Study of Extended Focused Assessment Sonography Accuracy versus Computed Tomography in Multiple Trauma Patients

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ABSTRACT
Background: Focused assessment with sonography for trauma (FAST), a technological advancement, allowed radiology residents to quickly check patients for injuries at their bedsides. Extended FAST (EFAST) is a recent procedure that scans the lower chest region to detect pneumothorax.
Objective: This study aimed to evaluate the accuracy of E-FAST compared with the results of CT as a gold standard in multiple trauma patients.
Patients and methods: During the six-month period from June 2021 to December 2021, our prospective, observational, and diagnostic accuracy study, which included 53 patients with multiple trauma and for whom CT scans were performed at the time of arrival in the emergency room, at the Radiodiagnosis Department, Zagazig University Hospital.
Results: FAST results in comparison to CT results among the participants indicated that there were 26 true positive diagnosis of hemothorax and pneumothorax, while 3 were false negative. There were 25 had true positive diagnosis of hemoperitoneum among them 18 had true positive solid organ injury while 3 had false negative diagnosis of hemoperitoneum among them 1 had false negative diagnosis of solid organ injury
Conclusion: E-FAST examination has an excellent specificity as considered as a useful diagnostic procedure for the primary assessment of trauma patients in ED. However, the sensitivity detected is not high enough to rule-out thoraco-abdominal injuries in multiple trauma patients. It is also a portable and non- invasive procedure but is operator dependent.
Keywords: Extended focused assessment sonography, Computed tomography, Multiple trauma.

INTRODUCTION

Accidents of Motor vehicles are a significant source of health concerns. These accidents have caused blunt abdominal injuries, which has increased morbidity and mortality [1].

Focused assessment with sonography for trauma, a development, let radiological residents to rapidly examine patients for injuries at the bedside, particularly those who were hemodynamically unstable and couldn't be moved to a computed tomography machine (CT). When a patient arrives at the hospital, it is possible to immediately determine whether there is any free fluid present in the peritoneal cavity, pericardium, or pleural spaces. FAST can also be used to detect solid organ damage as well as pneumothorax [2]. In addition, it can detect any free fluids in hepatorenal recess, perihepatic region, or Morrison pouch, upper right quadrant, peri-splenic view, upper left quadrant, the suprapubic area (the Douglas pouch), and the sub-xiphoid region (pericardial view) [3].

The "extended FAST" (EFAST) procedure is a new invention that scans the lower chest to look for pneumothorax. A FAST scan's accuracy is found to be correlated with and influenced by the severity of the injury, the patient's build (obesity) and condition (hemodynamic stability), the machine's features and resolution, and the operator's level of training and experience, despite the apparent accessibility and ease of use. FAST can also be problematic and commonly fails to detect the existence of blunt mesenteric, intestinal, diaphragmatic, or retroperitoneal injuries [4].

Extended-focused evaluation with sonography in trauma has been established as a technique for finding free fluid in the abdomen and is now used similarly to a stethoscope [5].

For the investigation of blunt abdominal injuries, computed tomography has emerged as the industry standard. Imaging time has been drastically shortened thanks to the introduction of multi-detector CT scanners, which have improved diagnostic capabilities with high intra-abdominal injury detection with sensitivity and specificity of over 95% and strong negative predictive value of almost 100% [6].

However, it is inappropriate for patients with hemodynamic instability because the patient must be transferred from the emergency room to the scanner. Additionally, some patients' CT evaluations may be slowed down or prohibited by worries about radiation and contrast. Because ultrasonography is rapid and can be done at the patient's bedside, it is still beneficial in trauma patients where time is of the essence. Its usefulness as a screening test has been demonstrated in numerous investigations, but only a small number of research have linked its diagnostic abilities to the underlying seriousness or grading of solid abdominal visceral injuries [7].

Evaluation of the accuracy of E-FAST compared with the results of CT as a gold standard in multiple trauma patients was the goal of this study.

