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E-FAST AS A PRIMARY SURVEY ADJUNCT IN TRAUMA PATIENTS: A CROSS-SECTIONAL STUDY

Original Research

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ABSTRACT

Background: Trauma remains a leading cause of morbidity and mortality worldwide, necessitating rapid and accurate diagnostic tools during the initial assessment. Conventional imaging methods such as chest and pelvic radiographs are time-consuming and resource-dependent. The extended Focused Assessment with Sonography for Trauma (e-FAST) integrates abdominal, thoracic, and pericardial views, enabling early detection of life-threatening injuries like pneumothorax, haemothorax, and hemoperitoneum. Its role as a primary survey adjunct, however, remains under evaluation.

Objective: To determine the diagnostic accuracy and clinical utility of e-FAST as a primary adjunct in the initial trauma survey and its influence on emergency management decisions.

Methods: A prospective, cross-sectional study was conducted over 12 months (May 2024–May 2025) in the Emergency Department of a tertiary care teaching hospital. One hundred adult trauma patients were enrolled using convenience sampling. Each underwent a real-time e-FAST examination performed by trained emergency physicians during the primary survey. Findings were compared with computed tomography (CT) or intraoperative results as reference standards. Diagnostic performance indices, including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), were calculated using IBM SPSS Statistics version 26.0. Associations were assessed using the Chi-square test with $p < 0.05$ considered significant.

Results: The mean age was 42.5 ± 16.8 years, with males comprising 75%. Road traffic accidents accounted for 60% of injuries. e-FAST demonstrated sensitivity and specificity of 94.4% and 98.8% for hemoperitoneum, 86.7% and 100% for hemothorax, and 91.7% and 99.9% for pneumothorax, respectively. The median scan time was 6 minutes (IQR: 4–8). In 15% of patients, e-FAST findings led to immediate surgical or procedural intervention ($p < 0.001$).

Conclusion: e-FAST is a highly accurate, rapid, and non-invasive diagnostic modality for the early identification of thoraco-abdominal injuries in trauma patients. It surpasses conventional radiographs in diagnostic efficiency and significantly influences critical management decisions. Routine integration of e-FAST into the primary trauma survey can optimize resuscitation workflows and improve patient outcomes.

Keywords: Abdomen, Emergency Medicine, Hemoperitoneum, Pneumothorax, Point-of-Care Ultrasound, Thoracic Injuries, Trauma.

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INTRODUCTION

Trauma remains one of the foremost causes of morbidity and mortality worldwide, contributing substantially to the global burden of disease (1,2). In Pakistan, major trauma continues to challenge public health systems due to the rising frequency of road traffic accidents, occupational injuries, and limited access to specialized trauma care (3,4). Early diagnosis and rapid management of injuries are essential to improving survival and minimizing complications. However, internal haemorrhages such as intra-abdominal bleeding, haemothorax, pneumothorax, and cardiac tamponade often remain "invisible" during initial evaluation, leading to missed or delayed diagnoses with potentially fatal outcomes (5). The initial management of trauma patients represents a crucial window in which rapid identification of life-threatening injuries and stabilization of vital functions must occur simultaneously. The Advanced Trauma Life Support (ATLS) framework underscores the importance of a structured and systematic primary survey supplemented with appropriate diagnostic adjuncts (6). Conventional imaging modalities—including chest X-ray (CXR), pelvic X-ray (PXR), and computed tomography (CT)—are integral to trauma assessment, yet their dependence on patient transfer, time, and resource availability limits their utility in fast-paced or resource-constrained emergency departments (EDs). The emergence of Focused Assessment with Sonography for Trauma (FAST) in the early 1990s revolutionized emergency trauma imaging by offering a rapid, non-invasive bedside method for detecting intraperitoneal and pericardial fluid (7). Its concurrent use during resuscitation facilitated early decision-making, establishing its role as a point-of-care diagnostic tool (8). The evolution of FAST into extended FAST (e-FAST) further enhanced its diagnostic scope by including thoracic views to detect pneumothorax and hemothorax alongside cardiac and abdominal assessments (7). Consequently, point-of-care ultrasonography has become an indispensable part of modern emergency and critical care medicine—often described as the "ultrasound stethoscope" of the contemporary clinician (9,10). It allows real-time evaluation of thoracic, cardiac, and abdominal structures with high diagnostic precision, without radiation exposure (11–14).

