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Investigating the Diagnostic Accuracy of Focused Assessment with Sonography in Trauma (FAST) Compared to CT Scan in Patients with Blunt Abdominal Trauma

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ABSTRACT

Background and Objective: The use of Focused Assessment with Sonography in Trauma (FAST) in blunt abdominal trauma has various advantages and disadvantages. Considering the importance of timely diagnosis of blunt abdominal traumas, the question is whether it is possible to manage these patients only by performing FAST in the emergency room? Therefore, this study was conducted with the aim of comparing the diagnostic accuracy of FAST with CT-Scan in patients with blunt abdominal trauma.

Methods: This cross-sectional study was conducted on 400 patients with blunt abdominal trauma referred to the emergency department of affiliated teaching hospitals of Kerman University of Medical Sciences in 2020. Data were obtained by examining the medical records of the patients. The results of FAST were compared with the results of abdominal and pelvic CT scan (as a gold standard), diagnostic peritoneal lavage (DPL) and laparotomy results (as a gold standard in case of unclear CT-Scan results) and the sensitivity, specificity, the positive and negative predictive value and its accuracy were determined.

Findings: The mean age of the participants was 36.27±10.44 years. 72.5% of them were men. The most common organ involved was the liver (73%). Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of FAST were equal to 75.1 (73.4-79.6), 91.7 (89.4-94.7), 94.1 (92.7-96.3), 77.2 (75.7-79.6) and 83.7 (80.3-85.5), respectively. Also, the odds ratio of FAST in detecting free fluid was 1335.3, injury to intra-abdominal organs was 7.53 and it was 28.9 for all cases.

Conclusion: The results of the study showed that FAST sonography in the emergency room is a suitable method for diagnosing free intra-abdominal fluid following blunt trauma, but it cannot properly diagnose the location of the injury.

Keywords: *FAST Ultrasound, CT Scan, Blunt Abdominal Trauma*.

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Introduction

Trauma is the first cause of death and one of the main causes of disability and handicap of the active population in developing countries and the fourth cause of death in developed countries (1). The results showed that abdominal traumas (including two types of penetrating and blunt) account for about 25% of all types of trauma. The main cause of death caused by this complication is delay in diagnosis and treatment (2).

The most common causes of blunt abdominal trauma in the world are traffic accidents such as car to car accident (CCA), motor to car accident (MCA) and pedestrian to car accident (PCA). Moreover, the other causes include falling from a height and traumas related to conflicts and fights (punches, sticks and batons in the 9 areas of the abdomen) (3).

Abdominal blunt trauma can cause a lot of damage to a person compared to penetrating trauma. That's because in most cases of penetrating trauma, especially gunshot and stab wound, if it hits the anterior part of the abdomen and passes through the peritoneum, causing hemodynamic instability and the occurrence of symptoms of generalized peritonitis, the person is subjected to exploratory laparotomy. This is despite the fact that in many cases of blunt abdominal trauma, especially in cases of stable hemodynamics, damage to the right anterior quadrant of the abdomen, left anterior quadrant of the abdomen and bilateral flank for the patient, the only diagnostic methods include Focused Assessment with Sonography in Trauma (FAST) and Computed Tomography Scan (CT-Scan). In cases of hemodynamic instability where FAST and CT-Scan cannot be performed for the patient, Diagnostic Peritoneal Lavage (DPL) and finally Exploratory Laparotomy are used as the gold standard. Therefore, in blunt abdominal trauma, the difficulty related to pathology evaluation, the lack of clarity of abdominal injury and the possibility of simultaneous injury to other body parts make it difficult to continue the treatment process (1-4). On the other hand, the results showed that the mortality rate due to bleeding following blunt abdominal trauma is higher than penetrating trauma (1). Therefore, anything that helps in the quick diagnosis of blunt abdominal traumas will be effective in saving the lives of patients (5).

