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Original article

Study of the accuracy of E-FAST (Extended Focused Assessment with Sonography in Trauma) in blunt trauma chest

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Abstract

Background: *Focused assessment with sonography in trauma (FAST) has been extensively utilized and studied in blunt and penetrating trauma of upper torso and abdomen for the past 3 decades.* ***Aims and Objectives:*** *To evaluate the diagnostic value of Extended-Focussed Assessment of sonography in trauma in comparison to clinical examination, chest X-ray, chest computed tomography scan in diagnosis of intrathoracicinjuries in blunt trauma chest.* ***Materials and Methods:*** *The present prospective observational study was conducted in a tertiary care hospital of the Armed Forces in the Department of Surgery from November 2017 to November 2019 on 110 patients.* ***Results:*** *In the present study, EFAST for hemothorax was 94.55% with sensitivity of 88.5% and specificity of 97.33%, accuracy of EFAST for pneumothorax showed 99.09 % sensitivity of 100% and specificity of 99.07%. Accuracy of EFAST for hemopneumothorax was 98.18%, with sensitivity of 66.67% and specificity of 99.07% and EFAST for rib fracture was 99.09 % with sensitivity of 97.3% and specificity of 100%.* ***Conclusion:*** *The sensitivity and negative predictive value of EFAST was significantly high for hemothorax and pneumothorax, the specificity and positive predictive value of EFAST was high in diagnosing these injuries, in blunt trauma chest. EFAST performed during primary survey found to be a reliable tool for evaluation of blunt trauma chest due to its high sensitivity and negative predictive value.*

Keywords: *Accuracy, E-Fast, Blunt, Trauma, Chest*

INTRODUCTION

Focused assessment with sonography in trauma (FAST) has been extensively utilized and studied in blunt and penetrating trauma of upper torso and abdomen for the past 3 decades. Prior to FAST, invasive procedures such as diagnostic peritoneal lavage and exploratory laparotomy were commonly utilized to diagnose intra-abdominal injury.[1,2] Today the FAST examination has evolved into a more comprehensive study of the abdomen, heart, chest, and inferior vena cava, and many variations in technique, protocols, and interpretation exist. Trauma management strategies such as laparotomy, laparoscopy, endoscopy, computed tomographic angiography, angiographic intervention, serial imaging, and clinical observation have also changed over the years. This state of the art review will discuss the evolution of the FAST examination to its current state in 2017 and evaluate its evolving role in the acute management of the trauma patient. Traumatic injury remains the leading cause of death of persons from age 1 to 44 years, with nearly 200 000 deaths per year in the United States[1,2] where the most common mode of injury being blunt injury, followed by penetrating and crush injuries.

Although chest CT scan imaging is considered as the gold standard for the detection of PTX, hemothorax, it also has some limitations such as the unavailability in some community hospitals, high cost, hazards of radiation (especially in children and pregnant females), the long procedure time, and the limited use in the vitally unstable patient.[5] This may potentially delay the diagnosis and treatment of PTX, hemothorax, that might affect the survival of major trauma patients. Of note, the use of ultrasonography for thoracic injuries is fairly new compared to other accepted ultrasound applications and it is gaining more attention and acceptability.[4,5]

However, the long procedure time and hemodynamic instability in trauma patients might restrain the early use of CT scan. It is important to detect PTX, hemothorax earlier as delayed diagnosis and treatment of PTX might affect the survival of patients with major trauma. Two earlier studies have reported ultrasound as a reliable modality for diagnosing PTX, hemothorax in trauma patients with a high sensitivity (94 %) and specificity (99.7 %).[6] However, these investigators have used CXR as the reference for comparison with the eFAST findings. Kirkpatrick et al[7] have investigated the diagnostic accuracy of eFAST and CXR to detect PTX, hemothorax using CT scan as the reference. The authors reported that eFAST had greater sensitivity than CXR (48.8 vs. 20.9 %).

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The extended part of the FAST is performed in the depicted manner. The probe placed over the chest wall and checked with M mode, in order to confirm the diagnosis of pneumothorax and hemothorax.