Multiple studies have demonstrated that thoracic ultrasonography surpasses supine CXR in detecting pneumothorax and hemothorax, especially in immobilized trauma patients (8,13). Additionally, evidence suggests that PXR contributes minimally to management decisions in hemodynamically stable trauma cases, whereas e-FAST provides a quick and reliable alternative capable of influencing early interventions. Despite these advantages, e-FAST has yet to achieve universal validation as a substitute for conventional imaging, particularly in developing trauma systems where resources and expertise vary. In low- and middle-income countries (LMICs) such as Pakistan, where constraints in manpower, imaging infrastructure, and emergency workflow are common, e-FAST offers distinct advantages. The technique is portable, cost-effective, easily reproducible, and safe, requiring limited training while providing immediate clinical insight. It primarily serves as a "rule-in" tool for critical findings, aiding in prioritization of interventions rather than exhaustive exclusion of injuries. In overcrowded EDs with high patient volumes, e-FAST can shorten length of stay (LoS), expedite decision-making, and improve overall patient outcomes. Structured POCUS (Point-of-Care Ultrasound) training initiatives in LMICs further support its feasibility, provided curricula are adapted to local healthcare realities (15). Although FAST is widely incorporated into trauma care algorithms, its extended version (e-FAST) remains less studied as a real-time diagnostic adjunct during the initial trauma survey, particularly in LMIC emergency settings. Most studies from Pakistan have been confined to radiology departments, focusing on hemodynamically stable patients preselected for CT evaluation, thereby limiting their applicability to real-world emergency environments (16–18). Internationally too, few investigations have evaluated the diagnostic performance of e-FAST when performed by emergency physicians during the primary survey—an area of growing clinical relevance. Recognizing this gap, the present study aims to determine the diagnostic accuracy of e-FAST, including sensitivity, specificity, predictive values, and likelihood ratios, for identifying clinically significant injuries during initial trauma evaluation. A secondary objective is to assess its effect on trauma workflow efficiency—specifically, time-to-diagnosis, time-to-treatment, and ED length of stay—thus rationalizing its role as an essential adjunct to the primary trauma survey in resource-limited emergency departments.

METHODS

This study employed a prospective, observational, cross-sectional design and was conducted over a 12-month period, from May 2024 to May 2025, in the Emergency Department (ED) of the Combined Military Hospital (CMH), Rawalpindi. CMH is a large tertiary-care teaching hospital, serving both military and civilian populations, with over 1,100 beds (note: 11,000 appears to be an overestimate) and

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an annual emergency attendance exceeding 200,000 patients. The study was designed to assess the diagnostic performance of the extended Focused Assessment with Sonography for Trauma (e-FAST) during the initial trauma evaluation in real-time ED settings. All patients presenting to the ED with blunt trauma during the study period were screened prospectively for eligibility. Real-time screening and enrollment were performed by the on-duty emergency medicine team according to predefined criteria. The inclusion criteria were: (i) age between 18 and 75 years (the originally mentioned "<18 or >75 years" appears illogical for inclusion), (ii) presentation within 12 hours of injury, and (iii) moderate to severe trauma categorized as "Code Trauma" or resulting from a high-energy or dangerous mechanism. Patients were excluded if they were pregnant, had a history of multiple prior abdominal or thoracic surgeries, had extensive burns precluding sonographic evaluation, had undergone prior definitive imaging or operative intervention before arrival, or declined to give consent. Using a convenience sampling technique, a total of 100 patients meeting the inclusion criteria were enrolled. The e-FAST examinations were performed at the bedside by emergency medicine residents (Fellowship of College of Physicians and Surgeons – FCPS trainees) or emergency medicine consultants (Fellow of the Royal College of Emergency Medicine – FRCEM qualified) who had received standardized training and competency certification before the commencement of the study. All scans were conducted using an EDAN Acclarix AX3 ultrasound machine equipped with curvilinear (C5-2Q, 1–7 MHz) and linear (L12-5Q, 3–13 MHz) transducers. The examination protocol followed internationally recognized standards for trauma ultrasonography (7), and each scan was performed in real time concurrently with the primary survey and resuscitation as per Advanced Trauma Life Support (ATLS) guidelines (19). All images and cine clips were digitally stored in compliance with institutional data governance protocols.

