Clinics in Surgery

Research Article
Published: 22 Feb, 2021

Evaluation of Diagnostic Value of Fast in Patients with Multiple Trauma Referring to a Trauma Center in Northern Iran

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Abstract

Background: Abdominal injuries are among the most common causes of death in trauma patients, one-third of who develop abdominal trauma.

Aim: Focused assessment with sonography is a part of the initial examination for emergency care of patients with abdominal blunt trauma.

Methods: This cross-sectional study was conducted on 180 patients with abdominal trauma admitted to Poursina Hospital, Rasht between 2016 and 2017. On admission, they were examined with FAST and divided into positive and negative. The patients underwent laparotomy/CT after physical examinations, and their results were mentioned as negative/positive.

Results: Sensitivity, specificity, positive and negative predictive values of FAST compared with CT-scan in all samples were 60%, 52.4%, 23.3% and 84.4%, respectively. Seventy-eight of 90 patients with positive FAST underwent laparotomy and 18 ones with negative FAST underwent laparotomy. Low blood pressure, GCS, and the hospital arrival time had significant relationship with the likelihood of false-positives of FAST tests compared to CT scans, whereas the significant relationship existed only in false-negative cases in age. There was a relationship between false-positive cases of Fast test compared with laparotomy in blood pressure. This relationship was significant in the case of false-negative cases in age (P<0.05).

Conclusions: Implementing FAST by surgical residents does not have high sensitivity and specificity, and false positives and false negatives of this test depend on various variables. Therefore, it is recommended to use more complete diagnostic methods such as CT-scan along with FAST, while paying attention to more accurate and sufficient education of surgical assistants in performing FAST.

Keywords: Diagnostic value; Multiple trauma; Surgery; FAST; CT-scan

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Received Date: *28 Dec 2020*
Accepted Date: *19 Feb 2021*
Published Date: *22 Feb 2021*

Citation:
Baghi I, Ebrahimian R, Rad EH, Pirooz A, Mousavi MS, Sattarzadeh T, et al. Evaluation of Diagnostic Value of Fast in Patients with Multiple Trauma Referring to a Trauma Center in Northern Iran. Clin Surg. 2021; 6: 3077.

Introduction

Trauma is the leading cause of death in the world [1], and is more common in patients under 40 years of age [2]. Given to industrialization, urbanization, and technological development in human societies, accidents are currently one of the most important threats to public health, leading to high mortality and morbidity [3,4]. Accidents will become the third leading cause of death in 2020 [5]. Abdominal injuries are one of the most common causes of death in trauma patients [3]. About one-third of trauma patients have abdominal trauma [6]. The abdomen is the third most vulnerable area in trauma, requiring surgery in 15% to 20% of cases, and non-penetrating abdominal injuries are still the most common mechanism of abdominal injury [7,8]. One of the important points in reducing the mortality rate of trauma patients is the rapid and timely diagnosis of organic injuries [7]. Clinical examination is not reliable in the correct evaluation of trauma patients, and acceptable standard gold methods such as CT scan and DPL are time consuming and invasive. If ultrasound can be used to replace these methods, given its major advantages, it is an important step to reduce the time and cost required to examine the injured while maintaining sufficient diagnostic accuracy [9,10]. Ultrasound is commonly used as a diagnostic method in many countries around the world for trauma to the abdomen [9]. Focused Assessment with Sonography for Trauma patients (FAST)

