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(REVIEW ARTICLE)

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Blunt thoracoabdominal trauma diagnosis using point of care ultrasound in the emergency room: A systematic review

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Abstract

Background: Blunt thoracoabdominal trauma is a common emergency condition which require rapid identification of internal injuries. Point-of-care ultrasound (POCUS), including Focused Assessment with Sonography for Trauma (FAST), extended FAST (eFAST), and contrast-enhanced ultrasound (CEUS), are used for bedside evaluation in trauma settings. We aimed to evaluate the diagnostic accuracy of POCUS modalities (FAST, eFAST, and CEUS) in identifying intra-abdominal and thoracic injuries in patients with blunt thoracoabdominal trauma.

Methods: A systematic search was conducted in PubMed, Embase, and Scopus for studies published between 2008 and 2025. Original studies in English assessing POCUS in blunt trauma were included. Data on study design, patient characteristics, ultrasound modality, and diagnostic performance were extracted.

Results: Ten original studies with a total of 10,965 patients were included. Most studies evaluated FAST, some investigated eFAST or CEUS. FAST sensitivity differs in settings, ranging from 28% to 95%, and specificity was high. In pediatric cases, CEUS show better performance compared to standard ultrasound, with sensitivity and specificity up to 100%. Thoracic POCUS showed strong accuracy to detect pneumothorax. Operator experience and patient condition influenced diagnostic outcomes.

Conclusion: POCUS modalities are good methods in the early assessment of blunt thoracoabdominal trauma. CEUS give additional benefit in pediatric patients.

Keywords: Blunt Trauma; Thoracoabdominal Injuries; Point-Of-Care Ultrasound; FAST; E fast; Contrast-Enhanced Ultrasound; Emergency Ultrasound; Diagnostic Accuracy

1. Introduction

Blunt thoracoabdominal trauma is one of the most common emergencies managed in trauma units worldwide, and result from road traffic accidents, falls, or physical assaults. Rapid identification of internal injuries in these patients is important, mainly in unstable individuals who may not tolerate delays in imaging or treatment (Stengel et al. 2018). Computed tomography (CT), provide detailed anatomical information but its time-consuming, require patient transfer, and unavailable in prehospital or resource-limited settings (Achatz et al. 2022).

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Point-of-care ultrasound (POCUS) is a crucial diagnostic modality for the initial assessment of trauma patients. Focused Assessment with Sonography for Trauma (FAST) and its extension, the extended FAST (eFAST), allow rapid bedside evaluation for free intraperitoneal or pericardial fluid and pneumothorax (Stengel et al. 2018). These protocols are now widely used into Advanced Trauma Life Support (ATLS) guidelines and frequently used in emergency departments and field hospitals (Liang et al. 2021).

The diagnostic performance of FAST and eFAST differ in populations and injury types. Studies reported lower sensitivity in pediatric patients and in cases of retroperitoneal or bowel injuries, where free fluid not accumulate or difficult to detect (Liang et al. 2021). Ultrasound is operator-dependent, and image acquisition is limited by obesity or subcutaneous emphysema (DeMasi et al. 2023). Contrast-enhanced ultrasound (CEUS) has been introduced, provide better visualization of solid organ injuries through improved parenchymal contrast. CEUS is promising in children, as it avoids ionizing radiation and serve as an alternative to CT in stable patients (Menichini et al. 2015). This systematic review aims to evaluate the diagnostic accuracy of POCUS modalities (FAST, eFAST, and CEUS) to identify intra-abdominal and thoracic injuries following blunt thoracoabdominal trauma.

2. Methodology

This systematic review conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. We aim to evaluate the diagnostic accuracy and clinical utility of point-of-care ultrasound (POCUS), including Focused Assessment with Sonography for Trauma (FAST), extended FAST (EFAST), and contrast-enhanced ultrasound (CEUS), in the assessment of patients with blunt thoracoabdominal trauma in emergency settings.