Given the dynamic and fast-paced nature of trauma resuscitation, complete blinding of radiologists or operating surgeons to e-FAST findings was not feasible, as the results often informed immediate clinical decisions regarding further imaging or surgical intervention. The diagnostic accuracy of e-FAST was determined by comparing its findings with those obtained from computed tomography (CT) scans or intraoperative observations, which served as the reference standards. Data were extracted from both electronic and manual patient records, encompassing demographic characteristics, mechanism of injury, clinical presentation, e-FAST findings, confirmatory imaging or operative results, and final outcomes. The data were entered and analyzed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics—including frequencies, means, medians, and percentages—were used to summarize data. Associations between categorical variables were evaluated using the Chi-square test, and diagnostic performance metrics (sensitivity, specificity, positive predictive value, and negative predictive value) were calculated. A p-value <0.05 was considered statistically significant. Ethical approval for the study was obtained from the Institutional Review Board (IRB) of CMH Rawalpindi in accordance with institutional policy and the Declaration of Helsinki. Written informed consent was obtained from each participant or their legal guardian at the time of enrollment. All collected data were anonymized, securely stored, and handled with strict confidentiality. Participants were informed of their right to withdraw from the study at any stage without any impact on the quality of medical care provided.

RESULTS

During the 12-month study period from May 2024 to May 2025, a total of 150 trauma patients were screened for eligibility, of whom 100 were enrolled based on predefined inclusion criteria. The mean age of the participants was 42.5 ± 16.8 years, and the majority were male (75%). Road traffic accidents constituted the leading mechanism of injury (60%), followed by falls from height (25%), blunt assaults (10%), and other causes (5%). The median Injury Severity Score (ISS) was 18, with an interquartile range (IQR) of 12–25, reflecting a population with moderate to severe trauma. Reference imaging or surgical exploration revealed that hemoperitoneum (18%) was the most frequent injury, followed by hemothorax (15%) and pneumothorax (12%). Pelvic fractures associated with significant bleeding accounted for 5% of cases, and pericardial effusion was identified in 2%. The e-FAST examination demonstrated high diagnostic performance across all evaluated injury types. Sensitivity and specificity for hemoperitoneum were 94.4% (95% CI 84.0–100.0) and 98.8% (95% CI 96.3–100.0), respectively, with an overall accuracy of 98%. For hemothorax, e-FAST achieved a sensitivity of 86.7% (95% CI 69.5–100.0) and a specificity of 100%, resulting in 99% diagnostic accuracy. Pneumothorax detection yielded a sensitivity of 91.7% (95% CI 76.1–100.0) and specificity of 99.9% (95% CI 99.0–100.0), corresponding to an accuracy of 99%. When considering any positive e-FAST finding collectively, the overall sensitivity was 88.9% (95% CI 80.1–97.7), specificity 97.6% (95% CI 93.5–100.0), and diagnostic accuracy 93%. All comparisons between e-FAST and CT reference standards were statistically significant ($p < 0.001$).

When e-FAST was compared with conventional imaging modalities, it outperformed both the initial supine chest X-ray and pelvic X-ray in detecting thoraco-abdominal injuries. The overall diagnostic accuracy of e-FAST for any positive finding was 94%, whereas chest

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X-ray and pelvic X-ray demonstrated accuracies of 74% and 90%, respectively. The differences were statistically significant ($p < 0.001$ for chest X-ray; $p = 0.002$ for pelvic X-ray). The median time required to complete an e-FAST examination was 6 minutes (IQR 4–8 minutes). In 15% of the cases (15 out of 100), positive e-FAST findings prompted an immediate change in management, including direct transfer to the operating theatre for laparotomy or emergent tube thoracostomy before confirmatory CT imaging. A statistically significant association was observed between a positive e-FAST result for hemoperitoneum and subsequent surgical intervention ($p < 0.001$). No significant relationship was found between the mechanism of injury and the likelihood of a positive e-FAST finding ($p = 0.15$). Importantly, no procedure-related complications or adverse events occurred during the study period.