is as a part of the initial examination as well as a valuable aid for emergency care of patients with abdominal blunt trauma [11]. After spending a short training course, emergency physicians can use FAST to make an initial assessment of trauma patients with sufficient care [12]. Nowadays given to technological advances, ultrasonography can be used as a portable apparatus during emergencies and in the patient's bedside. Unlike radiography or CT scans, ultrasound can be performed with resuscitation measures simultaneously in a trauma room to detect life-threatening injuries without any delay or even interruption [12]. FAST has been widely used in the last 3 decades. Prior to FAST, invasive methods such as Diagnostic Peritoneal Lavage (DPL) and laparotomy were used [13]. FAST is a bedside ultrasound protocol that can be used as a screening tool to identify lesions within the peritoneum, and less commonly the tamponade pericardium, and is performed by surgeons and radiologists with the same reliability. FAST is usually recommended in the primary survey of traumatic patients in circulatory stage in an unstable patient with abdominal trauma to examine intra-abdominal and pericardial fluid [14]. FAST ultrasound has many advantages in assessing early trauma patients and is useful as a screening test, especially in patients who are unable to have a CT scan due to unstable hemodynamics. The presence of free fluid in the FAST with unstable hemodynamics that does not respond to resuscitation measures indicates the need for immediate surgery [15]. In recent years, FAST ultrasound in emergency centers has utilized increasingly due to its portability and ease of use, as well as the lack of the need for a skilled radiologist [16]. Given that the test is performed in patient's bedside with no need to transportation of patient, it can be very useful in acute care [17], so it is necessary to use this technique and evaluate the diagnostic accuracy and awareness of the limitations and capabilities of this technique to assess patients with non-penetrating abdominal trauma in our country's emergency centers. Therefore, this study aimed to investigate positive FAST trauma patients under laparotomy surgery referring to Poursina Hospital from September 2016 to March 2017.

Methods and Materials

It was an analytical-cross-sectional study on 180 patients with abdominal trauma admitted at Poursina Educational and Medical Center in Rasht between September 2016 and September 2017. The patients were entered into the study through the complete enumeration method. The samples were people over the age of 12 who suffered from high transfer energy following multiple traumas. The patients underwent physical examination and diagnostic FAST as soon as they entered into the emergency department by a fourth-year surgical resident, and were divided into positive and negative FAST groups based on the results. In the next step, the patient underwent laparotomy if there were signs of generalized peritonitis or hemodynamic instability. The patient underwent CT scan if there were no peritoneal stimulation symptoms or evidence of hemodynamic instability. The results were reported as negative or positive.

The data required for this study were collected in a checklist including age, gender, time interval between occurring trauma and laparotomy, trauma type and mechanism, preoperative physical findings, and mortality rate. The data were analyzed using descriptive statistical tests such as mean, standard deviation, multiple logistic regression analysis using SPSS Version 21. By drawing a cross table, the sensitivity and specificity of FAST and its positive and negative predictive value were calculated. A statistical difference of less than 0.05 was considered significant.

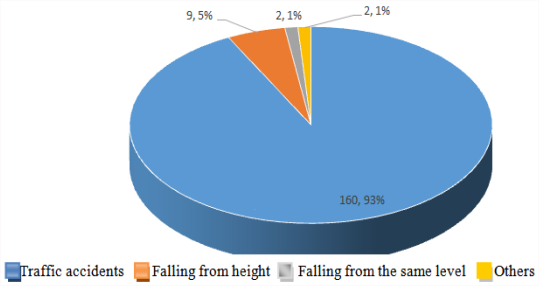

Figure 1: The frequency of multiple trauma patients referred to Poursina Hospital in terms of mechanism of injury.

Results

In the present study, 151 individuals (83.89%) were male and 29 (16.11%) female. The mean age of the samples was 34.45 ± 13.82 years old, with the age range of 14 to 74 years. The mean hospital arrival time was 2.8 ± 0.86 h. The mean GCS of patients was 13.05, with the GCS range of 3 to 15. The mean systolic and diastolic blood pressure was 103.09 ± 16.38 and 68.29 ± 8.69 mmHg, respectively. Also, the pulse rate was 99.5 ± 18.91 beats per minute.

Among trauma mechanisms, traffic accidents were the most common (93%). Falls from a height (5%) and falling from the same level ranked the second and third, respectively (Figure 1).

Table 1 showed that the sensitivity, specificity, positive and negative predictive value of FAST test were 60%, 52.4%, 23.3% and 84.4%, respectively, compared to CT-scan in all samples. Out of a total of 90 patients with positive FAST, 78 patients underwent laparotomy, and 18 out of 90 patients with negative FAST underwent laparotomy. The results of the FAST test in patients undergoing laparotomy indicated that the sensitivity, specificity, positive and negative predictive value of this test was 85.5%, 46.1%, 91.02%, and 33.3%, respectively, compared to laparotomy.