2.1. Search Strategy

Literature search was conducted using three electronic databases: PubMed, Embase, and Scopus. The search covered publications from January 2010 to January 2024. Keywords used in the search included: blunt abdominal trauma, thoracoabdominal trauma, point-of-care ultrasound, POCUS, FAST, EFAST, and contrast-enhanced ultrasound. Boolean operators were used to refine the results. The references of included articles were screened to identify additional relevant studies.

2.2. Eligibility Criteria

Studies were included if they were original research articles involving human subjects, assessed the use of POCUS, FAST, EFAST, or CEUS in the diagnosis of blunt abdominal or thoracoabdominal trauma, conducted in emergency departments, trauma centers, or acute care settings, reported at least one diagnostic performance metric (e.g., sensitivity, specificity, PPV, NPV), published in English between 2010 and 2024. We exclude case reports, editorials, letters, conference abstracts, or reviews, studies conducted exclusively on penetrating trauma or non-emergency settings, and studies not available in full-text format. We include 10 articles in our systematic review (Fig 1).

2.3. Data Extraction

Two independent reviewers screened titles and abstracts for eligibility. Full texts of selected articles were reviewed, and data extracted using a standardized form. Extracted variables included: study design, sample size, study setting, population characteristics, type of ultrasound modality used (FAST, EFAST, or CEUS), and diagnostic performance outcomes. Qualitative data synthesis was conducted rather than a meta-analysis. The primary outcome of interest was the diagnostic accuracy of ultrasound-based modalities to detect intra-abdominal or thoracic injuries in patients with blunt trauma.

3. Results

We include a total of 10 original studies evaluate the diagnostic performance of ultrasound in blunt abdominal trauma (Table 1). These studies total population of 10,965 patients in various clinical settings, including emergency departments, trauma centers, and post-disaster field hospitals. Most studies assessed the effectiveness of Focused Assessment with Sonography for Trauma (FAST), other studies discussed contrast-enhanced ultrasound (CEUS) or extended FAST (EFAST) (Table 2).

Sensitivity of ultrasound to detect intra-abdominal injury varied widely in studies. Several reports show high diagnostic accuracy, with sensitivity rates more than 90% (Zhou et al. 2012; Ojaghi Haghighi et al. 2014; Nandipati et al. 2011). Zhou et al. reported a sensitivity of 91.9% and a negative predictive value of 99.4% for FAST in earthquake victims evaluated across 147 hospitals. In a study from Iran, FAST had a sensitivity of 96.15% and specificity of 100% for

detecting pneumothorax and hemothorax (Ojaghi Haghighi et al. 2014). A multicenter prospective analysis involving 2,188 children show a sensitivity of 27.8% for intra-abdominal injury and 44.4% for injuries requiring intervention (Calder et al. 2017). Studies use CEUS in children how better performance. Menichini et al. show a sensitivity and specificity of 100% for CEUS compared to 38.8% for standard ultrasound (Menichini et al. 2015).

In adult trauma cases, sensitivity range from 28% to over 95% depending on operator expertise and imaging protocol. Verbeek et al. found low sensitivity (28%) of FAST to detect hemoperitoneum in patients with pelvic fractures, despite high specificity (94%) (Verbeek et al. 2014). Tsui et al. reported 86% sensitivity and 99% specificity in a Hong Kong emergency department setting (Tsui et al. 2008). DeMasi et al. found that thoracic point-of-care ultrasound had a sensitivity of 87% and specificity of 100% to detect clinically significant pneumothorax (DeMasi et al. 2023). Their findings were similar to Nandipati et al. with EFAST (Nandipati et al. 2011). When combined with chest X-ray, the diagnostic yield is suboptimal (Schellenberg et al. 2018).