Abdominal CT scan helps the physicians to see the organs, blood vessels and bones in the abdominal cavity from different angles. But on the other hand, it is time-consuming and cannot be done for all patients, and it imposes a lot of costs on patients and the treatment system (6). The targeted evaluation of patients using FAST ultrasound is increasing all over the world. The advantages of this method include being quick, being performed at the patient's bedside, being portable, low-cost, reducing the risk of radiation, being able to evaluate patients with unstable hemodynamics (impossibility to perform a CT scan), evaluating hemopericardium in cardiac tamponade, and the ability to repeat the series according to the clinical condition and ultimately reduce the number of CT scans in patients with a low probability of abdominal lesions (7-10). The disadvantages of this method include the inability to accurately diagnose liver and spleen lesions and often renal, retroperitoneal, pancreatic, intestinal mesentery and bladder lesions (in about a quarter of cases), the impossibility of evaluating the abdomen and retroperitoneum in the presence of skin wounds, broken bones, the limitation of the patient in changing the position, the accumulation of gas in the stomach and intestine (11, 12). Therefore, diagnostic errors caused by FAST are an inevitable challenge. Various studies have been conducted on the diagnostic value of FAST compared with CT-Scan in the Middle East region and the United States of America, the results of which differ significantly from each other (9, 13-15).

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Baghi et al. in a study in Guilan province showed that the sensitivity, specificity, positive and negative predictive value of FAST (gold standard CT-Scan and laparotomy) were 60%, 52.4%, 23.3% and 84.4%, respectively (13). In a study in Yazd province, Mohamad Karimi et al. showed that the sensitivity, specificity, positive and negative predictive value of FAST performed by a radiology assistant (gold standard CT-Scan and laparotomy) were 97.5%, 83.3%, 4.4 71% and 83.3%, respectively (14). In a study in the United States of America, Liang et al. showed that the sensitivity of FAST for blunt abdominal trauma is 35% and its specificity is 95% (gold standard CT-Scan and laparotomy) (15).

The results of a study by Waheed et al. in Saudi Arabia showed that FAST has a sensitivity of 76.1%, a specificity of 84.2%, and an accuracy of 79% (16). Tabassum et al. showed that FAST has 83.8% sensitivity, 93% specificity and 88% accuracy in people with blunt abdominal trauma (17). Montazer et al. showed that FAST ultrasound was reported positive in 13 patients (8.7%) and CT scan with oral and intravenous contrast in 10 patients (6.7%) (presence of free abdominal fluid) (18).

Considering the importance of timely diagnosis of blunt abdominal traumas in the emergency room and their targeted treatment, and considering whether it is possible to perform CT-Scan, DPL or exploratory laparotomy and other invasive procedures only by performing FAST in the emergency room by a doctor or radiologist, and considering that so far no research in Kerman province has compared the diagnostic value of FAST, this research aims to compare the sensitivity, specificity, positive prognostic value (PPV) and negative predictive value (NPV) of FAST ultrasound in patients with blunt abdominal trauma referred to the emergency department of Kerman University of Medical Sciences in 2020 in order to evaluate the advantages and disadvantages of this method.

Methods

After approval by the ethics committee of Kerman University of Medical Sciences with the code IR.KMU.AH.REC.1398.195, this cross-sectional study was conducted on 400 patients with blunt abdominal trauma (without any other trauma) referred to the emergency room of teaching hospitals of Kerman University of Medical Sciences, including Afzalipour and Shahid Bahonar hospitals in Kerman in 2020.

The inclusion criteria were being over 14 years old, referral with a diagnosis of blunt abdominal trauma (pure), having FAST ultrasound results of the abdomen and pelvis (by only one emergency medicine specialist) and abdominal and pelvic CT-Scan (written report by only one radiologist), DPL and the results of exploratory laparotomy (by only one surgeon) as the gold standard tools in the patients' clinical records, and the exclusion criteria were penetrating abdominal trauma, underlying malignant diseases such as chronic heart failure, chronic renal failure, chronic liver diseases and obesity (body mass index more than 30 kg/m2).

Information was obtained through examining the medical files of the patients in the archive section. After obtaining the necessary permits, the researchers extracted demographic information including age, gender, type of accident, involved organ, FAST ultrasound results, abdominal and pelvic CT-Scan report, and the results of DPL and exploratory laparotomy from the patient's file. The brand of FAST ultrasound machines was Sono Scape with probe 3.5 MHZ and the CT scan machine brand was Phillips 16 Slice Multi Detector. The collected data were analyzed using SPSS version 25, and the sensitivity, specificity, PPV and NPV and accuracy of the FAST method were measured by drawing a cross-table compared with Spiral Abdominal

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and Pelvic CT-Scan with IV Contrast, DPL and exploratory laparotomy (in cases where CT-Scan results were unclear and inconclusive, DPL and exploratory laparotomy were used as the gold standard) and $p<0.05$ was considered significant.