PATIENTS AND METHODS

During the six-month period from June 2021 to

December 2021, our prospective, observational, and diagnostic accuracy study, which included 53 patients with multiple trauma and for whom CT scans were performed at the time of arrival in the emergency room, at the Radiodiagnosis Department of Zagazig University Hospital.

Inclusion Criteria: Patients age >18 years. Patients presented in Emergency Department with history of trauma with suspected thoraco-abdominal injuries, and patients who had CT scans done when they entered the emergency room.

Exclusion Criteria: Patients with underlying diseases like cirrhosis that cause fluid buildup in the abdomen. Patients with inconclusive or limited FAST studies. Patients with hemodynamic instability who went straight from FAST to the operation room (OR) without first getting a CT scan. Patients <18 years. Trauma patients with isolated extremities injuries and no thoracoabdominal injuries. Contraindications to contrast media (e.g. those having a history of adverse responses to contrast agents), being pregnant, receiving radioactive iodine treatment for thyroid illness, having both chronic or acute kidney disease, and contraindications of CT radiations (as pregnant specsialy in first trimester and lactating women).

All studied groups underwent the following:
1. History taking: Full history was collected as occupation as well as family history.
2- Clinical examination: General examinations, vital signs, in addition to local examination of chest.
3- Imaging procedures:
Technique of E-FAST scan) (figure1).
Patient is lying flat. Convex transducer, 3.5–5.0 MHz, and with scanning off:

Pericardial view:
The liver in the epigastric area was used as a sonographic window to the heart to assess the pericardium. A pericardial effusion was checked for in the possible gap between the visceral and parietal pericardium. Parasternal or apical four-chamber views were employed if anatomical restrictions prevent epigastric probe placing.

Right flank view: Following each other, four probable areas were checked for the buildup of free fluid. After initially identifying the hepatorenal interface (Morison pouch), the more cephalad subphrenic and pleural spaces were assessed.

Left flank view: Similar to the right flank, four possible areas were successively studied on the left, but the splenorenal interface was evaluated.

Pelvic view: Using the bladder as a sonographic window, a transverse sweep was performed to look for free fluid in the Douglas pouch or rectovesical gap.

Anterior pleural views: Lung sliding was evaluated in the anterior pleura for presence or absence. The midclavicular line, which runs between the clavicle and the diaphragm, was the location of the probe in a sagittal orientation. Interrogation of the bilateral interspaces 5-8 from the front and side was performed.
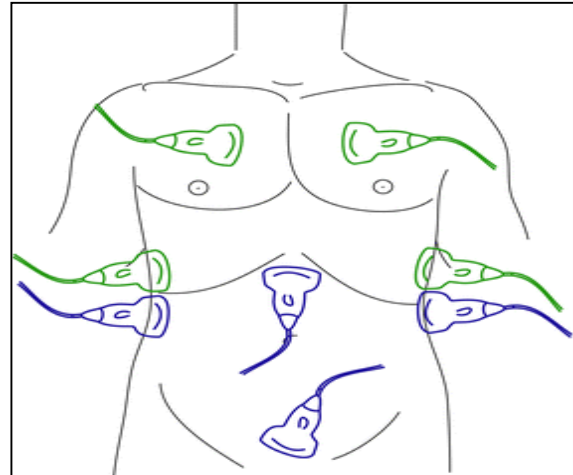
Figure (1): E-FAST scan.
Revising and analyzing of the imaging results was done. Finally, reverse patients to CT room to confirm diagnosis +ve and –ve data and exclude false +ve and false negative.

CT technique:
o Patient position: Supine, body centered within the gantry.
o Tube voltage: < 120KVP
o Scout: Above the lung apices to symphysis in thoracoabdominal, from above Luna apices to diaphragm in thoracic injuries, from diaphragm to symphysis in abdominal injuries.

