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ORIGINAL ARTICLE

Accuracy of Focused Assessment with Sonography for Trauma in Blunt Abdominal Trauma in Comparison with Computed Tomography

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ABSTRACT

Background: Abdominal injuries rank as the third leading cause of trauma-related fatalities. For patients who are stable in terms of hemodynamics, the focused assessment with sonography for trauma (FAST) exam provides valuable prognostic insights at a low cost. Although FAST is more accurate in identifying free intraperitoneal fluid, a positive result often leads to a preference for Computed Tomography (CT) scans to decide on the most appropriate treatment approach, whether surgical or non-surgical. This study aimed to evaluate the accuracy of sonography for trauma compared with the results of computed tomography as a gold standard in multiple trauma patients. **Methods:** A cross-sectional study conducted with 168 patients in the Emergency Department at Zagazig University Hospital. These patients had a history of blunt trauma and suspected abdominal injuries. Upon their arrival at the emergency room of Zagazig University Hospital, they underwent FAST and CT scans.

Results: The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of the FAST scan for identifying free intraperitoneal fluid were determined to be 98%, 100%, 100%, 99%, and 98%, respectively. In comparison, the CT scan showed values of 100% for sensitivity, specificity, PPV, NPV, and accuracy in detecting free intraperitoneal fluid.

Conclusion: We concluded that CT scans, unlike FAST scans, provide excellent imaging about sources of hemorrhage in addition to detection of IPFF. While FAST is also a highly useful tool, if the patient is stable, CT scan is seen to be the best option for accurately diagnosing blunt abdominal injuries.

Keywords: Abdominal Trauma; FAST; Computed Tomography.

INTRODUCTION

One of the main causes of morbidity and death for patients in the emergency room is blunt abdominal injuries. After head and chest traumas, abdominal injuries are the third most common cause of traumatic mortality [1]. Emergency doctors (EP) face a major diagnostic problem because unrecognized abdominal injuries are often the cause of avoidable deaths [2]. Since neglected injuries can result in avoidable fatalities, prompt diagnosis and treatment are thought to be essential to successful management [3].

The significance of prompt identification and treatment led to the creation of focused assessment with sonography in trauma (FAST) in 1997, which gained international recognition when it was incorporated into Advanced Trauma Life Support (ATLS) algorithms [4].

One quick and practical diagnostic technique for finding free fluid in trauma patients is focused assessment with sonography for trauma (FAST) [5]. Because it is portable, easily learnt, and covers the thorax, FAST is still becoming more and more popular [6].

FAST is intended to identify the presence of free fluid, which typically indicates blood in cases of serious trauma, in three specific regions of the body: the pericardial, plural, and peritoneal spaces. The scanning process concentrates on four key areas: the pericardium, right upper quadrant (RUQ), left upper quadrant (LUQ), and pelvis [8].

Both radiologists and emergency physicians may perform the FAST assessment quickly and accurately, at a low cost, and without exposing the patient to radiation [9].

Notwithstanding its benefits, FAST's accuracy varies. According to reports, the ranges for sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) are 28–76%, 83–97%, 87–96%, and 37–94%, respectively [10].

Computed tomography (CT) has become the gold standard for evaluating traumatic abdominal injuries, capable of identifying as little as 100 cc of intraperitoneal fluid [11]. The introduction of multi-detector CT scanners has significantly reduced imaging time and enhanced diagnostic accuracy, boasting a negative predictive value exceeding 100% and a sensitivity and specificity greater than 95% for detecting intra-abdominal injuries [12].

However, it is not suitable for patients who are hemodynamically unstable, as these individuals need to be transported from the emergency room to the scanner [13]. Moreover, some patients may experience delays or restrictions in their CT assessments due to concerns about radiation exposure and contrast-related complications. Since ultrasonography is quick and can be performed at the bedside, it remains valuable for trauma patients when time is critical [10].

Hemodynamically unstable patients might go directly to the operating room for an emergency laparotomy. However, for these patients, the absence of detailed imaging could lead to longer surgery times due to uncertainty about the location and severity of their injuries. On the other hand, hemodynamically stable patients may undergo CT scans to identify the source and severity of their injuries, allowing for timely and suitable treatment [12].

AIM OF THE WORK

This study aimed to evaluate the accuracy of sonography for trauma compared with the results of computed tomography as a gold standard in multiple trauma patients.

