Original Article

The Effect of Extended-Focused Assessment with Sonography in Trauma Results on Clinical Judgment Accuracy of the Physicians Managing Patients with Blunt Thoracoabdominal Trauma

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Abstract

Background: Extended-focused assessment with sonography in trauma (E-FAST) has been introduced as a free fluid identification technique in the abdomen, and currently, like stethoscopes, it is routinely used to assess traumatic patients, as part of physical examination tools. We decided to examine the effect of using E-FAST in the clinical judgment of the physicians managing patients with blunt abdominal and chest wall trauma. **Materials and Methods:** In this cross-sectional study, all patients who were admitted from May 2014 till May 2015 to the emergency department of Imam Khomeini and Sina Hospitals, Tehran, Iran, with an abdominal or chest blunt trauma and for whom E-FAST was conducted were enrolled. In a preprepared checklist, possible consequences based on the primary clinical judgment of a physician were recorded; and then, the results from E-FAST on existence or nonexistence of free fluid or air in the peritoneal or pleural space were presented, and the possible consequences according to the results obtained from the E-FAST were also recorded again. Based on actual outcome of patients' condition in the first 24 h, statistical characteristics for each pathology were calculated. **Results:** In this study, 115 patients with a mean age of 36.20 ± 12.37 years were examined including 92 (80%) men. The correlation coefficient between the possibility of hemorrhagic shock, pneumothorax, hemoperitoneum, solid organ damage, and hemothorax before and after the E-FAST based on the Kappa criteria was 0.803, 0.642, 0.430, 0.331, and 0.318, respectively. **Conclusion:** The results of this study showed that performing E-FAST increases the sensitivity of history and physical examination in diagnosis of pneumothorax, hemoperitoneum, solid organ damage, and hemothorax.

Keywords: Clinical decision-making, emergency department, extended-focused assessment with sonography in trauma examination, multiple trauma

Introduction

Trauma is one of the most common complaints of patients visiting the emergency department (ED) around the world. It is one of the usual challenges of the health system of any society because of increasing trend of mortality and morbidity.[1-3] Timely diagnostic and therapeutic actions are crucial in managing traumatic patients. Due to low sensitivity

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and specificity in history and physical examination of these patients, paraclinical diagnostic methods are generally used in dealing with them.[4-7]

Nowadays, based on existing guidelines, the use of bedside imaging methods in traumatic patients constitutes an important part of advanced life expectancy. Focused assessment with sonography in trauma (FAST) has been introduced since the 1980s as a free fluid identification technique in the abdomen, and currently, like stethoscopes, it is routinely used to assess traumatic patients, as part of physical examination tools.[4,8-13] In recent years, the anterior chest wall scan has also been added to FAST to identify pneumothorax, hemothorax, and atelectasis, which made extended-FAST (E-FAST) protocol. The sensitivity of this method in diagnosis of pneumothorax and hemothorax is reported to be about 43%–77%, which is much higher than a chest X-ray with 11%–21% sensitivity.[3,8,14,15]

There are controversies among surgeons and emergency medicine specialists, regarding the advantages and disadvantages of using E-FAST. Some physicians showed higher eagerness to use E-FAST, especially in unstable hemodynamic patients, due to short intervening time, reduction of costs, and benefits of using noninvasive methods for patients.[16,17] In contrast, some others consider E-FAST as an operator-dependent technique and believe that it is not much reliable than other imaging methods in the detection of some situations, such as hollow viscus injuries, retroperitoneal injuries, and pelvic fractures.[2-4,10-12,18-21]

Studies aiming to investigate the efficiency of E-FAST in traumatic patients reported higher diagnostic sensitivity of this method in unstable hemodynamic patients. However, diagnostic sensitivity was lower in severe traumatic patients, which makes the interpretation more difficult.[3,4,8,22,23] According to the mentioned content, there were different perspectives in terms of variation on the usage and efficiency of this tool by physicians. Therefore, we decided to examine the effect of using E-FAST in the clinical judgment of the physicians managing patients with blunt abdominal and chest wall trauma.

