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Evaluation of Focused Assessment with Sonography in Trauma (FAST) to Detect Non-penetrating Abdominal Trauma

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Abstract

Trauma is considered as the most important health issues worldwide. There are different ways in order to diagnose blunt abdominal trauma. Diagnostic peritoneal lavage and diagnostic laparotomy, which are considered as complicated and invasive methods and increase the possibility of injury to other organs and are less commonly used as the first line method. Focused assessment with sonography in trauma (FAST) technique is a rapid diagnostic procedure in blunt trauma. In this diagnostic study, 140 patients with blunt trauma referred to the emergency department of Razi Hospital in Qaemshahr were included and the results were confirmed or rejected using a CT scan to determine the parameters related to the accuracy of an imaging method. The result showed that accuracy, sensitivity, and specificity of FAST ultrasonography were 97.8, 92.8, and 100%, respectively. 100 and 97.01% were reported for positive predictive value and negative predictive value, respectively. It can be concluded that due to the high accuracy of sonography in the evaluation of trauma patients, this method can be used as a valid and reliable method in the emergency room in subspecialty trauma centers. The point to note about sonography is that its negative response should be evaluated by other methods due to the very high importance of this issue in trauma patients.

Keywords: Non-penetrating trauma, Blunt trauma, Focused Assessment with Sonography in Trauma, Sensitivity, Specificity.

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1. Introduction

Trauma is one of the most important problems in the health of societies in the world and is constantly increasing. Also, it is considered as a public health problem. The main reasons for which is the widespread use of transportation and rapid population growth [1]. Trauma-related lesions can range from small wounds to complex injuries that involve several organs in the body. All trauma patients need a systemic approach to evaluate and manage the risks associated with these injuries. Trauma is considered as the most important cause of death in the worldwide [2,3]. Trauma is one of the leading causes of death and disability of the active population in developing countries and the fourth leading cause of death in developed countries. In Iran, trauma is the second leading cause of death in young people. About 25% of these traumas occur in the abdomen. Traumas resulting from road accidents are the main cause of blunt abdominal trauma in civilians. Other reasons for its prevalence are falls and industrial or recreational accidents [4-6]. There are several methods for diagnosing injury amount in non-penetrating abdominal trauma. Diagnostic intraperitoneal lavage and diagnostic laparotomy are complex and invasive procedures and increase the risk of injury to other organs. Therefore, they are less commonly used as first line [7,8]. Although in many studies, CT scan is the selective method in trauma patients. However, due to the lack of access to all medical centers, the transfer of patients from the emergency room to the CT scan site, and the dangers of radiation in the last decade, there is always a constant debate to choose the most appropriate and practical method to diagnose injury in patients with abdominal trauma. Sonography test in trauma is increasingly becoming an essential part of the initial assessment of trauma patients in the emergency department [9-11].

Several studies have been performed on the diagnostic value of sonography and its strengths and weaknesses. Abdominal sonography is used to find damage to the abdominal viscera and intra-abdominal fluid as well as indirect evidence of injury [12]. Focused assessment with sonography in trauma (FAST) is a rapid diagnostic procedure in blunt trauma, which clearly answers a simple question: Is there fluid inside the peritoneum? FAST provides a rapid view of fluid accumulation below the diaphragm, subhepatic, ducts around the colon, pelvis, and pericardium. It can also in some cases detect solid tissues and their possible damage

[13,14]. In these studies, FAST is a valuable screening tool for detecting invisible bleeding for emergency physicians and surgeons, and it is easy to learn. This method is used in many medical centers due to its availability, cheapness, and low risk. The sensitivity and specificity of focused abdominal sonography for trauma was reported ranged from 63 to 100% and 90 to 100%, respectively. FAST results depend on several factors such as sonography parameters, patients status, operator skills and severity of injuries [15, 16]. This method has low sensitivity in children because they may not be able to detect intra-abdominal injuries in children [17,18].

Several studies have been published worldwide on the use of FAST for the initial evaluation of blunt abdominal trauma. To the best of our knowledge, no study has been conducted in Iran in this field. The aim of this study was to compare the diagnostic accuracy of sonographic findings in blunt abdominal trauma. If the diagnostic value is high, sonography should be used as the first step in the treatment of adult non-penetrating abdominal trauma and to avoid exposure to invasive methods such as X-ray and etc.

2. Materials and methods

This study is descriptive and diagnostic. The statistical population of this study was trauma patients suspected of abdominal injury in Qaemshahr Razi Hospital in 2020. About 140 patients with non-penetrating abdominal trauma referred to Razi Hospital were selected who underwent FAST technique for the intervention group and CT scan with injection for the control group.

