The use of ultrasound and multidetector computed tomography in abdominal trauma patients at Assuit University Hospitals: a clinical audit study

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Aim

Quick diagnosis of hidden intra-abdominal injuries is mandatory to prevent morbidity and mortality in abdominal trauma patients. This is a clinical audit study aiming to evaluate the practice of ultrasonography (US) and multidetector computed tomography (MDCT) in the diagnosis of abdominal trauma patients.

Patients and methods

This clinical audit study was conducted from November 2017 to January 2018 in Assiut University Hospital on patients undergoing an abdominal US and abdominal MDCT scanning for the diagnosis of abdominal trauma.

Results

Of the 65 traumatized patients with positive focused assessment of sonography in trauma (FAST), 55 of them underwent MDCT examination while the rest of them were in critical condition and underwent immediate surgical intervention. There were 65 patients, 54 men and 11 women with a mean ± SD age 23.9 ± 14.9. Regarding the mode of trauma, the majority of the cases were due to blunt abdominal trauma (72.3%) while 27.7% had penetrating trauma. The overall sensitivity and specificity of US in the detection of solid organ injury are 45.5 and 96.3%, respectively. The sensitivity of FAST examination in the detection of intraperitoneal collection reached 98%.

Conclusion

US with FAST examination is the modality of choice in the initial evaluation of traumatized patients while contrast-enhanced MDCT is the imaging modality of choice in evaluating hemodynamically stable traumatic patients.

Keywords:

focused assessment of sonography in trauma, multidetector computed tomography, trauma, ultrasound

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Introduction

Trauma is a major cause of death among the adult population. It may differ from minor trivial injury to major life-threatening injury. The incidence of intra-abdominal injuries following blunt trauma may reach 12–15% [1].

Quick diagnosis of hidden intra-abdominal injuries is mandatory to prevent morbidity and mortality in abdominal trauma patients. Detection of intra-abdominal trauma can be done using physical examination, laboratory investigations, ultrasound (US), and computed tomography [2,3].

Focused assessment of sonography in trauma (FAST) examination guidelines have been published by the American Institute of Ultrasound in Medicine and the American College of Emergency Physicians [4].

US has many advantages including short examination time, more accurate diagnosis of hemoperitoneum, portable, can be done multiple times with no risk of radiation exposure or intravenous contrast use. Additionally, the use of US has significantly reduced the number of unnecessary multidetector computed tomography (MDCT) scans, which is significantly useful in pregnant and pediatric patients [5].

Disadvantages of US examination include variable operator training levels, limited by obesity, subcutaneous emphysema, and luminal bowel gases, in addition to the possibility of intra-abdominal injuries cannot be completely ruled out on the basis of negative FAST examination alone [3].

MDCT has proven to be the most reliable imaging modality as it enables accurate localization and grading of different abdominal injuries. MDCT can also accurately detect fractures, pulmonary contusions, pneumothorax, and vascular injures which were not clear on plain radiographs and US [3].

The original intention for FAST examination was to detect intraperitoneal free fluid. However, US can detect abnormalities of solid organ parenchyma which may suggest organ injury, especially during serial studies. The sensitivity of US for the detection of solid organ injury has been shown to be limited, with two studies reported sensitivities of 41 and 44% [6,7].

The aim of this study is to evaluate the role of FAST and MDCT in the diagnosis of abdominal trauma patients in Assiut University Hospital's Trauma Unit by comparing our protocols and results to the worldwide standards, to improve the practice and quality of patient care at Assuit University Hospital.

Patients and methods

A prospective, clinical, audit study was conducted in the Diagnostic Radiology Department in Assiut University Hospital. The hospital is a tertiary healthcare center for trauma (level I trauma center). The patients underwent FAST and MDCT scanning for the diagnosis of abdominal trauma during the period from November 2017 to January 2018.

Inclusion criteria

Patients of any age groups or sex admitted to the trauma care unit with a positive abdominal US, MDCT, or laparotomy findings within 3 months.