Scan direction: Craniocaudal.
Scan geometry:
o Field of view :350 mm
o Slice thickness:< 0,75mm, interval <0,5mm
o Reconstruction algorithm: Soft tissue & bone.
o IV contrast media: Type: Low osmolarity, non-ionic, water soluble, iodine based.
o Dose: 1-2 mL/Kg.
o Injection: Manually through a wide bore cannula.
o Respiration phase: Single breath – hold inspiration.

Patients' management:
According to the status 23 patients treated by conservative treatment, 6 patients underwent laparotomy, 12 patients needed chest tube, one patient admitted to spinal injury unite.

Ethical consent:
An approval of the study was obtained from Zagazig University Academic and Ethical Committee [IRB Approval number (#6713/9-2-

2021)]. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

The IBM SPSS software programme version 20.0 was used. In order to determine the significance of the acquired results, a 5-percent threshold was used. It was a Chi-square test. For categorical variables, chi-square correction for more than 20% of cells with anticipated count less than 5 was required.

Student t-test: to calculate the quantities of data of normal distribution and to compare between two studied groups.
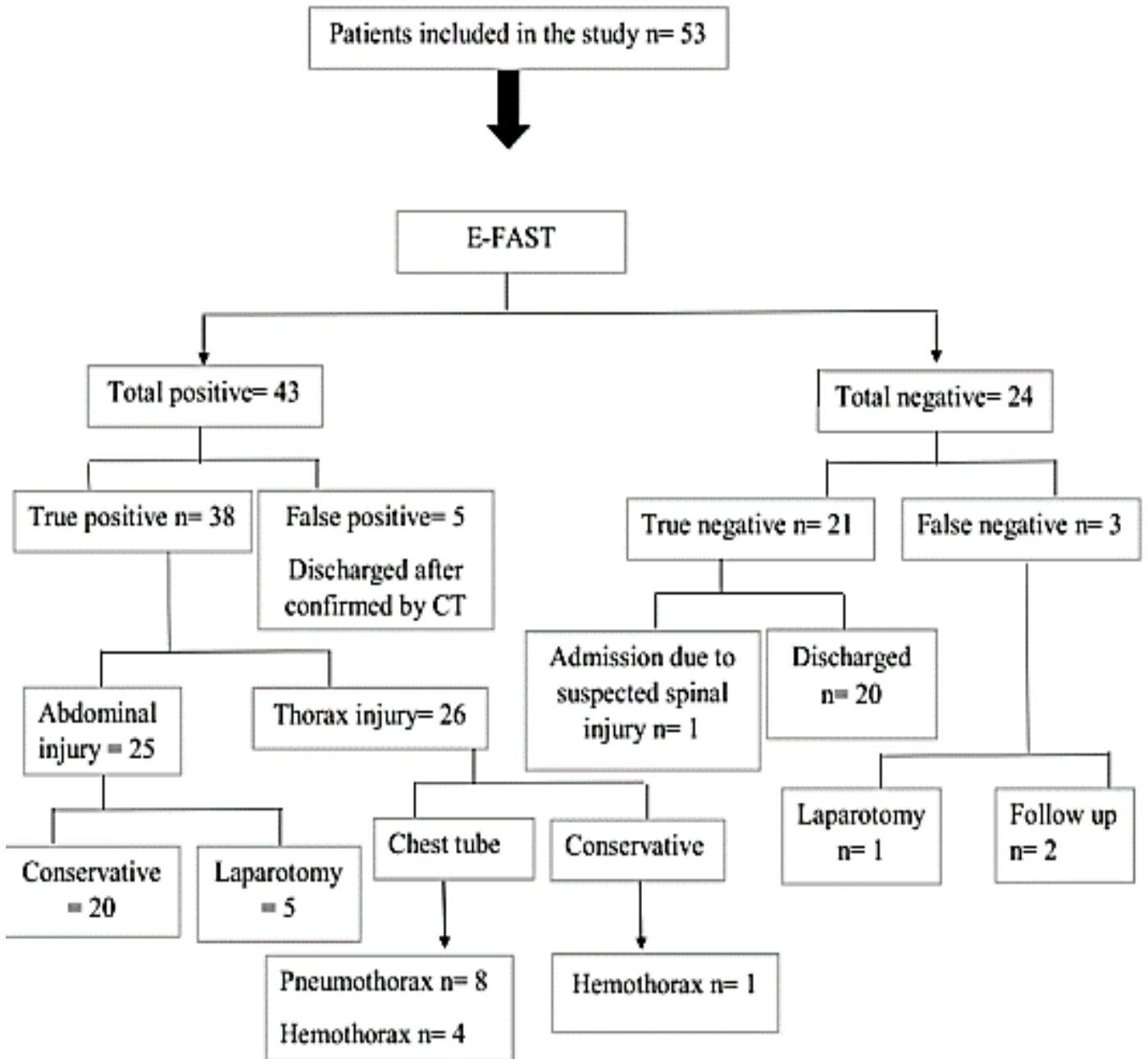
RESULTS