METHODS

This cross-sectional study was conducted on 168 patients who presented to the Emergency Department at Zagazig University Hospital, with a history of blunt trauma and probable abdominal injuries between May and December 2024. Patients were separated into two groups. Group 1 includes patients with hemodynamic instability who proceed directly from FAST to the operating room (OR) without first undergoing a CT scan. Group 2: Patients with hemodynamic stability who undergo a CT scan after FAST. All patients provided informed consent, and the study was approved by the Zagazig University Faculty of Medicine's research ethical committee (IRB# 11189). The inquiry followed the Declaration of Helsinki, the World Medical Association's code of ethics for human studies.

Patients must be older than eighteen, be enrolled in the study, be male or female, and appear in the emergency room with a history of blunt trauma and probable abdominal injuries to be eligible. and for whom stable patients gave their agreement to participate in the trial, FAST and CT scans were completed at the time of presentation in the emergency department at Zagazig University Hospital. Patients who had cirrhosis, which causes fluid to accumulate in the abdomen, trauma patients who had only injuries to their extremities and no injuries to their abdomen, patients who were pregnant, receiving radioactive iodine treatment for thyroid disease, patients with both acute and chronic kidney disease, patients who were unstable and in need of immediate medical attention, and patients who were pregnant, especially in the first trimester, or nursing patients were excluded.

Patients were handled in the operating room in accordance with advanced trauma life support (ATLS), which states that when a life-threatening condition is discovered, prompt corrective action must be taken and its effects assessed before proceeding to the next stage. The initial resuscitation takes place concurrently with the primary assessment. The "ABCDE" approach should be used for the primary assessment.

Following the initial resuscitation efforts, a comprehensive secondary survey was conducted on all patients, which included a thorough history intake; Name, age, sex, address, date of incident, time of incident, type of trauma, mechanism of injury, Vomiting, Past medical history, current medical history, allergies, referring hospital, time of arrival to ER unit.

Secondary survey assessment with Pelvi-abdominal ultrasound and Plain X- ray abdomen erect position and lateral decubitus according to suspected injury. Computed Tomography abdomen with contrast if patient has intra-abdominal free fluid and hemodynamically stable. laboratory investigations including complete blood count (CBC), liver function tests, serum creatinine , clotting profiles and definite management. After that, a clinical examination of all the patients are performed. To diagnose injuries to the abdominal organs, a FAST scan and an abdominal CT scan with intravenous contrast were performed after blunt abdominal trauma (BAT). The CT scans were evaluated and discussed with a radiology consultant to determine the specific organ injuries for each patient.

Abdominal ultrasonography (FAST scan):

Emergent sonography for trauma was conducted concurrently with physical examination, resuscitation, and stabilization shortly after the patient arrived at the emergency room. All patients were examined with Toshiba Famio 5 & Seminens Sonoline G20 using 3.5MHz probe. All sonograms were performed with the patients in supine positions, with abdominopelvic area exposed and water-soluble ultrasound transmission gel is applied on the abdomen and pelvis.

The examination involved positioning the transducer in the right upper abdomen to identify the liver, kidney, and diaphragm, as well as to assess for any fluid in the hepatorenal pouch. Afterward, the transducer was shifted to the left posterior axillary line near the lower ribs to visualize the spleen, kidney, and assess for fluid in the lieno-renal pouch.The transducer then placed in midline superior to symphysis pubis, to identify urinary bladder and the pouch of Douglas is examined for fluid collection. Evaluation of liver, kidneys, spleen and retroperitoneum for parenchymal injuries. US guided paracentasis was done for patients with suspicious of internal hemorrhage. It was done with patient in the supine position placing the transducer at a location where the fluid can be seen and provide continuous guidance during the procedure. Hard copy documentation was obtained. Follow up US done for all cases that were managed conservatively.

Computed tomography (CT.):

CT scanning performed for all patients included in this study using Siemens; Somatom Spirit dual slice CT scanner and GE; high speed SYS, Milwaukee scanner.