Materials and Methods

Study design

This cross-sectional study was carried out from May 2014 to May 2015 in the ED of Imam Khomeini and Sina Hospitals affiliated to Tehran University of Medical Sciences (TUMS), Tehran, Iran. The implemented protocol of the study was approved by the Ethics Committee of TUMS. Patients entered into the study after obtaining informed consent from them or their companions. No additional cost was imposed on patients to conduct this study. Collected information was used anonymously.

Study population

All patients who were admitted to the ED with an abdominal or chest blunt trauma and for whom E-FAST was conducted were included. Patients with penetrating trauma were excluded. Patients were selected by convenience sampling method.

Data gathering

On arrival to the ED, based on the Advanced Trauma Life Support Guideline, the patients had undergone a primary resuscitation, and airway status, head and neck condition, and vital signs status including blood pressure, heart rate, respiratory rate, and Glasgow coma score were investigated. To collect the data, a checklist with three parts was used.

- Part I: Patient's basic information was collected in a checklist and the revised trauma score (RTS) was also calculated and recorded for them. RTS was calculated by a postgraduate year 3 emergency medicine resident
- Part II: Possible consequences based on the primary clinical judgment of the in-charge general surgeon physician who had been consulted, then the results from E-FAST on existence or nonexistence of free fluid in the peritoneal space as positive or negative answers, and finally, possible consequences according to the results obtained from the E-FAST were recorded
- Part III: Actual outcome of patient's condition in the first 24 h (such as patient discharge without a follow-up order, patient discharge with a follow-up order, patient admission in general ward and/or intensive care unit, surgical intervention, and patient's death) and also patient's condition during the first 28 days (including without any permanent pathology [normal], with a permanent pathology [abnormal], and the patient's death) were recorded.

Statistical analysis

The prediction power of E-FAST in traumatic patients was assessed. Frequency and percentage were used to describe qualitative variables, while central and distributive indicators were used for quantitative variables. To analyze the data, assessment indicators of diagnostic tests including sensitivity and specificity, predictive values, and calculation of their 95% confidence interval (CI) were done. Negative predictive value (NPV) and positive predictive value (PPV) were calculated based on final diagnosis prevalence. Furthermore, we calculated area under cure (AUC) of receiver operating characteristic curve with 95% CI for all diagnosis. All information was analyzed by SPSS-19 (IBM SPSS® Inc., Chicago, IL, USA). statistical software.

Results

In this study, 115 patients were examined with multiple trauma including 92 (80%) men and 23 (20%) women. The mean age was 36.20 ± 12.37 years (range 15–72). The basic information of the patients studied is given in Table 1. Based on this, the most damage mechanism in this case was motor vehicle accident (41.7%).

Sixty-one patients (53%) were examined and treated without performing an abdominopelvic computed tomography (CT) scan. Among patients who underwent abdominopelvic CT scan, 43

Table 1: Basic information of the studied patients

Variable	Frequency (%)
Trauma mechanism	
Motor vehicle accident	48 (41.7)
Pedestrian or bicycle with MV	37 (32.2)
Falling	12 (10.4)
Assault	7 (6.1)
Gunshot or shotgun	1 (0.9)
Car accident	9 (7.8)
Unknown	1 (0.9)
Abdominopelvic CT findings	
Not done	62 (53.9)
Normal	43 (37.3)
Splenic injury (low grade)	4 (3.5)
Splenic injury (high grade)	1 (0.9)
Renal injury	1 (0.9)
Pelvic Fx	4 (3.5)
Thoracic CT findings	
Not done	63 (54.8)
Normal	39 (33.9)
Pneumothorax	5 (4.3)
Hemothorax	1 (0.9)
PTX + HTX	3 (2.6)
Pulmonary contusion	3 (2.6)
Pericardial effusion	1 (0.9)
Surgery findings	
Splenic injury	5 (4.3)
Hepatic injury	1 (0.9)
Intestinal injury	1 (0.9)
Cardiac injury	1 (0.9)
Primary outcome	
Death	1 (0.9)
ICU	24 (20.9)
Ward	41 (35.7)
Discharge with follow up	39 (33.9)
Discharge	2 (1.7)
Operation	8 (7.0)
Late outcome	
Death	8 (7.0)
Normal	89 (77.4)
Abnormality	18 (15.7)

CT: Computed tomography, ICU: Intensive care unit, PTX + HTX: Pneumothorax + hemothorax, MV: Motor Vehicle

individuals (37.4%) did not have any pathologic finding. The most intra-abdominal damage was for low-grade splenic injury (3.5%).