Figure (2): Conceptual framework of the study.

The total number of the participants was 53 patients. The mean age was 36.0 ± 9.3 years with median 37 years and ranging from 18 to 64 years. There were 70% males and 30% females among the participants (Table1).

Table (1): Basic characteristics of the participants

| Variable		n= 53
Age	(mean± SD)	36.0± 9.3
	Median (Range)	37 (18-64)
Gender	Male n (%)	37 (70)
	Female n (%)	16 (30)

Diagnostic value of E-FAST:

Regarding hemothorax by E-FAST scan, there were 13 patients positive and 40 negative, while by CT, there were 15 patients positive and 38 patients negative. Upon using ROC curve analysis, the area under the curve was 0.800, the sensitivity was 80% while specificity was 82%-95% CI (0.560: 1.000) and p value < 0.05 (Table 2 & figure 3). Regarding pneumothorax, by E-FAST scan there were 13 patients positive and 40 negative, while by CT, there were 14 patients positive and 39 patients negative. Upon using ROC curve analysis, the area under the curve was 0.867, the sensitivity was 93% while specificity was 80%-95% CI (0.644: 1.000) and p value <0.05 (Table 2 & figure 4).

Regarding Hemoperitoneum, by E-FAST scan there were 25 patients positive and 28 negative, while by CT there were 28 patients positive and 25 patients negative. Upon using ROC curve analysis, the area under the curve was 0.735, the sensitivity was 84% while specificity was 65% - 95% CI (0.524: 0.945) and p value <0.05 (Table 2 & figure 5).

Table (2): Comparison between E-FAST and CT scan results

Variable		US	CT scan
Hemothorax	Positive, n (%)	13 (24.5)	15 (28)
	Negative, n (%)	40 (75.5)	38 (72)
Pneumothorax	Positive, n (%)	13 (26)	14 (26)
	Negative, n (%)	40 (74)	39 (74)
Hemoperitoneum	Positive, n (%)	25 (47.2)	28 (52.8)
	Negative, n (%)	28 (52.8)	25 (47.2)
Solid organ injury	Positive, n (%)	18 (33.9)	19 (35)
	Negative, n (%)	35 (60.1)	34 (65)
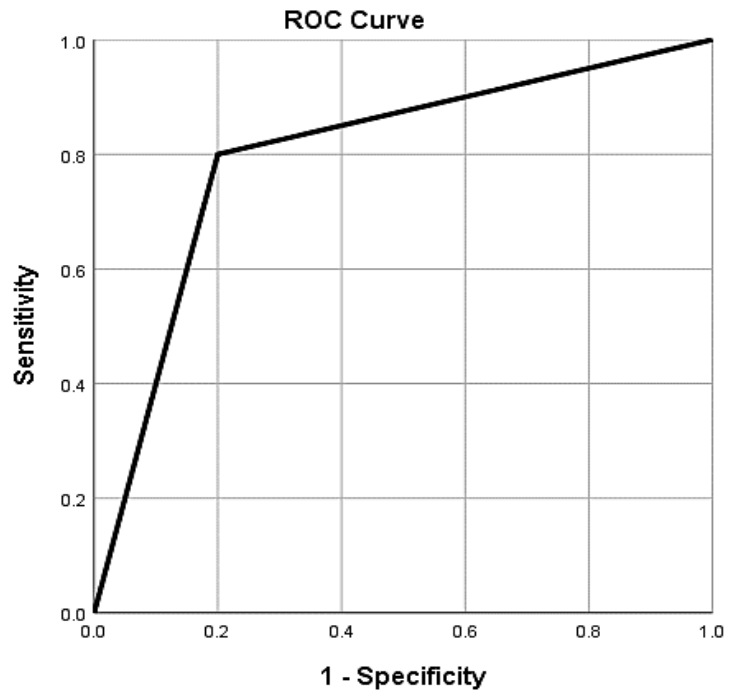
Diagonal segments are produced by ties.