The present study showed that age and sex had no statistically significant relationship with the probability of false positives. When the GCS and the hospital arrival time increase, the chances of false positives of Fast test rise and decrease, respectively. On the other hand, low blood pressure had direct and significant relationship with a false positive FAST test result. This means that people with low blood pressure three times more likely developed false positives. The significant relationship between variables and false negatives of the FAST test exists only for age, so that increasing one year of age raises likelihood of false negatives of FAST result about 5% (Table 2).

The CT scan findings indicated that there is a statistically significant relationship between evidence of solid organ injury and the false negatives of the FAST test. No significant relationship was found between existing free fluid and the false negatives of the FAST test. The odds ratio of this variable was 19.96, that is, if there is solid organ injuries evidence, the probability of being false negative of FAST test increases 19 times.

Also, the results related to the relationship between the site of free fluid and being false positive of FAST test showed that the presence of free fluid in RUQ and LUQ has a significant and direct relationship with false positives cases. If the free fluid is detected in these areas, the probability of being false positive of the test is 7 and 9 times higher,

Table 1: Sensitivity, specificity, positive and negative predictive value of FAST test compared to CT-SCAN and laparotomy in patients with multiple trauma.

		FAST Test Result			
		-	+		
Sensitivity	60%	14	21	+	**CT Test Result**
Specificity	52.4%	76	69	_	
		84.4%	23.3%		
		Negative Predictive Value	Positive Predictive Value		
Sensitivity	85.5%	12	71	+	**Laparatomy**
Specificity	46.1%	6	7	_	
		33.3%	91.02%		
		Negative Predictive Value	Positive Predictive Value		

Table 2: The Relationship between the study variables and false positives and negatives of FAST test compared to CT-scan.

	Variable	Odds Ratio	Standard Deviation	Z Statistics	p-value	Low Limit	High Limit
False Positive	Age	0.9865615	0.012222	-1.09	0.275	0.962895	1.010809
	Sex (Male)	2.139638	1.230412	1.32	0.186	0.693189	6.604336
	GCS	0.8529356	0.052029	-2.61	0.009	0.756821	0.961257
	Low Blood Pressure	3.049138	1.600501	2.12	0.034	1.089881	8.530512
	Hospital Arrival Time	0.4397471	0.095949	-3.77	0.000	0.286733	0.674416
	Constant Coefficient	35.23151	44.64998	2.81	0.005	2.93885	422.3623
False Negative	Age	1.05643	0.0211552	2.74	0.006	1.015769	1.098718
	Sex (Male)	0.4938877	0.3363624	-1.04	0.3	0.12999	1.87646
	GCS	1.20243	0.1949531	1.14	0.256	0.87509	1.652218
	Low Blood Pressure	0.86448094	0.747017	-0.17	0.866	0.159095	4.700922
	Hospital Arrival Time	0.7761242	0.2632834	-0.75	0.455	0.39919	1.508978
	Constant Coefficient	0.0029537	0.0081795	-2.1	0.035	0.000013	0.672316

Table 3: The relationship between free fluid observation site and false positives of FAST test.

Variable	Odds Ratio	Standard Deviation	Z Statistics	p-value	Low Limit	High Limit
Age	0.996412	0.01457	-0.25	0.806	0.968261	1.025381
RUQ Free Fluid	7.214308	3.132648	4.55	0.000	3.080207	16.89699
LUQ Free Fluid	9.114021	4.137861	4.87	0.000	3.743308	22.19037
Suprapubic Free Fluid	3.436072	3.625541	1.17	0.242	0.434435	27.17691
Interloops Free Fluid	0.138737	0.202616	-1.35	0.176	0.007926	2.428365
Pelvic Free Fluid	0.206378	0.228927	-1.42	0.155	0.023467	1.814971
Constant Coefficient	0.178599	0.106119	-2.9	0.004	0.055733	0.572325

respectively (Table 3).