Sixty-three patients (54.8%) in this study were tested and treated without undergoing thoracic CT scan. Among those who were exposed to thoracic CT scan, there were 39 cases without any pathological finding and 13 cases had a pathological issue in the CT scan. The highest frequency with five cases (4.3%) was for isolated pneumothorax.

From the participants of the study, eight patients (7%) underwent an abdominal and thoracic surgery. The most of the pathologic finding in these surgeries was related to splenic injuries, with a frequency of five cases.

On assessment of primary outcomes, one person (0.9%) died; on the other hand, 39 patients (33.9%) with an order of follow-up in case that warning signs occur and two patients (1.7%) without any follow-up order were discharged from the ED.

On late outcomes survey, eight patients (7%) died, 89 patients (77.4%) had no persistent pathology, and 18 patients (15.7%) suffered permanent injuries.

The correlation between final and possible diagnosis of two groups of with and without the results of E-FAST is reported in Table 2. The values of AUC revealed that except for hemorrhagic shock, E-FAST significantly increases the accuracy of diagnosis of posttraumatic complications, including pneumothorax, hemoperitoneum, solid organ damage, and hemothorax.

Discussion

The results of this study showed that performing an E-FAST increases the sensitivity of history and physical examination in diagnosis of pneumothorax, hemoperitoneum, solid organ damage, and hemothorax. Furthermore, among the positive cases reported by E-FAST for hemoperitoneum and solid organ damage diagnosis, true-positive cases in E-FAST were higher than history and physical examination. Furthermore, E-FAST is significantly more successful than history and physical examination in diagnosis of the solid organ damage and hemothorax.

Numerous studies have estimated the efficiency of FAST in traumatic patients with a sensitivity of about 64%–98% and specificity of 86%–100% and of E-FAST with a sensitivity of 43%–77% and specificity of 95%–100%.[3,8,9,12,19]

Nowadays, E-FAST, as a cost benefit, rapid, noninvasive, and repeatable on bedside technique, has been a key method in determining the presence of free fluid in the intraperitoneal and pleura spaces. As a result, it can increase the management quality of patients with blunt abdominal and thoracic trauma in the ED.[3,4,8-12,21] Furthermore, it is a good predictor for the assignment of patients in terms of transition to operation room or a conservative treatment.[24]

The results of this study also showed higher sensitivity and specificity by E-FAST in diagnosis of free fluid in the abdominal and thoracic spaces, especially in pneumothorax. In the study of Zieneldin *et al*. by performing FAST in theemergency ward, the sensitivity and specificity were assessed 91% and 100%, respectively.[25] In another study (2017), the sensitivity, specificity, PPV, NPV, false-positive, false-negative, and accuracy of this method were reported to be 92.6%, 100%, 100%, 92%, 0.0%, 7.4%, and 96%, respectively.[4]

Despite the widespread usage and availability of sonography in the ED for traumatic patients, FAST's success in helping to make decisions on treatment methods is unclear and the need to use factors such as patient's hemodynamic and CT still

Table 2: The correlation between primary impression and final diagnosis of the patients before and after knowing the results of E-FAST