Figure (3): ROC curve analysis of E-FAST in diagnosis of hemothorax in comparison with CT scan as a gold standard.
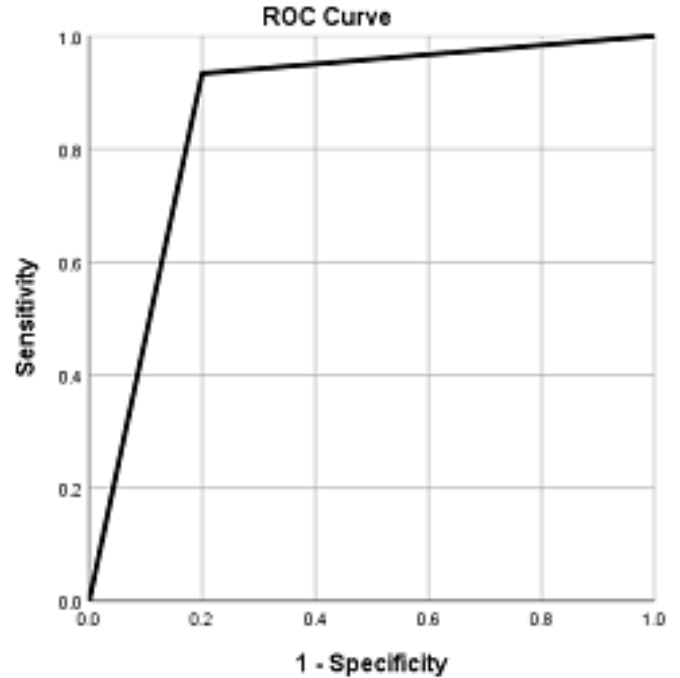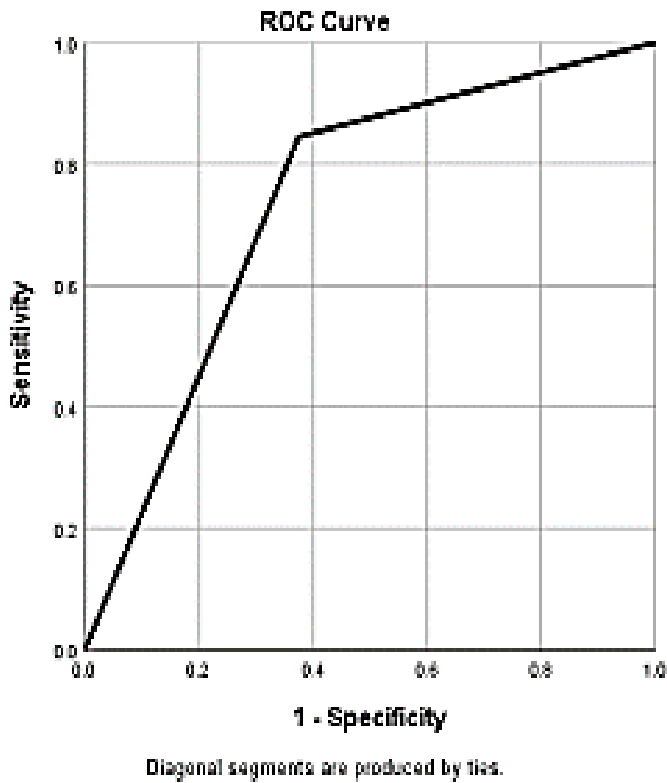

Diagonal segments are produced by ties.

