAST results cross-tabulated against CECT (n=276)

Operator	FAST result	CECT negative	CECT positive	Total
Emergency medicine resident	Negative	224	5	229
	Positive	3	44	47
Radiology resident	Negative	225	2	227
	Positive	2	47	49
Reference-standard total		**227**	**49**	**276**

EMR-FAST sensitivity was 89.8% (95% CI 78.2-95.6%), specificity 98.7% (96.2-99.5%), PPV 93.6% (82.8-97.8%), NPV 97.8% (95.0-99.1%) and accuracy 97.1% (94.4-98.5%). RR-FAST sensitivity was 95.9% (86.3-98.9%), specificity 99.1% (96.8-99.8%), PPV 95.9% (86.3-98.9%), NPV 99.1% (96.8-99.8%) and accuracy 98.6% (96.3-99.4%) (Table-III).

Table-III: Diagnostic performance of EMR-FAST and RR-FAST against CECT

Measure	EMR estimate	95% CI	RR estimate	95% CI
Sensitivity	89.8%	78.2-95.6	95.9%	86.3-98.9
Specificity	98.7%	96.2-99.5	99.1%	96.8-99.8
Positive predictive value	93.6%	82.8-97.8	95.9%	86.3-98.9
Negative predictive value	97.8%	95.0-99.1	99.1%	96.8-99.8
Overall accuracy	97.1%	94.4-98.5	98.6%	96.3-99.4
Cohen's kappa vs CECT	0.899	0.823-0.961	0.950	0.896-0.989

CI: confidence interval; CECT: contrast-enhanced computed tomography; EMR: emergency medicine resident; RR: radiology resident. Proportion CIs are Wilson intervals; kappa CIs are paired bootstrap intervals.

The RR accuracy exceeded EMR accuracy by 1.4 percentage points (paired bootstrap 95% CI -1.1 to 4.0), but the paired difference was not statistically significant (exact McNemar p=0.388). The operators agreed on 264/276 FAST classifications (95.7%); interoperator kappa was 0.849 (95% CI 0.757-0.925). Positive-result rates also did not differ (17.0% vs 17.8%; exact McNemar p=0.774). Paired findings are detailed in Table-IV.

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Table-IV: Paired comparison and agreement between operator groups (n=276)

Paired measure	Result
Both operators correct	264 (95.7%)
EMR correct / RR incorrect	4 (1.4%)
RR correct / EMR incorrect	8 (2.9%)
Both operators incorrect	0
RR minus EMR accuracy	1.4 percentage points (95% CI -1.1 to 4.0)
Exact McNemar test for paired accuracy	p=0.388
Overall operator-result agreement	264/276 (95.7%)
Cohen's kappa between operators	0.849 (95% CI 0.757-0.925)

Accuracy remained high in both haemodynamic strata. Among stable patients, EMR and RR accuracy were 97.1% and 99.3%, respectively; among patients stabilized after resuscitation, corresponding accuracies were 97.1% and 97.8%.

DISCUSSION

This paired diagnostic-accuracy study showed trained EMRs had an 89.8% sensitivity level, a 98.7% specificity level, and a 97.1% overall accuracy level for detecting intraperitoneal free fluid. Though RRs achieved slightly better sensitivity and accuracy levels, the overall accuracy difference was small, the confidence interval of the difference included no overall accuracy difference, and the exact McNemar test was not significant. There was high interoperator agreement. Based on these findings, EMR-performed FAST is a clinically useful bedside skill in a structured trauma pathway when trained and supervised and if used in conjunction with appropriate confirmatory imaging.

The performance observed in this study is better than recent Pakistani data. A 2022 cross-sectional validation study from Combined Military Hospital Kohat reported a sensitivity of 88.9%, a specificity of 82.4%, and an overall accuracy of 87.1% against laparotomy.[13] A CT-referenced study from Abbottabad reported a sensitivity of 93.9%, a specificity of 85.4%, and an overall accuracy of 91.1%,[14] and a 2025 study from Peshawar reported a sensitivity of 78.9%, a specificity of 91.8%, and an overall accuracy of 84.9%.[15] Differences in disease prevalence, outcome definition, verification strategy, and operator training may explain most of this variation. The present study's paired design is an additional strength because both operator groups were judged in the same patients against the same blinded CECT reference standard.

Consistently high specificity, but varying levels of sensitivity, is characteristic of FAST. Kim's study found a sensitivity of 33.3% and a specificity of 98.8%. The authors of the study noted that clinically significant injuries may occur despite a lack of initially detectable free fluid. Another study found similar results, showing varying levels of sensitivity to the FAST test.[6] Although the sensitivity was low in the studies, the positive results of the various tests sped up patient diagnoses and treatments.[7] Similar results of the FAST test on other injuries were obtained when the tests were used in conjunction with other methods (e.g., measuring the presence of blood in the urine).[8] Further studies on the use of Emergency Physicians to perform certain tests on traumatized patients showed good results. This method was also evaluated for the use of Trauma Ultrasound in stable patients. While the use of Trauma Ultrasound may be justified in certain situations, Trauma Ultrasound does require the use of supplemental validation.[16,17]

The impact of this research is important for a busy public sector Emergency Department. The use of Trauma Ultrasound has become standard in Emergency practices. Trauma

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Ultrasound requires the acquisition of a diagnostic image.[10] Trauma Ultrasound requires standard practices of image acquisition, interpretation, and documentation.[11,12] Reviewing images after each use of Trauma Ultrasound is important. To implement this at JPMC, use should be monitored and validated, and further training should be offered, rather than letting practices be unrestricted after a brief training course.

FAST should maintain its status as a rule-in and hypotension severity triage tool. Modern trauma and peritonitis guidelines endorse using CT for stable patients with versus without clinical suspicion, and FAST cannot rule in solid organ, mesenteric, or peritonitis injuries.[4,5,18] Even a normal CT is still interpreted with the clinical scenario and mechanism of injury.[19] In this study, EMR FAST was unable to detect five of the CECT-positive patients, and RR FAST was unable to detect two of the CECT-positive patients. This study leaves a lingering false-negative risk, thus requiring additional FASTs and the motivation for a timely CECT instead of reassurance from a negative bedside scan.

More recent studies show that FAST can help with prognosis and triage.[20,21] In addition, the perception is that serial FAST exams can reveal previously undetected fluid.[21] Pediatric studies and consensus also support the important notion that a negative FAST does not rule out injury.[22,23] The adult data presented here further support these notions by demonstrating that, as part of a protocol, EMR can approximate results of resident FAST exams with no loss in paired accuracy.

This study has several limitations. It used a single tertiary center and non-probability sampling. Therefore, it may be difficult to generalize the results. Every time the EMR examination was completed, the RR examination was done next. Therefore, it is possible that order effects are present even with masking, and neither the variability of experience nor examination times were included in the model. CECT was the reference standard only for the patients who were stable enough to undergo the imaging. This study does not apply to unstable patients who were taken directly to surgery. For CECT-positive cases, the sensitivity interval was larger than the specificity interval. This study assessed the detection of free fluid and not injury to other parts of the abdomen. This study also did not assess if EMR-FAST decreased the time to CT or to the patient's final destination.

CONCLUSION

The emergent evaluation of intraperitoneal free fluid by emergency medicine residents was accurate and agreed with the RR. The minor difference in favor of RR was not statistically significant. We expect that this study supports the decision to implement the EMR-FAST at JPMC under quality assurance and the continued use of CECT and surgical evaluation when the clinical situation warrants.

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