Diagnosis	Impression	Final diagnosis		Statistical index	Value (95% CI)	AUC (95% CI)	κ
		+	−				
Hemorrhagic shock							
Ph/E	+	13	2	PPV	86.7 (59.5-98.3)	0.92 (0.86-0.96)	0.803
				NPV	98.0 (93.0-99.8)		
	−	2	98	Sensitivity	86.7 (59.5-98.3)		
				Specificity	98.0 (93.0-99.8)		
Ph/E + E-FAST	+	12	2	PPV	85.7 (57.2-98.2)	0.89 (0.82-0.94)	
				NPV	97.0 (91.6-99.4)		
	−	3	98	Sensitivity	80.0 (51.9-95.7)		
				Specificity	98.0 (93.0-99.8)		
PTX							
Ph/E	+	5	6	PPV	45.5 (16.7-76.6)	0.89 (0.82-0.94)	0.642
				NPV	99.0 (94.8-100)		
	−	1	103	Sensitivity	83.3 (35.9-99.6)		
				Specificity	94.5 (88.4-97.9)		
Ph/E + E-FAST	+	10	2	PPV	83.3 (51.6-97.9)	0.94 (0.89-0.98)	
				NPV	99.0 (94.7-100)		
	−	1	102	Sensitivity	90.9 (58.7-99.8)		
				Specificity	98.1 (93.2-99.8)		
Hemoperitoneum							
Ph/E	+	5	2	PPV	71.4 (29.0-96.3)	0.68 (0.59-0.77)	0.430
				NPV	92.6 (85.9-96.7)		
	−	8	100	Sensitivity	38.5 (13.9-68.4)		
				Specificity	98.0 (93.1-99.8)		
Ph/E + E-FAST	+	10	0	PPV	100 (69.1-100)	0.88 (0.81-0.94)	
				NPV	97.1 (91.9-99.4)		
	−	3	102	Sensitivity	76.9 (46.2-95.0)		
				Specificity	100 (96.5-100)		
Solid organ damage							
Ph/E	+	3	3	PPV	50.0 (11.8-88.2)	0.62 (0.53-0.71)	0.331
				NPV	92.7 (86.1-96.8)		
	−	8	101	Sensitivity	27.3 (6.0-61.0)		
				Specificity	97.1 (91.8-99.4)		
Ph/E + E-FAST	+	10	0	PPV	100 (69.2-100)	0.95 (0.90-0.98)	
				NPV	99.0 (94.8-100)		
	−	1	104	Sensitivity	90.9 (58.7-99.8)		
				Specificity	100 (96.5-100)		
HTX							
Ph/E	+	1	1	PPV	50.0 (1.3-98.7)	0.60 (0.50-0.69)	0.318
				NPV	96.5 (91.2-99.0)		
	−	4	109	Sensitivity	20.0 (0.51-71.6)		
				Specificity	99.1 (95.0-100)		
Ph/E + E-FAST	+	4	0	PPV	100 (39.8-100)	0.90 (0.83-0.95)	
				NPV	99.1 (95.1-100)		
	−	1	110	Sensitivity	80.0 (28.4-99.5)		
				Specificity	100 (96.7-100)		

Ph/E: Physical examination, E-FAST: Extended-focused assessment with sonography in trauma, PPV: Positive predictive value, NPV: Negative predictive value, CI: Confidence interval, PTX: Pneumothorax, HTX: Hemothorax

exists. People with unstable hemodynamic are more likely to have positive FAST; therefore, they undergo a laparotomy. However, people with stable hemodynamic undergo CT scan for suitable decision-making.[3,25-27]

In this study, among patients with negative E-FAST who underwent a CT scan, the most common abdominal injury was related to low-grade splenic injury with four persons (3.5%) and the most common injury in the thoracic area was isolated

pneumothorax with five persons (4.3%). Furthermore, among eight patients in the study who underwent an abdominal or thoracic surgery, the most injury was evident in the spleen with five persons (4.3%).

In a study conducted by Kong *et al*., among 121 patients with blunt trauma, they have investigated the organ damage in CT scan over a year which showed that the highest visible damage on CT scan was related to splenic injury with 9.91% and then to hepatic injury with 6.61% frequency. The lower study population of the current study could justify the higher percentage of injury in Kong's study compared with the present study.[28]

Given the great importance of early evaluation in the acceleration of the therapeutic and diagnostic process of patients, the present study examined the accuracy of E-FAST in diagnosing and determining the outcome of patients with severe abdominal and thoracic trauma compared with physical examinations and as a result of the satisfactory rate of emergency medicine specialists.

The highest correlation between physical examination and bedside E-FAST based on the findings of this study was related to hemorrhagic shock, pneumothorax, hemoperitoneum, solid organ damage, and hemothorax, respectively. Since the first and most common cause of instability in hemodynamic is hemorrhagic shock, as soon as confronting such patients, abdominal injury can be either approved or rejected by sonography.