In conclusion, eFAST is a reliable and time saving bedside test that had superior diagnostic accuracy over the CXR and clinical examination. eFAST can be used as an efficient triaging tool in BCT patients that could be performed simultaneously along with resuscitation in trauma room to explore life-threatening injuries without any delay or even interruption of resuscitation. Based on the analysis, it is highly recommended eFAST to be introduced as an adjunct in ATLS trauma management algorithm.[8]

AIM AND OBJECTIVES

1. To evaluate the diagnostic value of Extended-Focussed Assessment of Sonography in Trauma in comparison to clinical examination, chest X-ray, chest computed tomography scan in diagnosis of intrathoracic injuries in blunt trauma chest.
2. To evaluate whether Extended Focussed assessment of sonography in trauma alone performed during primary survey is a reliable tool for evaluation of blunt thoracic trauma and whether additional information obtained with chest, computed tomography influences subsequent therapeutic decisions for early management of thoracic trauma patients.
3. To assess whether computed tomography scan of chest should be performed and included as a protocol in all stable cases of blunt thoracic trauma.

MATERIALS AND METHODS

The present prospective observational study was conducted in a tertiary care hospital of the Armed Forces in the department of surgery from November 2017 to November 2019. Ethical clearance for the study was obtained from the Institutional ethical committee prior to the commencement of the study. A total of 110 cases were included.

Inclusion Criteria:

1. All Trauma victims reported to Trauma Centre with history of blunt thoraco abdominal trauma with dangerous mechanism of injury.
2. All hemodynamically stable patients after primary survey.

Exclusion Criteria:

1. Paediatric age group (age <12 years)
2. Pregnant women
3. Female of child bearing age (age: 15-45 years)
4. Haemodynamically unstable patients

METHODOLOGY

Patients with blunt chest trauma were admitted at Command Hospital, Lucknow were subjected to primary survey, brief relevant history and secondary survey. All patients underwent E-FAST and only haemodynamically stable patients were underwent computed tomography scan of chest. Abnormal findings on E-FAST and computed tomography scan of chest was identified by using written report from the radiologist. All patients were evaluated for the diagnostic value of EFAST, along with clinical examination, chest X-ray and NCCT scan in diagnosis of intra thoracic injuries in blunt trauma chest. Cross tables were generated and Chi square test was used for testing of significance for association. Results of the NCCT findings were considered as the gold standard to EFAST, clinical examination, and chest X ray findings. Accordingly, for EFAST, clinical examination, and chest X ray , sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, negative likelihood ratio, accuracy were calculated. The results were recorded and analyzed statistically. Final outcome was evaluated.

Statistical Analysis

The analysis included profiling of patients on different demographic, clinical and laboratory findings. Quantitative data were presented in terms of means and standard deviation. Qualitative/categorical data were presented as absolute numbers and proportions. A p value of < 0.05 considered statistically significant. SPSS software Version 24.0 was used for statistical analysis.

RESULTS

In the present study, a total of 110 patients were examined. Out of which 72(65.5%) were males and 38(34.5%) were females. Out of 110, 81 patients had decreased breath sounds, which constituted 73.6%, out of which, eFAST turned to be abnormal in 87 patients (79%), the NCCT which was taken as gold standard was abnormal in 75 patients (68.2%). In the present study out of 110 cases hemothorax was found in 33 cases which accounts to (30%) with sensitivity of eFAST being 88.57%, and specificity being 97.33%. As per the study the accuracy of EFAST for hemothorax, is 94.55 %with sensitivity of 88.5% and specificity of 97.33%. As per the study the accuracy of EFAST for pneumothorax is 99.09 %, with sensitivity of 100% and specificity of 99.07%. As per the study the accuracy of EFAST for hemopneumothorax is 98.18 %, with sensitivity of 66.67% and specificity of 99.07%. As per the study the accuracy of EFAST for rib fracture is 99.09 %, with sensitivity of 97.3% and specificity of 100% (Tables 1 – 8).