Most of patients were emergent critical cases searching for parenchymal injuries and internal hemorrhage. Therefore, CT examination carried out urgently without the need of routine preparation to save time, which is essential in management of such patients. Intravenous contrast material for adult 80-150 ml water-soluble high molecular weight ionic intravenous (urographin 76%), as single rapid bolus. The dose for children is about 1.5-2.5ml/kg body weight. Antihistaminic agents were prepared for contrast allergic reaction. Melgumine diatrizonate (Gasterografin) was used diluted in percentage of 30ml/1000 mm water for average adult patient. The oral contract was given 2:8 hours before CT scans. The patient was scanned in a lying position with no tilt to the gantry. The CT protocol involved volumetric data collection starting from the diaphragm down to the pubic symphysis, utilizing a breath-hold technique (to the best of the patient's ability) to minimize respiratory artifacts. Slice thickness used was 10 mm with exposure factors of 120-140 kV and 100-150 mAs. Pre and Post intravenous contrast images were taken as all cases were given intravenous contrast material except two patients (splenic hematoma follow up) and only 11 patients (whom were under follow up) were taken oral contrast and IV contrast.

Post processing, the scans were reconstructed and reviewed at 2mm intervals. Multiplanar reconstructions (MPR) acquired in coronal, sagittal, and oblique planes. Also, curved planar reformatting (CPR). Attenuation Values for areas of lesions of interest were measured. Imaging of obtained axial and reformatted cuts.

STATISTICAL ANALYSIS

The data were gathered and the outcome measures were coded, entered, and analyzed with Microsoft Excel software. Subsequently, the data were imported into SPSS (version 22.0) for further analysis. Qualitative data were represented as numbers and percentages, while quantitative continuous data were summarized using mean ± standard deviation (SD). To assess statistical significance, the Chi-square test (X^2) was employed to examine differences and associations among qualitative variables. P value was set at <0.05 for significant results &<0.001 for high significant result.

RESULTS

From table (1), the mean age of studied cases is 43.12±17.45. Males are 65% of studied cases and females are 35%. the peak incidence (38%) was from 31-43Years old because of civilian violence, road traffic accidents, and industrial accidents. It is also clear that the less incidence was at > 60 years old (13%) because of the old age are of less activity.

The most frequent cause of blunt abdominal trauma was Road traffic accident (RTA) in 118 patient (70%) in form of motor car accidents (52%), motorcycle crash (12%) and bicycle accidents (6%). Followed by 28 patients (16%) suffered from falling from a height and 16 patients (10%) suffered from direct blunt abdominal trauma. 6 patients (4%) suffered from the falling of heavy objects figure 1.

The values of sensitivity, specificity, PPV, NPV and accuracy of FAST scan for detection of Free intraperitoneal fluid were calculated to be 98%, 100%, 99% and 98% as shown in table 2.

Table 3; showed that the values of sensitivity, specificity, PPV, NPV and accuracy of CT scan for detection of Free intraperitoneal fluid were calculated to be 100%, 100, 100%, 100% and 100%. The values of sensitivity, specificity, PPV, NPV and accuracy of CT scan for detection of Splenic injuries were calculated to be 98%, 100%, 96% and 97%. The values of sensitivity, specificity, PPV, NPV and accuracy of CT scan for detection of hepatic injuries were calculated to be 97%, 99, 99%, 98% and 99%. The values of sensitivity, specificity, PPV, NPV and accuracy of CT scan for detection of renal injuries were calculated to be 40%, 100%, 89% and 86%. The values of sensitivity, specificity, PPV, NPV and accuracy of CT scan for detection of Pancreatic injuries were calculated to be 98%, 95.44, 78%, 98% and 95.67%. The values of sensitivity, specificity, PPV, NPV and accuracy of CT scan for detection of Retroperitoneal hematoma were calculated to be 100%, 97.44, 80%, 100% and 97.67%.

Case presentation:

Female patient 30 year- old presented to ER after RTA, the patient was hypotensive, hypothermic and tachycardic. Primary survey in cluding FAST revealed: Mild intraperitioneal free fluid seen at subhepatic and pelvic regions figure 2.

CT abdomen and pelvis with IV contrast revealed: **A:** Moderate Intraperitoneal free fluid. **B**: Right hepatic lobe heterogenous hypodense area seen at segment VI & VII and lesser extend to VIII measuring 28 ×63mm reaching capsule …. contusion and linear hypodense lesion measuring 32mm in depth (laceration) figure 3.