Patients with severe non-penetrating trauma and patients for whom FAST technique was performed in the emergency section were considered as inclusion criteria. Exclusion criteria also included patients with non-penetrating abdominal trauma, pregnant women, unwillingness to participate, and children under 18 years.

Considering CT scan as a golden diagnostic method, sensitivity, specificity, positive and negative predictive value, and accuracy of sonographic data compared to CT scan in the diagnosis of free abdominal fluid were calculated for liver, spleen, and kidney trauma. Data collection was based on a researcher-made checklist and the files were reviewed by the researcher. The study was a field research and the data collection tool was a checklist of information records, patient records, sonography and CT scans reports.

Data analysis was performed by SPSS version 21. True/false positive and negative cases, specificity, sensitivity, positive and negative predictive value were reported.

3. Results and Discussions

The results showed that the mean age of participants was 28.14±3.37 years, which varied from 18 to 45 years. The highest frequency was related to the age group between 23 and 28 years. 62.8% of participants were male and 37.2% of participants were female (Table 1). According to the results obtained from the frequency distribution of patients based on the cause of trauma, the highest frequency was related to vehicle accidents (69.3%) and the lowest frequency was related to sports accidents (1.4%) (Table 2). In addition, in terms of frequency distribution of injured viscera due to blunt abdominal trauma, the results showed that the most damage was reported for the spleen (40.5%) and the least damage was reported for the intestine (4.8%) (Table 3). Table 4 shows the frequency of false/true positives and negatives in all samples. Accuracy is defined as the ability of a test to properly differentiate between sick and healthy cases from other cases. The results showed that the accuracy of sonography findings was 97.8%. Also, sensitivity of 92.8% was obtained by the ratio of true positives to the sum of true positives and false negatives. In fact, sensitivity is the ability of a test to find patients. The Specificity of the sonographic findings were 100%, which is obtained from the ratio of true negative cases to the sum of true negative and false positive cases. Specificity is applied to test ability to find healthy cases.

Positive predictive value indicates that a positive test has been reported and that the person is actually ill. In fact, this index includes the ratio of people who really have the disease to the total number of cases that have been reported positive (including those that are healthy and have been misdiagnosed). This feature can predict how likely a person is to be really ill if a test is reported positively. The findings of this study showed that the positive predictive value of sonographic findings is 100% (Table 5). Negative predictive value refers to items that have reported a negative test and are really healthy. Negative predictive value refers to cases that negative test has been reported for them and they are really healthy. In fact, it is the ratio of people who are really healthy to the total number of cases reported negative by the test (including those who are sick and reported to be incorrectly healthy). This feature can predict how likely a person is to be really healthy if a test is reported negatively. The findings showed that the negative predictive value of sonographic findings is 97.03% (Table 5). Area under the Curve (AUC) showed that the sonographic test had a high diagnostic power (AUC = 0.985). Also, the p-value <0.0001 means the use of sonographic method was better than random selection (Figure 1).

In this study, the diagnostic accuracy of sonographic findings in non-penetrating abdominal trauma has been determined on 140 patients at Qaemshahr Razi Hospital in 2020. The mean age of participants was 28.14 ±3.37 years, ranging from 18 to 45 years. The highest mechanisms of injury were related to accident (69.3%), fall (13.6%) and conflict (5.7%), respectively. Also, the most affected organs were spleen (40.5%) and livers (33.3%), respectively. In the study of Amini et al.[19], 105 people were selected and the average age of patients was 27 years. Therefore, it can be concluded that our study with a sample size of 140 people has an acceptable size. In addition, it should be noted that during the corona epidemic, follow-up of patients was very difficult and exhausting, and therefore conducting this study in a larger sample size was challenging. This study was conducted only in one city and in a subspecialty center. Therefore, it is recommended to conduct nationally or international study with a higher sample size. The mean age of patients in our study is approximately equal to the mean age of other studies. This reflects the epidemiological nature of trauma, which usually targets young people and dynamic groups of society. Most trauma patients are younger and have no concurrent illness.

Table 1. The results of demographic data

Variables		Frequency	Percentage
Age	18-23	12	8.6
	23-28	78	55.7
	28-33	38	27.1
	33-38	7	5.0
	38-45	5	3.6
Sex	Male	88	62.8
	Female	52	37.2

Table 2. Frequency distribution of damaged viscera due to blunt abdominal trauma

Viscera	Frequency	Percentage
Vehicle crash	97	69.3
Fall from height	19	13.6
Impenetrable substance hitting	7	5
Conflict	8	5.7
Sporting events	2	1.4
Unknown	7	5

Table 3. Frequency distribution of patients with blunt abdominal trauma based on the cause of the trauma.