Table 1: Comparison of E-FAST and NCCT findings

E-FAST Findings	NCCT Findings		
	Abnormal	Normal	Total
Abnormal	74	0	74 (67.3)
Normal	1	35	36 (32.7)
Total	75 (68.2)	35 (31.8)	110 (100.0)

Chi Square Value = 105.519; p-value < 0.0001*;* p-value < 0.05, statistically significant

Table 2: Diagnostic evaluation of E-FAST with respect to NCCT (Gold Standard)

Statistic	**Value**	**95% CI**
Sensitivity	98.67%	92.79% to 99.97%
Specificity	100.00 %	90.00% to 100.00%
Positive Likelihood Ratio		
Negative Likelihood Ratio	0.01	0.00 to 0.09
Positive Predictive Value	100.00%	
Negative Predictive Value	97.22 %	83.32% to 99.59%
Accuracy	99.09%	95.04% to 99.98%

Table 3: Comparison of E-FAST and NCCT findings for Pneumothorax

E-FAST Findings	**NCCT Findings**		
	Abnormal	**Normal**	**Total**
Abnormal	2	1	3 (2.7)
Normal	0	107	107 (97.3)
Total	2 (1.8)	108 (98.2)	110 (100.0)

Chi Square Value = 72.654; p-value < 0.0001*;* p-value < 0.05, statistically significant

Table 4: Diagnostic evaluation of E-FAST with respect to NCCT (Gold Standard)

Statistic	Value	95% CI
Sensitivity	100.00%	15.81% to 100.00%
Specificity	99.07 %	94.95% to 99.98%
Positive Likelihood Ratio	108.00	15.35 to 759.79
Negative Likelihood Ratio	0.00	-
Positive Predictive Value	66.67%	22.14% to 93.36%
Negative Predictive Value	100.00%	-
Accuracy	99.09%	95.04% to 99.98%

Table 5: Comparison of E-FAST and NCCT findings for Hempneumothroax

E-FAST Findings	NCCT Findings		
	Abnormal	**Normal**	**Total**
Abnormal	2	1	3 (2.7)
Normal	1	106	107 (97.3)
Total	3 (2.7)	107 (97.3)	110 (100.0)

Chi Square Value = 47.528; p-value < 0.0001*;* p-value < 0.05, statistically significant

Table 6: Diagnostic evaluation of E-FAST with respect to NCCT (Gold Standard)

Statistic	Value	95% CI
Sensitivity	66.67%	9.43% to 99.16%
Specificity	99.07 %	94.90% to 99.98%
Positive Likelihood Ratio	71.33	8.66 to 587.52
Negative Likelihood Ratio	0.34	0.07 to 1.67
Positive Predictive Value	66.67%	19.54% to 94.28%
Negative Predictive Value	99.07%	95.53% to 99.81%
Accuracy	98.18%	93.59% to 99.78%

Table 7: Comparison of Chest X Ray and NCCT based on pathological findings (n, %)

Findings	Chest X-Ray	E-FAST	NCCT	NCCT Vs. Chest X-Ray		NCCT Vs. E-FAST	
				Z - value	**p-value**	**Z - value**	**p-value**
Rib Fractures	43 (39.1%)	43 (39.1%)	44 (40%)	0.136	0.889	0.136	0.889
Hemothorax	31 (28.2%)	33 (30%)	35 (31.8%)	0.583	0.562	0.289	0.772
Pneumothorax	2 (1.8%)	3 (2.7%)	2 (1.8%)	-	-	0.450	0.653
Hemopneumothorax	3 (2.7%)	3 (2.7%)	3 (2.7%)	-	-	-	

Table 8: Final outcome

Intervention	Number (n=110)	Percent (%)
No intervention	30	27.3
ICD placement	80	72.7
Hospital stay		
<15 days	92	83.6
>15 Days	18	16.4
Outcome		
Healthy	88	80
Morbidity	19	17.3
Mortality	3	2.7
Outcome		
Healthy	88	80
Morbidity	19	17.3
Mortality	3	2.7

DISCUSSION

According to WHO global health observatory data –May 2017, the leading cause of blood trauma chest was road traffic accident, of these, 20.9% of the cases were seen in the age group 31-40, with male predominance. The mean age in my study was 48.5 years, and 65.8%, were males. As per WINFOCUS (World interactive network focused on critical ultrasound), is currently developing the use of ultrasound for initial poly trauma patients evaluation. This protocol has been included in ultrasound trauma life support(US-ATLS) algorithm. Based on this sequence, the ABC approach to trauma is suggested, starting by the airways (confirmation of patient airways and support of surgical airway), breathing (in which pneumothorax and hemothorax are evaluated) and circulation, by bleeding as hemoperitoneum is investigated. One pneumothorax was evidenced out of every 5 major traumas, which, if not identified could lead to severe hemodynamic changes and death. Blaivas et al evaluated chest X-ray versus pulmonary Ultrasound accuracy for occult pneumothorax identification found to have approximately 94% accuracy versus X-ray. In the present study out of 110 cases, on X-ray there were 2 pneumothoraces detected , EFAST showed 03 pneumothoraces, out of which NCCT Chest confirmed there were 02 pneumothoraces.