Table 1: Distribution according to age and gender.

	n=168	%
Age/ years mean±SD	43.12±17.45	
18-30	48	28
31-43	64	38
44-59	36	21
>60	20	13
Sex		
Male	110	65
Female	58	35

Table 2: Validity of FAST in detection of Free intraperitoneal fluid (in 168 patients):

Statistics	Free intraperitoneal fluid
Sensitivity	98 %
Specificity	100%
PPV	100%
NPV	99%
Accuracy	98%
AUC	0.99

Table 3: Validity of CT in detection of solid organ lesions and Free intraperitoneal fluid (in 168 patients):

	Free intraperitoneal fluid	Splenic injuries	Hepatic injuries	Renal injuries	Pancreatic injuries	Retroperitoneal hematoma
Sensitivity	100.0%	98%	97%	85%	98.0%	100.0%
Specificity	100.0%	100%	99%	100%	95.44%	97.44%
PPV	100.0%	100%	99%	100%	78%	80%
NPV	100.0	96%	98%	89%	98.0%	100.0%
Accuracy	100.0%	97%	99%%	86%	95.67%	97.67%
AUC	0.998	0.99	0.95	0.75	0.972	0.942

Figure 1: Distribution according to mode of trauma**.**

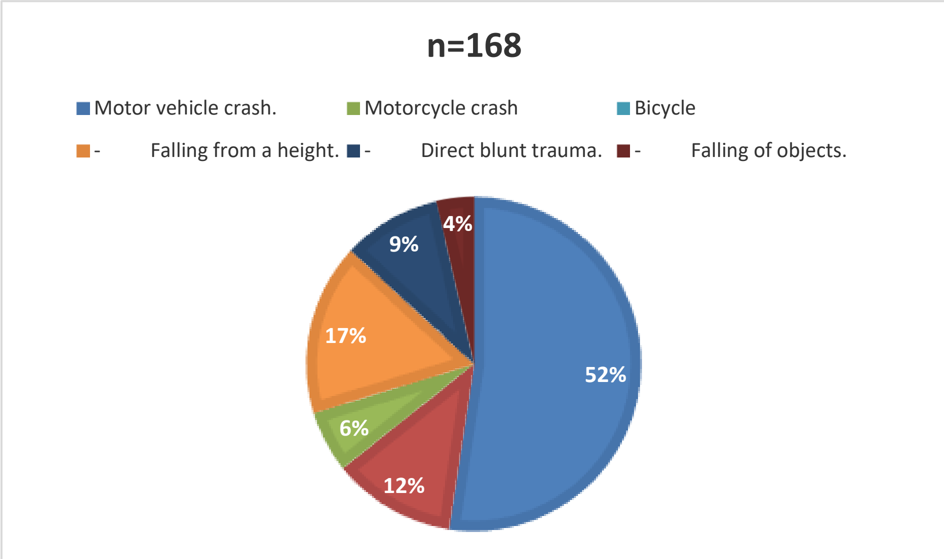
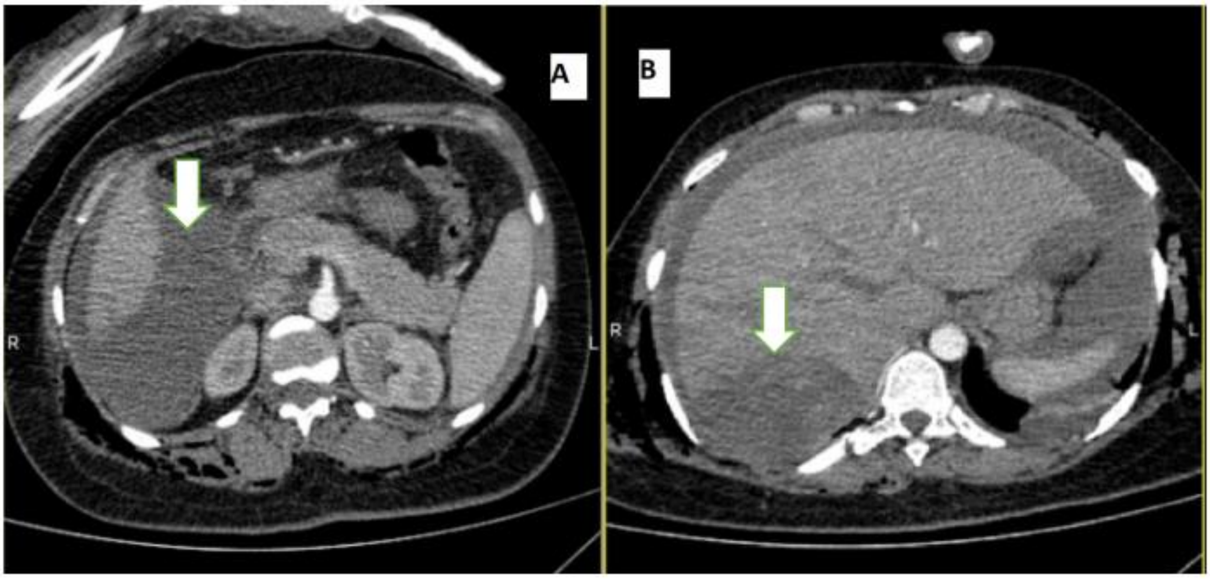


Figure 2: The focused assessment with sonography in trauma.