Type of trauma	Frequency	Percentage
Liver	14	34.1
Spleen	17	41.5
Kidney	6	14.6
Intestine	2	4.9
Others	2	4.9

Table 4. Frequency of true and false positives and negatives

	Frequency	Percentage
True positive	39	27.8
False positive	0	0.0
True negative	98	70.0
False negative	3	2.2

Table 5. Sonographic results

Parameters	Formula	Percentage
Positive predictive value	$\frac{\text{True positive}}{\text{False positive} + \text{True positive}} \times 100$	100.00
Negative predictive value	$\frac{\text{True negative}}{\text{False negative} + \text{True negative}} \times 100$	97.03
Accuracy	$\frac{\text{True positive} + \text{True negative}}{\text{Total}} \times 100$	97.87
Sensitivity	$\frac{\text{True positive}}{\text{False negative} + \text{True positive}} \times 100$	92.86
Specificity	$\frac{\text{True negative}}{\text{False positive} + \text{True negative}} \times 100$	100.00

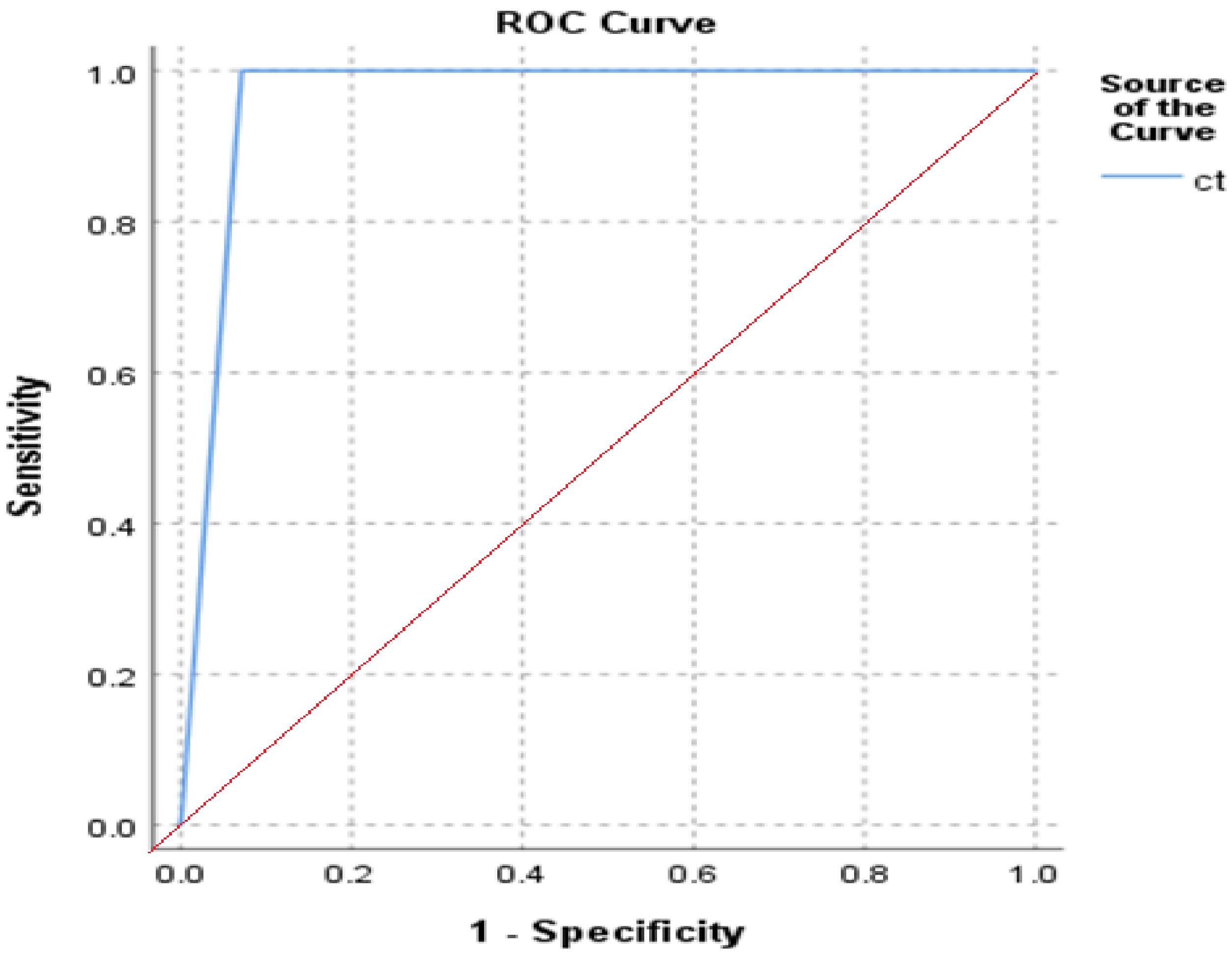

Figure 1. ROC for comparison of sonographic test and CT scans.