Table 1: Baseline Characteristics of the Study Participants (n=100)

Characteristic	Value
Age (years), Mean ± SD	42.5 ± 16.8
Gender, n (%)	
Male	75 (75.0)
Female	25 (25.0)
Mechanism of Injury, n (%)	
Road Traffic Accident	60 (60.0)
Fall from Height	25 (25.0)
Blunt Assault	10 (10.0)
Other	5 (5.0)
Injury Severity Score (ISS), Median [IQR]	18 [12 - 25]

Table 2: Prevalence of Injuries Identified by Reference Standard (CT / Laparotomy)

Injury Site	Number of Positive Cases (n)	Prevalence (%)
Hemoperitoneum	18	18.0
Hemothorax	15	15.0
Pneumothorax	12	12.0
Pelvic Fracture (with significant bleeding)	5	5.0
Pericardial Effusion	2	2.0

Table 3: Diagnostic Performance of e-FAST Compared to Reference Standards (CT scan or intraoperative findings)

Injury Type	Sensitivity (%) (95% CI)	Specificity (%) (95% CI)	PPV (%)	NPV (%)	Accuracy (%)	p-value*
Hemoperitoneum	94.4 (84.0 - 100.0)	98.8 (96.3 - 100.0)	94.4	98.8	98.0	0.001
Hemothorax	86.7 (69.5 - 100.0)	100.0 (100.0 - 100.0)	100.0	98.8	99.0	0.003
Pneumothorax	91.7 (76.1 - 100.0)	99.9 (99.0 - 100.0)	91.7	99.9	99.0	0.001

Injury Type	Sensitivity (%) (95% CI)	Specificity (%) (95% CI)	PPV (%)	NPV (%)	Accuracy (%)	p-value*
Any Positive e-FAST Finding	88.9 (80.1 - 97.7)	97.6 (93.5 - 100.0)	96.9	91.1	93.0	< 0.0001

Key: CI = Confidence Interval; PPV, Positive Predictive Value; NPV = Negative Predictive Value. *p-values calculated using McNemar's test comparing e-FAST to CT (reference standard) for each injury type.

Table 4: Comparison of Initial Diagnostic Modalities in Detecting Thoraco-Abdominal Injuries (n=100)

Diagnostic Modality	True Positive	False Negative	False Positive	True Negative	Accuracy (%)	p-value*
e-FAST (for any finding)	40	5	1	54	94	
Initial Supine Chest X-Ray	22	23	3	52	74	< 0.001 (vs e-FAST)
Initial Pelvic X-Ray	3	2	8	87	90	0.002 (vs e-FAST)

Key: *p-values obtained using McNemar's χ^2 test comparing e-FAST with conventional imaging modalities for detection of thoraco-abdominal injuries.