Figure 3: A: Moderate Intraperitoneal free fluid. **B**: Right hepatic lobe heterogenous hypodense area seen at segment VI & VII and lesser extend to VIII measuring 28 ×63mm reaching capsule contusion and linear hypodense lesion measuring 32mm in depth (laceration).



DISCUSSION

In this study, CT scans and FAST were employed to evaluate blunt abdominal trauma in 168 patients. Most of the subjects were male, with males making up 65 percent of the sample. This result is consistent with earlier studies, which suggest that a greater number of men participate in outdoor activities, encounter road accidents, and experience other forms of blunt trauma, whereas fewer women generally endure such injuries. These factors collectively contribute to a higher incidence of blunt trauma among males [6].

In the present study, the peak incidence (38%) was from 31-43Years old because of civilian violence, road traffic accidents, and industrial accidents. It is also clear that the less incidence was at > 60 years old (13%) because of the old age are of less activity.

This study may have included a diverse group of individuals who rode motorcycles, which increased their risk of injury, based on the kind of vehicle and the driving abilities of the riders. Nevertheless, there were only a small number of patients from both younger and older age groups, roughly around sixty, as these demographics tend to rely on others and are less accustomed to outdoor activities.

Consistent with those findings, earlier studies showed that most participants were younger, as they typically spend more time outdoors compared to older individuals [14].

In the present study, the most common cause of blunt abdominal trauma was found to be road traffic accidents (RTA) in 118 patients (70%) in form of motor car accidents (52%), motorcycle crash (12%) and bicycle accidents (6%). Followed by 28 patients (16%) suffered from falling from a height and 16 patients (10%) suffered from direct blunt abdominal trauma. 6 patients (4%) suffered from heavy objects falling.

Consistent with that finding, studies have indicated that most blunt abdominal trauma cases are caused by road traffic accidents, falls, and assaults [7].

In the current study, the effectiveness of FAST in identifying free intraperitoneal fluid was assessed. The calculations for sensitivity, specificity, PPV, NPV, and overall accuracy of the FAST scan yielded results of 98%, 100%, 100%, 99%, and 98%, respectively.

In the current investigation, the sensitivity, specificity, PPV, NPV, and accuracy of the CT scan for the detection of free intraperitoneal fluid were determined to be 100%, 100%, 100%, and 100%, respectively.

In line with the present research, a cross-sectional study was conducted to evaluate the diagnostic accuracy of the FAST procedure in patients with blunt abdominal trauma, using surgical findings as the gold standard. The study involved 155 patients who had sustained blunt abdominal injuries, all of whom underwent a FAST examination. The findings revealed that FAST had a sensitivity of 82.1%, a specificity of 90.6%, and an overall diagnostic accuracy of 83.9%. The study concluded that FAST is a dependable diagnostic tool that should be utilized in all cases of blunt abdominal trauma [5].

Another study was conducted to evaluate how effective FAST and CT scans are in diagnosing blunt abdominal trauma. This prospective research included patients with stable blunt abdominal injuries who were eligible for both ultrasound and CT imaging. The results showed that most trauma cases (58.9%) resulted from road accidents, while falls from heights constituted 32.1%. The abdominal organs most injured were the liver (73.2%), spleen (51.8%), kidneys (46.4%), and pancreas (12.5%). The CT scan successfully detected hemoperitoneum in all patients (100%), while the FAST scan identified it in only 83.9% of cases. The study concluded that CT scans are more effective than FAST scans in detecting blunt abdominal trauma, although patients must be hemodynamically stable to undergo a CT scan [15].