This issue shows that efforts to reduce the rate of trauma are important for maintaining the health of young people in the community. The results of our study showed that the accuracy, sensitivity, and specificity of sonographic findings was 97.8%, 92.8%, and 100%, respectively. The results agree with most previous studies in this field. For example, Ghafouri et al. were reported 93.1% and 93.4% for the sensitivity and specificity of FAST, respectively [8]. In another study, Qamari et al. were reported the sensitivity (91.9%) and specificity (94.34%) of FAST, which is in line with our results [20]. In a study by Behboodi et al. that evaluated the outcome of patients with non-penetrating abdominal trauma and FAST positive [21], in 68.9% of trauma patients, the results of CT scan and FAST technique were consistent and positive, while in our study, the accuracy of sonography was higher than Behboodi et al. Other reasons for the variable accuracy of sonography in various studies is related to the level of literacy and experience of the operator performing in an emergency situation which affects the result. In another study, Amini et al. evaluated the diagnostic accuracy of FAST method in 105 trauma patients [19]. The results showed the sensitivity, specificity, accuracy, positive predictive value and negative predictive value of FAST in diagnosing abdominal lesions were 87.1%, 62.5%, 82.1%, 90% and 55.6%, respectively. These results indicate that the FAST technique has acceptable sensitivity, accuracy, high predictive value, specificity, and acceptable negative predictive value in the diagnosis of abdominal lesions in trauma patients, therefore, it can be used as a tool for initial screening of trauma patients requiring laparotomy. Our study agreed with the study of Amini et al. [19] and its diagnostic accuracy was acceptable and It was determined that sonography is a valuable and valid tool in the initial screening of trauma patients. In this study, FAST method detected most cases of high-intensity lesions of solid viscera and free abdominal fluid, which indicates that FAST sonography is an important tool with high sensitivity and specificity for initial evaluation in non-penetrating abdominal trauma. In the study of Kornezos et al. [22], it was found that the FAST method is an accurate method for assessing the possibility of impenetrable abdominal trauma in stable patients and due to its high negative predictive value, the use of this method is recommended for stable patients [15]. The results of our study in line with the Kornezos study which was performed on stable patients, but in our study, patients were not distinguished in terms of stable and unstable hemodynamics. Given the alignment of these two studies, it can be assumed that the diagnostic accuracy of FAST method is not related to patients' hemodynamics.

Elbaih et al. conducted a study on 150 patients of abdominal impermeable trauma with hemodynamically unstable, it was shown that the sensitivity of this diagnostic method was 92% and its specificity was 100% [23]. Also, the negative predictive value and positive predictive value were 92% and 100%, respectively. The diagnostic accuracy of 96% was reported for this study. The result of Elbaih study was consistent with our study, but we did not screen patients hemodynamically. The role of FAST method in assessing impenetrable abdominal trauma in adolescents after high-energy trauma was examined by Tummers et al [24]. The results showed that the sensitivity of this method was 50% and its specificity was 100%. Its positive predictive value and negative predictive value were 100% and 93%, respectively. In this study, FAST's diagnostic ability was lower than other studies, but in combination with clinical examination, the sensitivity increased to 90%. Therefore, they concluded that the combination of physical examination and sonography in the evaluation of trauma patients was much better than either method alone [25]. However, our study did not discuss the role of physical examination in the evaluation of trauma patients. Hence, it is suggested that it be addressed in future studies. Some limitations can be considered for this study include this study was conducted only in a subspecialty trauma center in a city. Also, considering that part of this study was at the time of the corona epidemic, Razi Hospital in Qaemshahr was recognized as a treatment center for infectious and coronary diseases. Therefore, this hospital was removed from the trauma center and trauma patients were referred to other centers. Therefore, this study could be done on a larger scale and with a larger sample size. In addition, pregnant women were excluded from the study due to X-ray injury, moreover, the fetus and children under 18 years were excluded due to the possibility of teratogenicity to X-ray exposure to their gonads, thyroid glands, and eyes.

4. Conclusions

In general, it can be concluded that due to the high accuracy of sonography in the evaluation of trauma patients, this method can be used as a valid and reliable method in the emergency room in trauma centers. Sonography is an operator-based method and due to the constant presence of emergency specialists in the initial moments on the patient's bedside has an important role in improving the treatment protocol in trauma patients. Also, due to the great importance of trauma patients, FAST method should not be used alone and other diagnostic methods such as CT scan should be used. It is worth noting that sonography is an operator-based method, and the more professional and experienced the operator is in performing this method, it can lead to more reliable and reliable results.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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