Results

The results of the present study showed that the mean age of all participants was 36.27±10.44 years. The youngest participant was 14 years old and the oldest was 78 years old. 290 (72.5%) of the participants were male. The results related to the mechanism of trauma showed that 78.5% of these people were traumatized by road accidents with vehicles (CTCA: Car to Car Accident, MTCA: Motor to Car Accident) and (PTCA: Pedestrian to Car Accident). The most common organ involved was the liver (73%) (Table 1).

According to the results of sonography with FAST method, 134 people (33.5%) and according to the results of CT-Scan, DPL and laparotomy, 148 people (37%) had intra-abdominal free fluid (21 people DPL positive and 11 people laparotomy positive). Also, based on FAST results, 48 people (12%) and based on CT-Scan and laparotomy results, 156 people (39%) had intra-abdominal organ damage (18 positive laparotomy cases). In total, 154 cases (38.5%) based on FAST and 193 cases (48.2%) based on CT-Scan, DPL and laparotomy had abnormal findings (free fluid and intra-abdominal organ damage). Also, the odds ratio for the FAST method in detecting free fluid was 1335.3, intra-abdominal organ damage was 7.53, and it was 28.9 for all cases (Table 2).

The results of the present study showed that the sensitivity, specificity, PPV, NPV and accuracy of ultrasound for detecting intra-abdominal free fluid were 89.8%, 99.6%, 99.2%, 94.3% and 96%, respectively. Other results related to sensitivity, specificity, PPV, NPV and accuracy of FAST for detecting intra-abdominal organ damage alone and for detecting intra-abdominal free fluid and intra-abdominal organ damage simultaneously are presented in Table 3.

Table 1. Frequency distribution of demographic and clinical characteristics of the participants

Variable	Number(%)
Gender	
Woman	110(27.5)
Man	290(72.5)
Trauma mechanism	
Accident (CCA) (MCA) (PCA)	314(78.5)
Falls from a height	46(11.5)
Other (sports injuries, fights, fall of heavy objects)	40(10)
Organs involved	
Liver	146(73)
The spleen	98(49)
Kidneys	89(44.5)
Pancreas	27(13.5)
Other organs (intestines, diaphragm, mesentery, stomach)	30(15)

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Table 2. Results related to the comparison of FAST results with CT-Scan and laparotomy

	Diagnosis method	CT-Scan+laparotomy+DPL			Odds ratio
	FAST	Positive	Negative	Total	
Free fluid	Positive	133	1	134	1335.3
	Negative	25	251	266	
	Total	148	252	400	
Intra-abdominal organ damage	Positive	38	10	48	7.53
	Negative	118	234	352	
	Total	156	244	400	
Total cases	Positive	145	17	154	28.9
	Negative	56	190	246	
	Total	193	207	400	

Table 3. Results of sensitivity, specificity, PPV, NPV and accuracy of FAST ultrasound for detecting intra-abdominal free fluid and intra-abdominal organ damage and total results

	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)	Accuracy (95% CI)	Positive likelihood ratio (LR^+) (95% CI)	Negative likelihood ratio (LR^-) (95% CI)
Intra-abdominal free fluid	89.8 (86.1-93.4)	99.6 (93.6-98.1)	97.1 (94.5-99.4)	94.3 (89.4-95.6)	96 (93-98)	231.23 (219.41-245.56)	0.34 (0.21-0.38)
Intra-abdominal organ damage	24.3 (21.3-28.9)	95.9 (93.3-97.6)	79.1 (77.3-85.4)	66.4 (63.4-69.6)	68 (65-71)	139.16 (116.32-167.41)	0.72 (0.54-0.83)
Total results	75.1 (73.4-79.6)	91.7 (89.4-94.7)	94 (92.7-96.3)	77. 75.7-78.6)	83.7 (80.3-85.5)	184.19 (175.41-194.13)	0.56 (0.51-0.59)

Discussion

The results of this study showed that the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasound were 75.1%, 91.7%, 94.1%, 77.2% and 83.7%, respectively. The present study is the first study of its kind in Kerman province (as the trauma center of the southeastern region of the country) that has investigated the diagnostic accuracy of FAST in recent years.