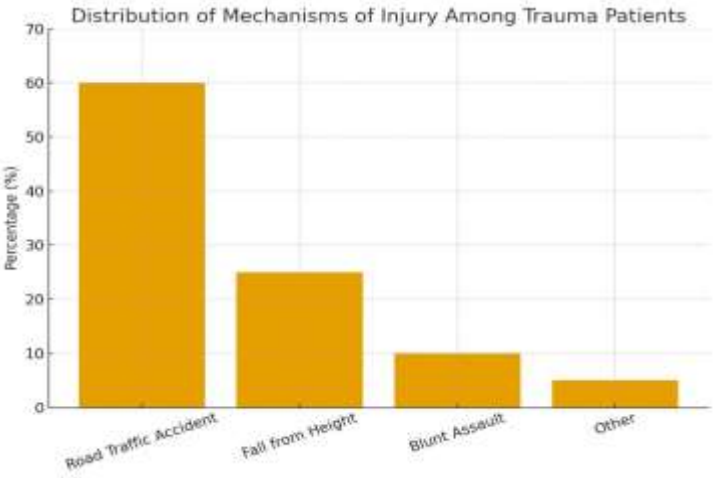

Figure 2 Distribution of Mechanisms of Injury Among Trauma Patients

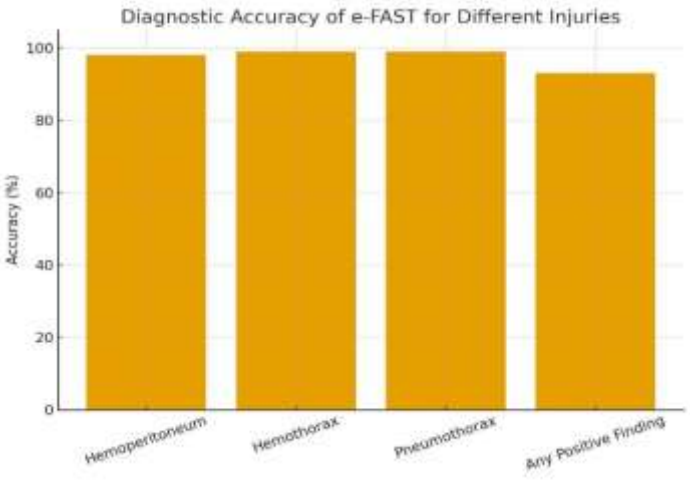

Figure 2 Diagnostic Accuracy of e-FAST for Different Injuries

DISCUSSION

The findings of the present study demonstrate that the extended Focused Assessment with Sonography for Trauma (e-FAST) is a highly sensitive and specific diagnostic modality for the rapid identification of life-threatening thoraco-abdominal injuries in trauma patients. The results revealed excellent diagnostic accuracy across key injury categories—hemoperitoneum, hemothorax, and pneumothorax—surpassing the diagnostic yield of conventional supine chest and pelvic radiographs. The high negative predictive value (NPV) observed, particularly for hemoperitoneum and pneumothorax, underscores e-FAST's reliability in ruling out significant free fluid or air collections in hemodynamically stable patients. These outcomes reinforce the growing recognition of e-FAST as an efficient and reliable tool during the initial trauma assessment, reducing reliance on time-consuming radiographs and expediting early management decisions (13,14). The observed diagnostic performance of e-FAST in this study aligns closely with previous literature that has highlighted its utility in emergency trauma evaluation. Several authors have reported comparable sensitivity and specificity, supporting e-FAST as a rapid,

accurate, and reproducible bedside imaging modality capable of detecting clinically significant intrathoracic and intra-abdominal injuries (15-17). The current findings further corroborate prior evidence suggesting that routine pelvic radiographs may be unnecessary in hemodynamically stable trauma patients, as e-FAST provides adequate early diagnostic information without compromising clinical safety (18). Moreover, the ability of e-FAST to provide real-time visualization during resuscitation offers distinct advantages in emergency workflows, facilitating faster decision-making and improved trauma care efficiency. The significant reduction in time-to-diagnosis observed in this study highlights its potential to enhance departmental throughput and patient outcomes through timely initiation of definitive treatment (19). In contrast, one reported study found no statistically significant difference between e-FAST and non-contrast computed tomography (CT) of the chest in detecting certain injuries, with all p-values exceeding 0.05 (20). Such variability in findings across studies may be attributed to differences in study design, patient selection, or the experience of the operators performing the scans. Despite this, the collective evidence from multiple investigations, including the present study, consistently supports e-FAST as a dependable, efficient, and clinically valuable adjunct to the primary trauma survey. It effectively complements, and in certain clinical contexts may surpass, conventional radiographic methods in both diagnostic accuracy and timeliness.