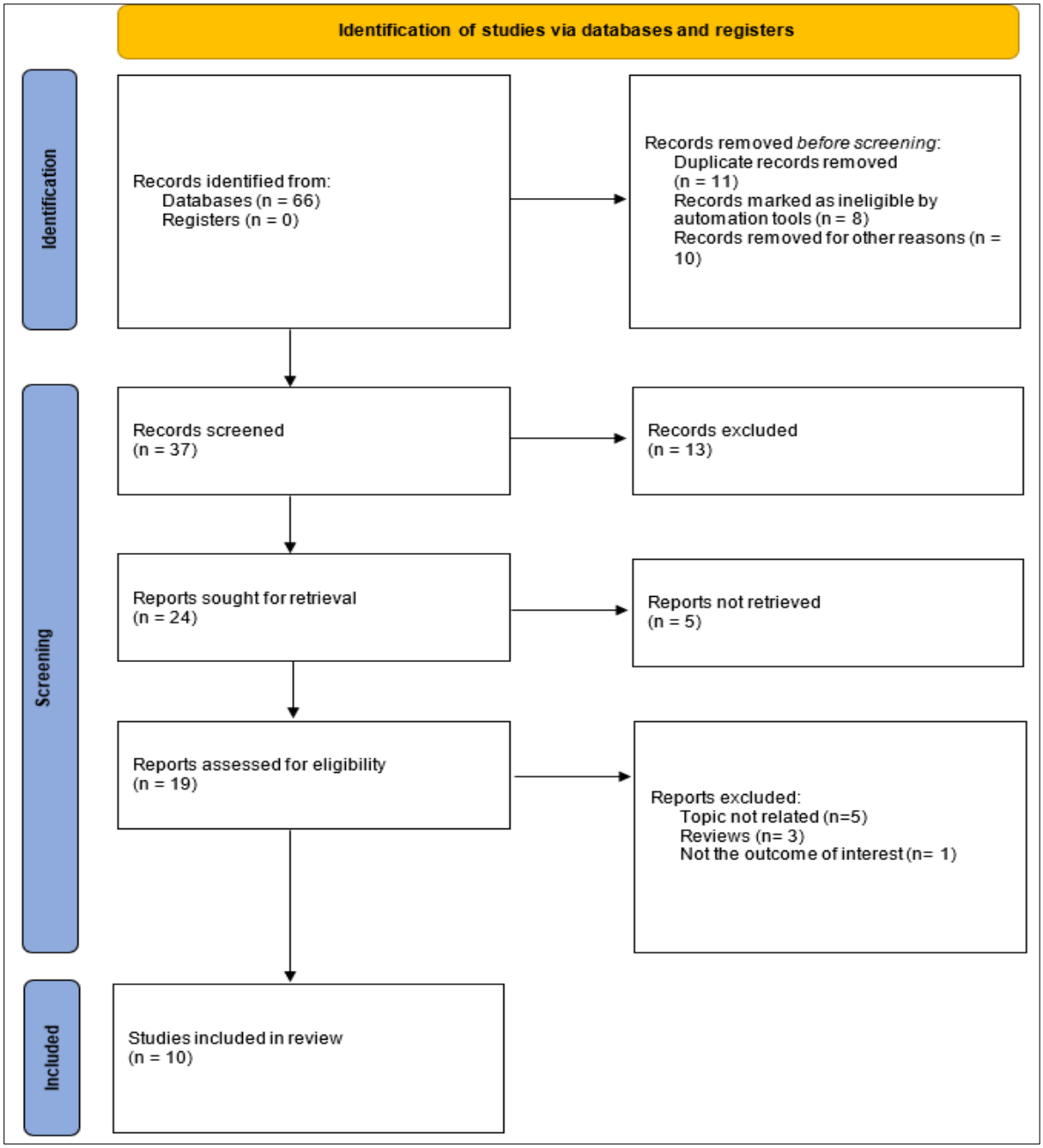

Figure 1 PRISMA consort chart of selection process

Table 1 characteristics of the included studies

Citation	Study Design	Study Duration	Study Setting	Population Characteristics	Study Aim	Methodology
Verbeek et al. (2014)	Retrospective cohort	Jan 2004 – Dec 2009	Level I trauma center, Netherlands	120 adult patients with high-energy major pelvic fractures	To assess FAST accuracy in detecting hemoperitoneum and need for hemorrhage control	FAST within 5 min of arrival; CT/laparotomy confirmation; subgroup: hemorrhagic shock
Tsui et al. (2008)	Retrospective cohort	Jan 2004 – Dec 2006	ED, public hospital, Hong Kong	242 BAT patients, age 16–82, FAST by EPs	Evaluate EPs performance using FAST for BAT	FAST vs CT or observation; stats on sensitivity, specificity, etc.
Calder et al. (2017)	Prospective multi-center observational	1 year	14 Level I pediatric trauma centers, USA	2,188 children <16 years old with blunt abdominal trauma	Evaluate FAST for intra-abdominal injury in children	Compare FAST vs CT/intraoperative findings; test performance calculated
Valentino et al. (2010)	Prospective diagnostic accuracy study	Not stated	University hospital, Italy	133 hemodynamically stable patients with BAT	Evaluate CEUS diagnostic accuracy vs CT	US, CEUS, and CT used; comparison of sensitivity/specificity
Menichini et al. (2015)	Retrospective diagnostic comparison	Oct 2012 – Oct 2013	Pediatric Emergency Department, Rome, Italy	73 hemodynamically stable children (mean age 8.7)	Compare CEUS and US vs MDCT for solid organ injuries	All underwent US, CEUS, CT; diagnostic metrics calculated