Figure (4): ROC curve analysis of E-FAST in diagnosis of pneumothorax in comparison with CT scan as a gold standard

Figure (5): ROC curve analysis of E-FAST in diagnosis of hemoperitoneum in comparison with CT scan as a gold standard.

There were 26 true positive diagnosis of hemothorax and pneumothorax while 3 were false negative. There were 25 had true positive diagnosis of hemoperitoneum among them 18 had true positive solid organ injury, while 3 had false negative diagnosis of hemoperitoneum among them 1 had false negative diagnosis of solid organ injury (Table 3).

Table (3): E- FAST results in comparison to CT results among the participants

Variable	False negative by E-FAST	True positive by E-FAST
Hemothorax	2	13
Pneumothorax	1	13
Hemoperitoneum	3	25
Solid organ injury	1	18

Figure (6): Male 38 years old patient had blunt trauma in the left side of the chest, Fig B: E-FAST Revealed: Left –sided apical and posterior, inter-scapular and supra-scapular, absent pleural sliding denoting pneumothorax, Fig A: CT chest, revealed: Left sided pneumothorax with underlying relaxation collapse. Management: Left sided chest tube with its tip directed upwards and medially.

DISCUSSION

Trauma is one of the main causes of death worldwide. Trauma has the unfortunate distinction of having the worst global rate of road traffic accidents (RTA). The issue of inadequate infrastructure in affluent countries is exacerbated by the lack of skilled emergency care personnel at various levels of health care [8].

Our prospective, observational, diagnostic accuracy study was conducted at the Radiodiagnosis Department, Zagazig University Hospital during six months from June 2021 to December 2021. The study included 53 multiple trauma patients and for whom CT scans were performed at time of arrival in the emergency room. It was aiming to evaluate the accuracy of E- FAST exam compared to the results of CT as a gold standard in multiple trauma patients.

Regarding the demographic data in our study, the total number of the participants was 53 patients. The mean age was 36.0 ± 9.3 years with median 37 years and ranging from 18 to 64 years. There were 70% males and 30% females among the participants.

The major part of the participants (70%) had mechanism of injury due to road traffic accident. About 8% had injury due to fall from height. There were 9% who had injury due to penetrating trauma. Among the participants 13% had injury due to blunt trauma. A similar prospective, observational, diagnostic accuracy study by **Akoglu et al.** [9] was completed between August 2014 and December 2015 at the emergency department of a Level 1 Trauma Center, which sees 20,000 trauma patients annually. The study population's median age was 38 years, Male patients made up 102 patients (79%), blunt trauma mechanisms were present in 115 patients (89.1%), and high energy trauma was the cause of 107 patients (82.9%), such as car accidents or falls from great heights [9].

A comparison between E-FAST and CT scan results was done during our study. Regarding hemothorax by E-FAST scan, there were 13 patients positive and 40 negatives, while by CT, 15 patients were positive, and 38 patients were negative. Upon using ROC curve analysis, the sensitivity was 80% while specificity was 82%. On the other hand, considering pneumothorax, by CT scan, there were 14 patients positive and 39 negatives, while by E-FAST, 13 patients were positive, and 40 patients were negative. Upon using ROC curve analysis, the sensitivity was 93% while specificity was 80%. Higher sensitivity and specificity by E-FAST were also demonstrated in the results of **Bagheri et al.** [5] particularly in the case of pneumothorax, in the identification of free fluid in the abdominal and thoracic areas. Using FAST in the emergency room, **Zieneldin et al.** [10] found that the sensitivity and specificity were 91 percent and 100 percent respectively.