In the present study, the relationship between the study variables and the false positives of FAST test compared with laparotomy was investigated. The results of the analyses using the logistic regression model showed that age and sex, patient GCS, and EMS arrival time did not have a significant relationship with the probability of being false positive, while low blood pressure had direct and significant relationship with being false positive FAST test result. This means that people with low blood pressure were eight times more likely to develop false positives. Also, the study of the relationship between variables and false negatives of FAST test compared to laparotomy showed that except for the age variable, the other variables did not have a significant relationship with false negative results of FAST test (Table 4).

Discussion

In our study, the most important trauma mechanism was road traffic accident, followed by falling down. The frequency of trauma is higher in men with an average age of 34.45 years. Various studies are consistent with our study [13,18,19]. Our study showed that the sensitivity, specificity, positive and negative predictive value of the FAST test compared to CT-scan were 60%, 52.4%, 23.3% and 84.4%, respectively. Also, the sensitivity, specificity, positive and negative predictive value of FAST test compared to laparotomy were 85.5%, 46.1%, 91.02% and 33.3%, respectively. Higher sensitivity of FAST in laparotomy compared to CT scan can be due to the clinical status of these patients and the observation of free fluid in the Morrison space by the ultrasound operator. Demir et al. reported the sensitivity, specificity, and positive and negative predictive value of Fast at 50%, 93.7%, 60%, and 90.8%, respectively. Maylon et al. [20] showed sensitivity and specificity of Fast at 85% and 96%, respectively. Over the past few decades, various studies have reported different percentages for sensitivity and specificity of FAST for the diagnosis of intra-abdominal injury [21-23]. One of the reasons for the variability

Table 4: The relationship between the study's variables and false positives and negatives of the FAST test compared to laparotomy.

	Variable	Odds Ratio	Standard Deviation	Z Statistics	p-value	Low Limit	High Limit
False Positive	Age	0.997949	0.028008	-0.07	0.942	0.944536	1.054382
	Sex (Male)	0.132561	0.176979	-1.51	0.13.	0.009683	1.814827
	Hospital Arrival Time	1.025904	0.575508	0.05	0.964	0.341667	3.080426
	GCS	1.103905	0.148811	0.73	0.463	0.847591	1.43773
	Low Blood Pressure	8.73714	8.316765	2.28	0.023	1.352453	56.44384
	Constant Coefficient	0.06063	0.150965	-1.13	0.26	0.000461	7.982455
False Negative	Age	1.057749	0.022183	2.68	0.007	1.015153	1.102133
	Hospital Arrival Time	1.303351	0.560593	0.62	0.538	0.560977	3.028151
	GCS	1.162666	0.179316	0.98	0.328	0.859361	1.57302
	Low Blood Pressure	1.284331	1.050399	0.31	0.76	0.258533	6.380252
	Constant Coefficient	0.001068	0.002787	-2.62	0.009	6.42E-06	0.177764

in the standard is the reference with which FAST is compared. In some studies, only patients with CT, DPL, or laparotomy as confirmatory tests were included [24,25], while others studied only patients under clinical supervision [26-29]. AST indications also vary from center to center. For example, some centers use FAST for almost all of their injured patients, while others use it selectively [21]. Ultrasound apparatuses and their required standards may also differ [2,4,7]. Also, the organizational experience of FAST is very different among various centers [28,30]. FAST is performed by a radiologist in some centers [26,28] and experienced ultrasound technicians [27,29], while it is performed by physicians or emergency surgeons in other centers [22,30].

The comparison of FAST test with CT-scan in the present study showed that age variable has a significant relationship with being false negative of this test. Sheng et al. [31] in their study showed that younger patients underwent more ultrasound than older people. This study using univariate and multivariate logistic regression showed that the tendency to use CT and FAST remained statistically significant after the patients' age was controlled.