DeMasi et al. (2023)	Retrospective observational study	Dec 2021 – Jun 2022	Urban Level I trauma center, USA	846 trauma patients ≥15 years old	Evaluate thoracic POCUS accuracy for pneumothorax	Compared POCUS vs CT/CXR; diagnostic accuracy measured
Schellenberg et al. (2018)	Retrospective diagnostic study	Year 2016	LAC+USC Medical Center, USA	1,311 blunt thoracic trauma patients ≥15 years	Assess combined utility of EFAST and CXR for thoracic injury	Compared EFAST, CXR, physical exam to CT findings
Nandipati et al. (2011)	Prospective observational study	Jun 2007 – May 2008	Level I trauma center, Queens, NY, USA	204 trauma patients (mean age 43, 152 males)	Evaluate EFAST in diagnosing pneumothorax	EFAST vs clinical exam, CXR, and CT; diagnostic values computed
Ojaghi Haghighi et al. (2014)	Diagnostic accuracy study	Not specified	Emergency Department, Tabriz University, Iran	163 multiple trauma patients	Evaluate ultrasound vs CXR/CT for hemopneumothorax	All patients underwent US, CXR, CT; sensitivity/specificity compared
Zhou et al. (2012)	Retrospective diagnostic accuracy study	May 12 – May 31, 2008	147 hospitals during Wenchuan earthquake, China	2,204 patients with suspected blunt abdominal trauma	Evaluate diagnostic accuracy of screening ultrasound post-earthquake	Ultrasound vs CT, DPL, laparotomy, repeated US, or clinical course