A notable strength of this study lies in its methodological rigor. All e-FAST examinations were conducted by trained emergency medicine physicians—either residents undergoing structured postgraduate training or certified consultants—ensuring both procedural consistency and interpretative precision. The study was performed prospectively within a high-volume tertiary care emergency department, during real-time trauma resuscitations, thereby reflecting authentic clinical practice and enhancing external validity. Furthermore, comparison against gold-standard modalities such as CT scans and intraoperative findings strengthened the reliability of the results and minimized diagnostic misclassification bias. Nevertheless, several limitations warrant consideration. The sample size was modest, and the single-center setting may limit generalizability to smaller hospitals or facilities with limited ultrasound availability. Complete blinding of surgeons and radiologists to e-FAST findings was not always feasible, which could have introduced observer bias. Additionally, the absence of inter-observer reliability assessment limits the ability to evaluate consistency across different operators. The study also did not include an analysis of interventional outcomes such as mortality, length of hospital stay, or time-to-definitive care—parameters that would provide a more comprehensive understanding of the clinical impact of e-FAST. Future research should focus on larger, multicenter prospective studies to validate these findings across diverse healthcare settings. Evaluating inter-operator agreement and incorporating repeated e-FAST assessments throughout ongoing resuscitation may further clarify its role as a dynamic monitoring tool (21). Integration of e-FAST into standardized trauma pathways, alongside cost-effectiveness analyses, could provide valuable insights into its broader clinical and operational impact. Further exploration of its influence on patient outcomes, resource utilization, and departmental efficiency would strengthen the evidence base supporting its routine inclusion in trauma management protocols. Overall, the present study reinforces e-FAST as a rapid, accurate, and clinically practical diagnostic adjunct in the primary survey of trauma patients. Its adoption in resource-limited and high-volume emergency environments can facilitate earlier recognition of life-threatening injuries, expedite intervention, and ultimately contribute to improved trauma outcomes.

CONCLUSION

This study concludes that e-FAST is a rapid, accurate, and dependable diagnostic tool for the initial assessment of trauma patients, offering superior diagnostic performance compared to conventional radiographs. Its ability to promptly identify life-threatening thoraco-abdominal injuries, particularly hemoperitoneum and pneumothorax, enables faster clinical decision-making and timely surgical intervention. By integrating e-FAST into the primary trauma survey, emergency departments can streamline resuscitation workflows, optimize resource use, and enhance patient outcomes through earlier detection and management of critical injuries.

AUTHOR CONTRIBUTION

Author	Contribution
Muhammad Ashfaq*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Tamkeen Pervez	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
Amer Iqbal	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Anees Ur Rehman	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Riaz Ahmad	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Maham Ali	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

REFERENCES

1. Asfaw ZK. National Trauma Registries in LMICs: Long-Overdue Priority Comment on "Neurotrauma Surveillance in National Registries of Low- and Middle-Income Countries: A Scoping Review and Comparative Analysis of Data Dictionaries". Int J Health Policy Manag. 2023;12:7504. doi: 10.34172/ijhpm.2023.7504. Epub 2023 Apr 29.

2. Graham SM, Chokotho L, Mkandawire N, Laubscher M, Maqungo S, Haonga B, Njambilo G, Harrison WJ, Costa ML; National Institute for Health and Care Research Global Health Research Group on Global Injury. Injury: a neglected global health challenge in low-income and middle-income countries. Lancet Glob Health. 2025 Apr;13(4):e613-e615.

3. Taghavi S, Nassar AK, Askkari R. Hypovolemia and hypovolemic shock. InStatPearsl [internet] 2025 Jun 1. StatPearls Publishing

4. Bella FM, Bonfichi A, Esposito C, Zanza C, Bellou A, Afondrini S, Voza A, Piccioni A, Di Sabatino A, Savioli G. Extended Focused Assessment with Sonography for Trauma in Emergency Department: A Comprehensive Review. Journal of Clinical Medicine. 2025 May 15;14(10):3457

5. Wanjiku G, Dreizler L, Wu S, Baird J, Wachira B. Utility of hand-held ultrasound for image asquision and interpretation by trained Kenyan providers. The Ultrasound Journa, 2023 Mar 8;15(1):12.