Our findings also revealed that regarding hemoperitoneum by CT scan, there were 28 patients positive and 25 negatives, while by E-FAST, 25 patients were positive, and 28 patients were negative. Upon using ROC curve analysis, the sensitivity was 84% while specificity was 65%. In addition, considering solid organ injury by CT scan, there were 19 patients positive and 34 negatives, while by E-FAST, 18 patients were positive, and 35 patients were negative. Upon using ROC curve analysis, the sensitivity was 69% while specificity was 67%.

The benefits and drawbacks of utilising E-FAST are hotly debated among surgeons and experts in emergency medicine. Due to the short intervening time, lower costs, and advantages of adopting noninvasive procedures for patients, several doctors demonstrated a higher enthusiasm to utilise E-FAST, especially in unstable hemodynamic patients [11]. In contrast, **Dammers et al.** [12] deemed E-FAST to be an operator-dependent approach and think it is less accurate than other imaging techniques at detecting certain conditions, like pelvic fractures, retroperitoneal injuries, and hollow viscus injuries. In the study of

Akoglu et al. [9] E-diagnostic FAST's accuracy (AUC) for the detection of abdominal free fluid was 0.71, pneumothorax was 0.87, and pleural effusion was 1.00. EP-performed FAST (just abdomen) has a sensitivity of 42.9% and a specificity of 98.4%. The +LR (true positive/false positive) and LR (false negative/true negative) of the FAST assessment for abdominal free fluid were 26.8 and 0.58, respectively. In our investigation, E-FAST had a sensitivity and specificity of 75 and 99.2% respectively for pneumothorax [9]. In contrast, **Abdulrahman et al.** [13] showed that in patients who had blunt trauma, the sensitivity was 42.7% and the specificity was 98.1% for pneumothorax. **Becker et al.** [14] in 3181 individuals with stable hemodynamics and blunt abdominal trauma were investigated. The purpose of their study was to evaluate FAST's efficacy in relation to the intensity of trauma. They discovered that patients with greater severity had lower FAST sensitivity (65.1%), specificity (97.1%), and diagnostic accuracy (90.6%) than patients with lesser severity. Therefore, research implied that individuals who experienced more severe trauma had a larger probability of concealed injuries in the FAST technique [14].

In our study, FAST results in comparison to CT results among the participants indicated that there were 26 true positive diagnoses of hemothorax and pneumothorax while 3 were false negative. There were 25 had true positive diagnosis of hemoperitoneum among them 18 had true positive solid organ injury while 3 had false negative diagnosis of hemoperitoneum among them 1 had false negative diagnosis of solid organ injury. According to the research, there was a wide range of sensitivity (42.0-91.7%), specificity (83-100%), and accuracy (9-96%) for the use of FAST and E-FAST exams [15, 16].

It is still necessary to consider parameters like the patient's hemodynamics and CT scans despite the fact that sonography is frequently used and accessible in the emergency department for traumatised patients. Because those who have unstable hemodynamics are more likely to have positive FAST results, laparotomies are performed on them. However, stable hemodynamic patients get a CT scan to help them make good decisions [10].

CONCLUSION
We concluded that E-FAST examination has an excellent specificity and is considered as a useful diagnostic procedure for the primary assessment of trauma patients in ED. However, the sensitivity detected was not high enough to rule-out thoraco-abdominal injuries in multiple trauma patients. It is also a portable and non-invasive procedure but is operator dependent. The sensitivity of a history and physical exam in detecting pneumothorax, hemoperitoneum, solid organ injury, and hemothorax was increased by an E-FAST. It

had been found that E-FAST greatly improves diagnostic accuracy, with the exception of hemorrhagic shock.

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