The results showed that the mean age of the patients was around 37 years, which is in agreement with similar studies conducted in this area (13-18), and these accidents are more common in young and middle-aged people (1). The results showed that the most common cause of pure blunt abdominal trauma is trauma caused by Motor Vehicle Crash (CTCA, MTCA and PTCA), which is in line with other researches (13-18). After vehicle accidents, the next cause was falling from a height and street conflicts, which is consistent with the results of the researches of Baghi et al. (13), Mohamad Karimi et al. (14) and Poletti et al. (19).

The results of this study showed that the sensitivity, specificity, PPV, NPV and overall accuracy of FAST were 75.1%, 91.7%, 94.1%, 77.2% and 83.7%, respectively. These values in the research of Baghi et al. (13) were equal to 60%, 52.4%, 23.3% and 84.4%, Mohamad Karimi et al. (14) equal to 97.5%, 83.3%, 4 71.83% and 83.3%, Liang et al. (15) equal to 35% (sensitivity) and 95% (specificity), Waheed et al. (16)

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76.1% (sensitivity), 84.2% (specificity) and 79% (accuracy), in the research of Stengel et al. (20) 74%, 96%, 88% and 90% and in the research of Lee et al. (10) were equal to 92.1%, 98.7%, 90.7% and 98.8%. The reason for these differences can be explained by the fact that performing FAST is a technique dependent on the technician and can be performed by different people (emergency technician, emergency general physician, emergency medicine assistant, emergency medicine specialist, surgical assistant, surgeon, radiology assistant, and radiology specialist) and can be interpreted in various ways. Regarding the other reasons for the difference in the results, we can mention the difference in the gold standard, which in some of the mentioned researches, the gold standard was only CT-Scan, and in others, CT-Scan and laparotomy and DPL. Moreover, another reason for the difference in the results is the difference in the indications for performing FAST, DPL and exploratory laparotomy in each center according to the conditions, facilities and opinions of the experts of each center. Also, the accuracy of FAST devices in each center is different from another center, which can influence the results. According to the results obtained related to the FAST features, it can be said that the use of this method in more than 90% of cases is able to correctly detect free fluid and intra-abdominal organ damage, and if it is performed by a skilled person, it can be an easy, cheap, fast and acceptable method.

The results of the present study showed that the values of sensitivity, specificity, PPV, NPV and accuracy of ultrasound for detecting intra-abdominal free fluid compared to CT-Scan, DPL and laparotomy were 89.8%, 99.6%, 99.2%, 94.3% and 96%, respectively, according to which FAST has a very high accuracy for evaluating the presence of intra-abdominal free fluid following blunt trauma and can be very reliable. However, the results showed that the values of sensitivity, specificity, PPV, NPV and accuracy of ultrasound for diagnosing intra-abdominal organ damage were equal to 24.3%, 95.9%, 79.1%, 66.4% and 68%, respectively. Unlike other studies (13-18), very low sensitivity and low negative predictive value of FAST make it unable to be used as a method to properly estimate intra-abdominal organ damage and determine the location of the damage.

In the present study, the most common organs involved were the liver and spleen, which was in line with the results of a study by Kochoei et al. (21). The reason for the low level of damage to organs such as the small intestine, abdominal vessels, and large intestine can be explained by the fact that in the present study, only people with pure blunt abdominal trauma were included in the study, while damage to the abdominal vessels, intestines, and mesentery is more common in penetrating traumas and non-pure (blunt and penetrating at the same time) traumas (9).

The sample size of this research is almost double compared to similar studies (13-18), which is one of the strengths of this research. Also, in all reviewed cases, an emergency medicine specialist, radiologist, and FAST surgeon had performed CT scan report, DPL, and laparotomy (to eliminate confounding variables), which was one of the strengths of the present study.

Among the limitations of this research, it can be mentioned that it is retrospective, there is no definitive radiology report for a number of patients, it is limited to two treatment centers, and the lack of evaluation of variables such as age, gender, time of arrival at the hospital, and level of consciousness.

Overall, the results of the present study showed that performing FAST by a skilled person is a highly accurate method for diagnosing intra-abdominal free fluid, but it cannot properly diagnose the location of the injury. Therefore, in cases of positive FAST and stable hemodynamics, CT-Scan is recommended, and in cases of unstable hemodynamics, complementary measures such as DPL and, if necessary, exploratory

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laparotomy are recommended. It is suggested that in order to further investigate the various aspects of the subject, additional researches, especially of meta-analysis type, should be conducted in the region.

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