Exclusion criteria

(1) Patients discharged from the hospital without having MDCT examination or laparotomy done
(2) Hemodynamically unstable patients that required immediate surgical intervention without FAST examination.

Equipment and examination protocol

The US examination is carried out using General Electric (GE) (New York, USA) LogiQ P6 ultrasound machine with a curved transducer (3.5–5 MHz).

The FAST scan can be completed in less than 5 min and involves up to six views [8]:

(1) Subxiphoid to detect pericardial effusion.
(2) Right upper quadrant to assess Morison's pouch, diaphragm, liver, and kidneys.
(3) Left upper quadrant to assess the lienorenal interface, spleen, diaphragm, and kidneys.
(4) Right and left flank to assess the kidneys.
(5) Longitudinal and axial pelvis to look for free fluid adjacent to the bladder.

Multidetector computed tomography techniques

The scan is carried out using 16 row General Electric (GE) (New York, USA) BrightSpeed or 64 row Toshiba (Tokyo, Japan) Aquilion MDCT scanners.

When IV contrast administration is indicated, adapted to the body weight, 120–150 ml of nonionic iodinated contrast media (270 mg iodine/ml), injected at a rate of 3 ml/s is adequate.

Arterial phase scan should be initiated after 20–30 s after the start of injection.

In the portovenous phase the scan should be delayed till 80 s postinjection (PI).

The late scan is very useful in the case of renal trauma to evaluate the renal excretion and function and the scan should be done at a delay of 100 s PI for the nephrogenic phase and 6–10 min PI to evaluate the collecting system and the urinary bladder.

When rectal administration of contrast is indicated, 100 ml of water-soluble contrast agent (contains 2% iodine) is instilled via rectal enema, after that the scan is done, and the data is collected.

When the use of oral contrast is indicated, oral administration of 800–1000 ml of a water-soluble contrast agent containing 2% iodine was done.

Statistical analysis

Categorical data were expressed as the number and percentage, while continuous data were expressed as range or mean and SD. Diagnostic accuracy, sensitivity, and specificity were calculated using statistical package for the Social Sciences (SPSS) version 24 (IBM, New York, USA).

Results

The mean age of the included 65 patients was 23.9 ± 14.9 years. The male to female ratio was about 5: 1. The frequency of the sex is summarized in Table 1.

Table 1 Sex and age

Sex	*n* (%)
Male	54 (83.1)
Female	11 (16.9)
Age [mean±SD (range)]	23.9±14.9 (4-66)

The most frequent mode of trauma in this study was blunt trauma as shown in Table 2.

The sensitivity, specificity, positive, and negative predictive values of FAST in the detection of injuries of the liver, spleen and kidneys are shown in Table 3. These are the most commonly affected organs in abdominal trauma. These results show that US sensitivity in the detection of renal injuries is significantly lower than the liver and the spleen. Regrading splenic and hepatic injuries as shown in Tables 4 and 5, it has been indicated that FAST has good sensitivity at splenic grades III–V injuries (Figs. 1 and 2) and hepatic grades III–IV injuries (Fig. 3) rather than milder injuries (grades I and II) that had significantly lower sensitivity. In this study, we encountered three patients with vascular injuries.

Discussion

In this study, we examined patients with abdominal trauma for which they were referred to Assiut University Hospital's trauma unit as a tertiary center, excluding patients free from abdominal injuries and patients who had a very bad general condition preventing even US examination.