A different study was carried out to investigate patients with abdominal injuries. This research aimed to assess the effectiveness of ultrasound in the early identification of intra-abdominal injuries following blunt abdominal trauma, as well as to monitor these patients for any late-onset complications. In total, 120 patients who arrived at the emergency department underwent a Focused Assessment with Sonography for Trauma (FAST), followed by a follow-up ultrasound conducted 12 to 24 hours later. The results indicated that FAST had a sensitivity of 93% and a specificity of 99%. Ultrasound is regarded as the preferred method for the initial evaluation of patients with blunt abdominal injuries due to its non-invasive nature, availability, and time efficiency. Furthermore, ultrasound is particularly valuable for monitoring individuals with intra-abdominal injuries and can help decrease the reliance on CT scans, which are costly and involve significant radiation exposure [16].

A different study was conducted to assess the diagnostic accuracy of emergency FAST in patients with abdominal injuries. This was a descriptive cross-sectional study that took place over a period of three months and included 197 participants with a mean age of 27 years and a standard deviation of 11. The ratio of male to female participants was 5:1. The findings indicated that the specificity of EFAST was 97%, sensitivity was 100%, NPV was 100%, and PPV was 87%. On average, each EFAST scan took about 5 minutes to complete, with 168 patients, or 85%, undergoing the EFAST examination. Among the participants, 82 (48%) were discharged on the same day of admission, while 7 (4%) remained hospitalized even after two weeks. The study noted a mortality rate of 18 (9%). The findings suggest that EFAST is a dependable method for diagnosing abdominal injuries, even in resource-limited settings [2].

An observational descriptive study was conducted involving 105 patients who suffered blunt abdominal trauma due to motor vehicle accidents. These patients underwent CT and FAST scans to detect free fluid. The findings revealed that the sensitivity of FAST was 76.1% (95% CI: 64.14-85.69%), with a specificity of 84.2% (95% CI: 68.75-93.98%) and a precision of 79% (95% CI: 70.01-86.38%). In most cases of severe visceral injuries, the focused sonography assessment for trauma successfully identified free fluid. Nearly half of the true negative cases involved low-grade visceral or other injuries. The study concluded that FAST is an effective tool for the initial evaluation of blunt abdominal trauma, demonstrating high sensitivity and specificity [12].

This aligns with earlier research, which demonstrated that very high sensitivity and specificity were achieved, with sensitivity at 98 percent and specificity at 100 percent [17].

Computed tomography is considered the benchmark for evaluating blunt abdominal injuries; nevertheless, it necessitates moving the patient, involves a prolonged assessment period, and subjects the patient to different forms of radiation. Consequently, FAST is becoming more popular in emergency departments and trauma referral centers. This is due to the high volume of cases in these settings and the convenience of performing FAST at the bedside. Consequently, the United States plays a significant role in identifying patients who might need additional procedures for hemodynamic stabilization [17].

Due to time limitations, patients with severe injuries could not be taken for a CT scan, making it more efficient to transport these critically injured individuals directly for treatment rather than performing the scan first [8].

Considering the results of the current study and comparing them with previous global research on the diagnostic accuracy of FAST scans versus CT scans, it is evident that both methods are crucial for diagnosing blunt abdominal trauma and are being used more frequently in emergency departments. However, it is advisable to perform a CT scan after the FAST scan if the patient is stable, as this helps confirm deeper injuries and provides more accurate results.

It has been noted that the use of FAST inspections has risen, serving increasingly as the sole imaging method for blunt abdominal trauma, in place of abdominal contrast CT scans. Accurately assessing patients with blunt abdominal trauma is a difficult task for emergency physicians. However, employing the FAST technique to quickly identify abdominal free fluid can be achieved with an inexpensive and portable ultrasound device during the initial assessment. While abdominal CT scans are considered the gold standard due to their superior accuracy, they come with drawbacks, including high costs, the need to transfer patients out of the emergency department, and radiation exposure. In contrast, ultrasound can be a safe alternative, provided that the FAST method demonstrates high sensitivity and specificity [12].

CONCLUSION

We concluded that the FAST examination is highly effective and serves as a valuable diagnostic tool for the initial evaluation of patients with blunt abdominal trauma in the emergency department, as well as for identifying intraperitoneal fluid or free fluid. Additionally, it is a portable, non-invasive, quick, and cost-effective procedure. FAST is one of the ideal screening modalities for trauma patients being quicker, non-invasive, easy to perform, portable and of high importance to hemodynamically unstable patients. CT scans, unlike FAST scans, provide excellent imaging about sources of hemorrhage in addition of detection of IPFF. While FAST is also a highly useful tool, if the patient is stable, CT scan is seen to be the best option for accurately diagnosing blunt abdominal injuries.

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