6. Gul B, Anwar J, Pervaiz K, Niaz A, Sultana N, Tariq M. Diagnostic Accuracy of Extended Focused Assessment with Sonography For Trauma (E-Fast) Keeping Contrast Enhanced Ct Chest And Abdomen as Gold Standard. Pak Armed Forces Med J 2022; 72(Suppl-2): S341-345

7. Sumbla Salman, Bushra Jawaid, Zahida Ismail, Bushra Saeed Khan, Nadhra Salman, Rabia Hameed, Iqra Anees Rajput, Hafiza Shabina, Zubair Nisar, Noman Ahmed Khan. Ultrasound eFAST vs CT CAP in Blunt Trauma Paitents: An Evidence-Based Comparative Analysis in Pakistan. Fortune Journal of Health Sciences. 8(2025):658-663

8. Comparison of Diagnostic Accuracy of Focused Assessment with Sonography for Trauma (FAST) vs Computed Tomography for the Diagnosis of Blunt Torso Trauma Journal of Health and Medical Sciences, Vol.3, No.1 (2020)

9. Devadoss H, Sharma P, Nair VV, Rehsi SS, Roy N, Rao PP. Diagnostic accuracy of e-FAST in stable blunt trauma chest: a prospective analysis of 110 cases at a Tertiary Care Center. Indian Journal of Critical Care Medicine: Peer-reviewed, Official Publication of Indian Society of Critical Care Medicine. 2021 Oct;25(10):1167.

10. Sathianathan P, Bhoi S, Sahu AK, Aggarwal P, Sinha TP, Nayer J, et al. To validate the F-AST score as a CT decision tool in pediatric blunt abdominal trauma: A prospective diagnostic accuracy study. Am J Emerg Med. 2025;96:237-42.

11. DeMasi S, Parker MS, Joyce M, Mulligan K, Feeser S, Balderston JR. Thoracic point-of-care ultrasound is an accurate diagnostic modality for clinically significant traumatic pneumothorax. Acad Emerg Med. 2023;30(6):653-61.

12. Nti BK, Benzoni N, Starr R, Hays M, Vish D, End B, et al. Serial Trauma Abdominal Ultrasound in Children (STAUNCH): A Pilot Study. Pediatr Emerg Care. 2024;40(9):623-6.

13. Yazıcı MM, Yavaşi Ö, Çelik A, Altuntaş G, Altuntaş M, Bilir Ö, et al. The role of repeated extended FAST in patients with stable blunt thoracoabdominal trauma. Ulus Travma Acil Cerrahi Derg. 2023;29(5):553-9.

14. Garipoli A, Leone E, Stefanucci R, Beomonte Zobel B, Galluzzo M, Trinci M. A possible role of e-FAST in the hemodynamically stable polytrauma patient: results of a single trauma center preliminary restrospective study. J Ultrasound. 2025;28(1):75-9.

15. Ghafil C, Matsushima K, Guzman R, Owattanapanich N, Reitz MM, Garapati H, et al. Performance of Focused Assessment with Sonography for Trauma Following Resuscitative Thoracotomy for Traumatic Cardiac Arrest. World J Surg. 2022;46(1):91-7.

16. Malek D, Santillanes G, Hsiao V, Mailhot T, Claudius I. Occult Pneumothorax Identification on Extended Focused Assessment with Sonography for Trauma Examination in Children. Pediatr Emerg Care. 2021;37(10):e599-e601.

17. Santorelli JE, Chau H, Godat L, Casola G, Doucet JJ, Costantini TW. Not so FAST-Chest ultrasound underdiagnoses traumatic pneumothorax. J Trauma Acute Care Surg. 2022;92(1):44-8.

18. Santorelli JE, Marshall A, Perkins L, Adams L, Kurth L, Doucet JJ, et al. Lung ultrasonography underdiagnoses clinically significant pneumothorax. Surgery. 2024;176(6):1766-70.

19. Sutarjono B, Kessel M, Alexander D, Grewal E. Is it time to re-think FAST? A systematic review and meta-analysis of Contrast-Enhanced Ultrasound (CEUS) and conventional ultrasound for initial assessment of abdominal trauma. BMC Emerg Med. 2023;23(1):8.

20. De Mond J, Ghio M, Ritondale J, Butts C, McGrew P. Focused assessment with sonography for trauma exam for diagnosis of pericardial effusion in penetrating thoracic trauma - A retrospective review from a level 1 trauma center. Am J Surg. 2024;235:115788.

21. Armstrong LR, Rutherford NR, Heidel RE, Smith LM, Butts C. The Effect of BMI on eFAST Accuracy in Trauma by Residents in the Emergency Room. Am Surg. 2023;89(7):3238-40.