There were 65 patients, 54 men and 11 women with a mean age of 23.9 ± 14.9 years, and regarding the mode

Table 2 Mode of trauma

	n (%)
Blunt trauma	
Road traffic accident	23 (35.4)
Fallen from height	24 (36.9)
Penetrating trauma	
Stab wound	7 (10.8)
Fire arm injury	11 (16.9)

Table 3 Sensitivity of ultrasound in the detection of solid organ injury

Organs	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
Liver	56.3	97.4	90	84.4
Spleen	60	96.7	93	74.4
Kidneys	20	96	33.3	92.3

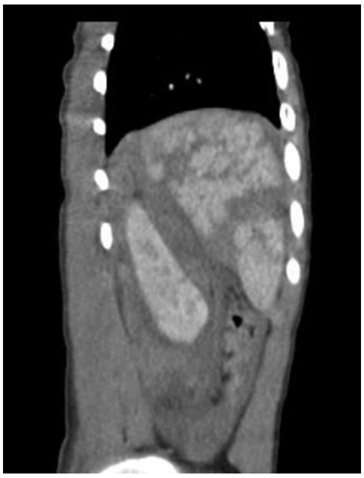
Table 4 Sensitivity of focused assessment of sonography in trauma about the severity of splenic injuries

Grade	Number of cases	Sensitivity (%)
I	3	33.3
II	9	33.3
III	9	77.8
IV	1	100
V	3	100

Table 5 Sensitivity of focused assessment of sonography in trauma about the severity of hepatic injuries

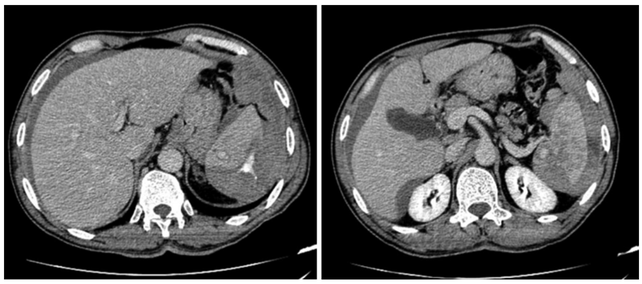
Grade	Number of cases	Sensitivity (%)
I	2	0
II	5	20
III	8	87.5
IV	1	100
V	0	-

Figure 1



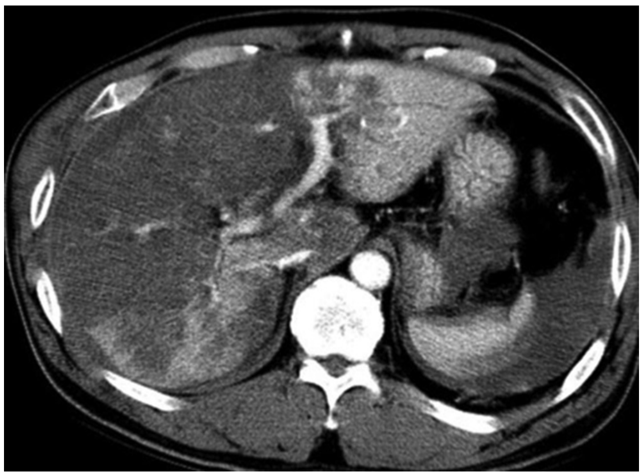
Oblique MPR image of contrast enhanced computed tomography (CECT) at the portal phase showing shattered spleen grade V.

Figure 2



Axial image of CECT at the portal phase showing grade III splenic hematoma with active contrast extravasation into the peritoneum (jet).

Figure 3



Axial CECT scan obtained at the portal phase, showing grade IV liver hematoma.

of trauma the majority of the cases (72.3%) were due to blunt abdominal trauma while the rest (27.7%) had penetrating injuries.

The overall sensitivity, specificity, positive predictive value, and negative predictive value of FAST in the detection of solid organ injury are 45.5, 96.3, 72.1, and 83.7%, respectively.