Different studies show that various factors affect the predictive power of sensitivity and specificity of FAST to determine intra-abdominal hemorrhage. One of these variables is blood pressure. Brett et al. reported that patients with abdominal blunt trauma and low blood pressure at the time of admission had FAST sensitivity, specificity, and accuracy to predict the need for therapeutic laparotomy at 85, 60, and 77 percent, respectively. In their study, they concluded that, FAST has acceptable accuracy and sensitivity in patients with low blood pressure. If the FAST is positive, the trauma patient can undergo therapeutic laparotomy without performing a CT scan [14]. Rowell et al. [32] reported that patients underwent therapeutic laparotomy during the first 6 h of admission in 22% of negative FAST cases. They suggested that physicians should still be highly suspicious of significant abdominal hemorrhage in patients with low blood pressure with negative FAST. However, our study showed that the FAST false-positives increase significantly. Perhaps, one of the reasons for the high level of false positives is the low skill of the residents who perform FAST. Therefore, it is necessary to educate these physicians in performing FAST, and to provide a suitable ground for increasing their skills by offering opportunities for practical implementation of this technique. There is no international agreement on duration or number FAST test. For example, American College of Emergence Physicians' ultrasound guidelines recommendations considers performing 25 to 40 FAST tests under supervision as acceptable [33], while some studies consider doing more than 40 FAST tests to be necessary [34,35]. Scalea recommends a 4-h educational program, a 4-h practical program, and doing 200 supervised tests to gain skills [36].

Our study showed that hospital arrival time had inverse relationship with the false positive FAST result. The results of other studies are consistent with our findings [24,28]. The interval between trauma occurrence and doing FAST is an important measure for increasing the sensitivity and specificity of this diagnostic test, because the accumulation of sufficient blood volume in the peritoneal cavity requires time for diagnosis by FAST [13]. Rajabzadeh et al. stated that time as an important factor can affect the accuracy of FAST [37]. Therefore, FAST serial scans may be helpful in cases where the initial FAST is negative or in patients suffering blunt trauma with persistent hemodynamic status [13,38,39].

Other results of the present study showed that patients with reduced levels of consciousness were more likely to show false positives, while false-negatives rise with increasing age. Perhaps, it is due to the accumulation of gas in the intestines resulted from low mobility [18], or their inability to hold a full bladder during an ultrasound, because an empty bladder limits the assessment of free fluid in the pelvis [40]. The findings also showed that the observation of free fluid in the RUQ and LUQ spaces (7 and 9 times, respectively) was associated with more false positives. Therefore, it seems necessary to perform a CT scan in these groups. In various studies, these factors have been suggested as indications for CT scan [35,41].

Given to the results of the present study and other researches in this field, it can be stated that FAST is highly valued in patients with abdominal trauma with unstable hemodynamic status, because the implementation of this method reduces the time required to perform treatment measures, length of hospital stay, therapeutic costs, and radiation exposure. It is also non-invasive and repetitive [13,42-44]. On the other hand, being negative of FAST does not rule out the possibility of intra-abdominal injuries in patients with blunt trauma due to its low sensitivity and low specificity, as this test is not able to clearly show solid parenchyma injury, posterior peritoneum, or diaphragmatic defects. It also works insufficiently in detecting intestinal damages. Therefore, other diagnostic methods such as CT should be performed for patients with negative FAST to rule out other injuries [19]. Although CT has a high sensitivity and specificity for detecting intra-abdominal injuries, it takes about 30 min to

perform and is not suitable for patients with unstable hemodynamics status and pregnant women [18]. However, CT should be performed as a confirmatory test for screening patients with negative FAST who appear to be at high risk for intra-abdominal hemorrhage [32].

Our study has several limitations. Firstly, the place of the study is unique, and the sample size is small. Therefore, it is recommended that FAST be compared with CT and laparotomy in future studies with a larger sample size. Secondly, there is the selection bias due to being retrospective of the study, which may affect the results, because only patients with proven abdominal injuries were examined in this study. Furthermore, our study was designed to determine the characteristics of the FAST test for any amount of free bleeding, regardless of its clinical significance. It is generally understood that the sensitivity and specificity of the FAST test are higher for patients with unstable hemodynamic status with moderate to high intra-peritoneal hemorrhage, while the capacity of the FAST test to detect small and medium amounts of bleeding is limited.

Conclusion

The present study showed that the implementation of FAST by surgical residents does not have high sensitivity and specificity, and false positives and false negatives and depends on various variables and factors. Therefore, it is recommended to use more complete diagnostic methods such as CT-scan along with FAST, as paying attention to more accurate and sufficient education of surgical residents in performing FAST.

Ethics Approval

Institutional review board of Guilan University of Medical Sciences approved this study.

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