Nandipati *et al*. (2011) studied among 204 patients with thoracic or thoracoabdominal blunt or penetrating trauma during 1 year, with the objective of investigating the result of E-FAST in pneumothorax diagnosis. The result showed that through 10.3% (21 persons) of patients, pneumothorax was diagnosed where 12 persons had blunt trauma. Sensitivity, specificity, PPV, and NPV were 95.2%, 99%, 95%, and 99%, respectively.[29]

In the current study, almost half of patients with stable hemodynamic underwent abdominopelvic CT scan and only three cases were reported an intra-abdominal pathology, among which only in one case E-FAST and physical examination estimated a low probability of low-grade renal damage at the primary survey. In two other cases, although, by physical examination, the probability of intra-abdominal damage was low, E-FAST estimated it over 60% and CT scan confirmed abdominal pathology of low-grade splenic injury. Finally, all three of them had low-grade pathologies and were subjected to observation.

Among patients with unstable hemodynamic, all reports of E-FAST were true positive and had good evidence for more usage in unstable hemodynamic patients.

In this context, in Nandipati *et al*.'s study (2011) on 21 patients with blunt thoracic or thoracoabdominal trauma and positive E-FAST, there was only one false positive.[29] On the other hand, in the study of Dammers *et al*. with the aim of comparing the results of FAST in 421 patients with stable hemodynamic during 1 year, six cases of false-negative FAST were reported (all patients were undergone a CT scan) and the sensitivity of 67% in patients was achieved. Based on the results of this study, the sensitivity of FAST in patients with stable hemodynamic is lower but is useful predictor in initial management of stable traumatic patients and should not be eliminated.[21]

In another study conducted on 172 patients, 147 patients did not have any positive finding in FAST. Among patients with negative FAST, seven persons underwent an abdominopelvic CT scan. Two patients had a positive finding without need to intervention, including splenic contusion and renal laceration, and three patients with negative FAST underwent a laparotomy for other causes.[30]

However, damages that have not been encountered by sonography did not have a clinical significance. Furthermore, in the present study, positive results of E-FAST in hemodynamically stable patients did not need significant intervention. On the other hand, in hemodynamically unstable patients, no false-negative result was seen.

Ianniello *et al*. investigated 368 hemodynamically unstable patients with severe trauma during 2 years to assess the diagnostic accuracy of pneumothorax by E-FAST. The results showed that among 87 cases where pneumothorax diagnosis had been confirmed, 67 cases had been diagnosed by E-FAST and 20 cases were false negative. However, with 80% sensitivity and 99.8% specificity, it is a useful method in the early evaluation of patients with severe trauma and unstable hemodynamic.[31]

Becker *et al*. studied 3181 patients with blunt abdominal trauma and stable hemodynamic. The aim of the study was to assess the effectiveness of FAST based on the severity of trauma. They found that the sensitivity (65.1%), specificity (97.1%), and diagnostic accuracy (90.6%) of FAST in patients with more severity are lower than patients with less severity. Therefore, it suggested that patients with harder trauma had higher risk of hidden injuries in FAST.[32]

Grünherz *et al*. investigated the satisfaction of 175 trauma surgeon on using either an emergency CT scan or FAST for traumatic patients during 8 months with planning nine online questions. They found out that the satisfaction rate for performing FAST on hemodynamically stable patients was 77.6% and for emergency CT scan was 82.3%. However, in patients with unstable hemodynamic, 93.4% preferred FAST and around 47.5% preferred emergency CT scan.[33]

In the present study, the effect of E-FAST on clinical judgment accuracy of the physicians managing patients with blunt thoracoabdominal trauma was considerable. It seems that in-charge physicians were more satisfied with their decision on the patient when assessing the E-FAST results.

Limitations

There were some limitations in the present study. For example, there was limitation on filling out a questionnaire over patients with unstable hemodynamic immediately after physical examination and before E-FAST. Another limitation was in the study population and patient selection system. In the current study, only patients with abdominal or thoracic blunt trauma underwent E-FAST and patients with other types of trauma such as penetrating trauma were missed from the study. It is also should be mentioned that the sampling method in this study is the convenience sampling method and the selection bias can threat the results of this study.

Conclusion

The results of this study showed that performing an E-FAST increases the sensitivity of history and physical examination in diagnosis of pneumothorax, hemoperitoneum, solid organ damage, and hemothorax. It can be reported that except for hemorrhagic shock, E-FAST significantly increases the accuracy of diagnosis.

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Conflicts of interest

There are no conflicts of interest.

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