In observational studies occult pneumothorax in trauma patients was detected by chest CT in about 55%. In the eFAST sequence, the so called lung point (LP), Ultrasound sign can be searched, with 98% sensitivity, and 100% specificity for pneumothorax identification, which was also supported by Lichenstein et.al. as presence of LS and B lines identification has a negative predictive value of 97%, meaning that in a chest region with Lung sliding and B lines, there is NO pneumothorax.[9]

Nunes et al reported that serial EFAST examinations decreased the false negative rate by 50% and increased sensitivity for free fluid detection from 69% to 85% . In the present study of total 110 patients were examined. Out of which 72(65.5%) were males and 38(34.5%) were females. Out of 110, 81 patients had decreased breath sounds, which constituted 73.6%, out of which, eFAST turned to be abnormal in 87 patients(79%), the NCCT which was taken as gold standard was abnormal in 75 patients (68.2%).

A recent systematic review showed moderate evidence supporting prehospital EFAST use. It has been used successfully in air medical transport of injured patients. Press et al reported moderate accuracy for helicopter paramedics performing EFAST, with 46% sensitivity and 94.1% specificity for detection of hemothorax, and 18.7% sensitivity and 99.5% specificity for detection of pneumothorax. In the present study out of 110 cases hemothorax was found in 33 cases which accounts to (30%) with sensitivity of eFAST being 88.57%, and specificity being 97.33%. Quick and colleagues studied the ability to identify hemopneumothorax with in flight thoracic Ultrasound, among 149 subjects, 16 out of 20 hemopneumothoraces, were correctly identified with sensitivity of 68% and accuracy of 91%. In contrast, emergency department ultrasound had sensitivity of 84% and specificity of 98% and accuracy of 96%.Fox.et.al studied EFAST in 357 patients with blunt chest trauma. sensitivity for hemopneumothorax was 52% and specificity was 96%, a Meta analysis

determined eFAST had an overall sensitivity of 66% and specificity of 95% for detection of hemopneumothrax. In the present study out of total 110 cases, hemopneumothorax was found in 03 cases accounting to 2.7%, with sensitivity of eFAST being 66.67%, and specificity being 99.07%.

In a study published in 2017 under American college of radiology, they have stated ultrasound is increasingly being used for trauma patients, to help, identify, and observe fracture, hemothorax, pneumothorax. According to study published in Chinese journal of traumatology 2017, out of 61 suspected patients, there were totally 38 rib fractured patients, detected by Ultrasound and 20 rib fractured patients detected by radiograph. The sensitivity and specificity, being 98.31%, 100,% and positive predictive value, negative predictive value of Ultrasound in detecting rib fractures being 100% and 95.83% respectively. In the present study out of 110 cases 43 cases were identified to have rib fractures with sensitivity and specificity of 97.7% and 100 % respectively.

In this study, it was observed that 18.2% patients, who had ISS>15, NISS>22, PH<7.35, HB%:<10gm/dl, PCV<37%, required intubation. Also NISS was found to be good indicator of overall morbidity and mortality. ISS>50 was found to be good indicator of mortality, but ISS lacked predicting morbidity. NISS on other hand is better indicator of major trauma, and was able to detect significantly more major trauma patients as compared to ISS. NISS is also better predictor of need of intervention and requirement of ICU care.

CONCLUSION

The sensitivity and negative predictive value of EFAST was significantly high for hemothorax and pneumothorax , the specificity and possItive predictive value of EFAST was high in diagnosing these injuries, in blunt trauma chest. EFAST performed during primary survey is reliable tool for evaluation of blunt trauma chest due to its high sensitivity and negative predictive value. Additional information obtained with chest tomography influences, subsequent therapeutic decisions for early management of blunt trauma chest patients and also needs to significant change in outcome of patients. Computed tomography of chest should be performed and included as a protocol in all hemodynamically stable cases of blunt trauma chest after EFAST performed in trauma bay to rule out emergency (immediately life threatening) chest injuries.

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