Table 2 main findings of the included studies

Citation	Demographic Characteristics	Main Findings	Outcome
Verbeek et al. (2014)	120 adults with major pelvic fractures	FAST had low sensitivity (28%) but high specificity (94%) in detecting hemoperitoneum	Recommended as initial tool but not sufficient alone to rule out injury
Tsui et al. (2008)	242 patients aged 16–82 with blunt abdominal trauma	Sensitivity 86%, specificity 99%, overall accuracy 97%	FAST is reliable for initial screening by emergency physicians
Calder et al. (2017)	2,188 children <16 years with BAT	FAST had low sensitivity for IAI (27.8%) and IAI-I (44.4%)	Limited impact on management; recommended with caution
Valentino et al. (2010)	133 hemodynamically stable adults with BAT	CEUS sensitivity 96.4%, specificity 98%, comparable to CT	CEUS proposed as alternative to CT in initial evaluation
Menichini et al. (2015)	73 stable children (mean age 8.7)	CEUS had 100% sensitivity, US had only 38.8%	CEUS effective and recommended for pediatric trauma
DeMasi et al. (2023)	846 trauma patients, 95% blunt trauma	Thoracic POCUS sensitivity 87%, specificity 100%	Effective for detecting clinically significant PTX
Schellenberg et al. (2018)	1,311 blunt thoracic trauma patients	Combined EFAST+CXR had low sensitivity <73%	CT still required if suspicion remains
Nandipati et al. (2011)	204 trauma patients, mean age 43	EFAST sensitivity 95.2%, better than CXR or exam	Supports EFAST as reliable in pneumothorax detection
Ojaghi Haghighi et al. (2014)	163 multi-trauma patients	US sensitivity 96.15%, specificity 100% for PTX	Highly effective; better than CXR for early diagnosis
Zhou et al. (2012)	2,204 patients post-Wenchuan earthquake	US sensitivity 91.9%, specificity 96.9%, NPV 99.4%	Reliable screening tool post-disaster for BAT

4. Discussion

This systematic review evaluated the diagnostic accuracy of point-of-care ultrasound (POCUS), and Focused Assessment with Sonography for Trauma (FAST), in patients with blunt thoracoabdominal trauma. The results showed that ultrasound is a good initial imaging tool, its sensitivity and specificity vary based on patient population, injury pattern, and clinical setting (Farahmand et al. 2005).

In mass casualty situations and high-volume trauma settings, ultrasound proven to be an effective screening modality. A large-scale analysis of patients following the Wenchuan earthquake showed a FAST sensitivity of 91.9% and a negative predictive value of 99.4%, which support its use in disaster response scenarios (Farahmand et al. 2005). In emergency department settings, the accuracy of FAST is high when performed by experienced operators. FAST show a sensitivity of 96.15% and specificity of 100% for detecting pneumothorax and hemothorax in a study evaluate patients with multiple trauma (Farahmand et al. 2005).

The utility of FAST in pediatric trauma is limited. A prospective multicenter study involves over 2,000 children with blunt abdominal trauma show low sensitivity values for FAST, with 27.8% for intra-abdominal injuries and 44.4% for injuries need surgical intervention. Contrast-enhanced ultrasound (CEUS) improved the diagnostic capabilities of ultrasound in trauma evaluation. In pediatric patients, CEUS was better compared to conventional ultrasound, with a sensitivity and specificity of 100% to detect solid organ injuries, compared to 38.8% sensitivity for standard ultrasound. CEUS can serve as a safer and accurate alternative to CT imaging in hemodynamically stable patients, mainly in settings where radiation exposure is a concern (Farahmand et al. 2005).

A retrospective study evaluates thoracic POCUS in trauma patients found a sensitivity of 87% and specificity of 100% to diagnose significant pneumothorax. These findings support the use of EFAST as a rapid and reliable modality to detect thoracic injuries in emergency settings (Farahmand et al. 2005). Ultrasound is operator-dependent, and its performance affected by patient body habitus, presence of bowel gas, and the examiner's experience. POCUS modalities provide rapid bedside evaluation, and their limited sensitivity in pediatric and pelvic trauma, means they should not replace more comprehensive imaging modalities when clinical suspicion remains high (Farahmand et al. 2005).

FAST and its extended applications are a good method in the initial assessment of blunt thoracoabdominal trauma. The ease of use, rapid availability, and noninvasiveness make them indispensable in emergency care. The addition of CEUS enhances diagnostic accuracy in adult and pediatric populations. Careful clinical judgment and the integration of CT, is essential in trauma evaluation (Farahmand et al. 2005).

5. Conclusion

POCUS, FAST, eFAST, and CEUS, is a good method in the early assessment of blunt thoracoabdominal trauma. CEUS improves accuracy while ultrasound is operator-dependent. POCUS should support and not replace clinical judgment and CT imaging. Its role is important in emergency and resource-limited settings because to its speed, safety, and bedside applicability.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict-of-interest to be disclosed.

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