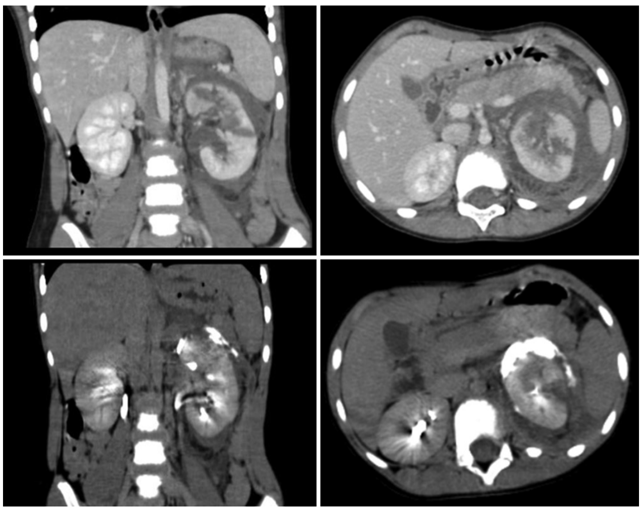
In this study, the sensitivity of FAST examination in the detection of intraperitoneal fluid (IPF) collection reached a sensitivity of 98% and specificity of 100%.

The Schnuriger *et al.* [9] study results showed that FAST sensitivity and specificity in the detection of solid organ injuries increases in proportion to the severity of injury, thus grade III–V organ lesions were detected more frequently than grade I and II lesions. This was similar to the current study results as the sensitivity of FAST increases as the severity of injuries increase.

Szmigielski *et al.* [10] stated that the US is an unreliable imaging modality for the diagnosis of renal parenchymal injuries. Another study reported US sensitivity reaching as low as 22% [11].

This was similar to this study results (Fig. 4), the sensitivity of FAST in the detection of renal trauma was the lowest in comparison to the liver and the spleen that showed a significant difference, even there was a patient with completely devascularized kidney and the US was unremarkable. Thus, we concluded that FAST cannot be used as a sole imaging modality in case of suspected renal injury and can easily miss significant renal injuries.

Figure 4



A CECT showing grade IV renal injury extending through the renal cortex, medulla and the collecting system; the portal phase which demonstrates parenchymal injury, and delayed excretory phase demonstrating extravasation from the collecting system.

Special attention has to be paid to patients with suspected bowel injuries, even to a subtle mesenteric hematoma, especially if it is located at the sites of predilection for small bowel perforation, it may be the only sign of bowel injury [12].

Multiple studies have found that MDCT is more sensitive and specific than abdominal US, and clinical examination for the diagnosis of bowel and mesenteric injuries, and it has become the diagnostic test of choice for the evaluation of blunt abdominal trauma in hemodynamically stable patients [13,14].

Regarding bowel and mesenteric injuries, in this study there was a minor rule for FAST in the detection of those injuries, in the presence of free IPF collection which in one case appeared to be pure intestinal contents and the patient underwent surgical intervention. Other than the presence of free IPF collection, detection of bowel injuries can be difficult even by using MDCT which had no conflict with the aforementioned studies.

There was a study conducted on 65 trauma patients suffering from nonaortic acute vascular injury by MDCT. Computed tomography scan provided information about the morphology, organ of involvement, the location of hemorrhage, and the initial size of hematoma. Follow-up MDCT scan can evaluate the rate of expansion and possible complications [15].

In this study, there were three patients presented with vascular injury on MDCT; one of them was hemodynamically unstable and MDCT showed truncated left internal iliac artery, so the patient underwent conventional angiography with interventional embolization of the internal iliac artery. The other two patients were hemodynamically stable and treated conservatively as they had injuries involving small muscular branches of the internal iliac injured from fractured bony fragments.

Our limitations of this study is that the diagnostic capability of FAST depends on the experience and training of the examiners and we did not encounter patients with grade V liver injuries.

Conclusion

The FAST examination is the modality of choice in the initial evaluation of traumatized patients which has fairly good sensitivity in the detection of advanced splenic and hepatic injuries (grades III, IV and V) as well as free IPF collection. Negative US should always be correlated with the clinical examination as some patients may require MDCT examination despite negative FAST. MDCT is the imaging modality of choice for traumatic patients providing precise localization of the organ injuries, accurate grading of the injury, prediction of the outcome, and planning the next step of management.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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