Evaluation of splenic injury in blunt abdominal trauma by multidetector computed tomography

Eman A. Elhamd, Mohammed Zidan, Fatma M. Osman

Department of Diagnostic Radiology, Assiut University Hospitals, Faculty of Medicine, Assiut University, Assiut, Egypt

Correspondence to Fatma M. Osman, Department of Diagnostic Radiology, Assiut University Hospitals, Faculty of Medicine, Assiut University, Assiut, Egypt. Tel: +20 114 059 4246/20 102 289 3374; e-mail: fatmaosman203@yahoo.com

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Background
Multidetector computed tomography (MDCT) has been evolved in the assessment of cases with blunt abdominal trauma. It can easily detect injuries to different abdominal viscera.

Aim
The current work aimed to evaluate the role of MDCT in the diagnosis of splenic injuries in patients with blunt abdominal trauma.

Patients and methods
Over a period from March 2019 to June 2019, 40 patients with different forms of splenic injuries were reviewed. The splenic injuries were diagnosed based on abdominal ultrasound, CT, and/or laparotomy if done.

Results
Of the studied patients, 85% were males. The mean age of all patients was 21.40 ± 14.39 years. The most frequent form of trauma was motor car accidents (42.5%). Based on CT, 17 (42.5%), 16 (40%), seven (17.5%), and two (5%) patients had splenic laceration, hematoma, shattered spleen, and vascular extravasation, respectively. All patients had intraperitoneal fluid collection. Moreover, grades I, II, III, IV, and V splenic injuries were presented in seven (17.5%), six (15%), 19 (47.5%), two (5%), and six (15%) patients, respectively. All patients with grades I, II, and III were conservatively managed, whereas those with grades IV and V were managed with splenectomy. Diagnosis by MDCT in 20% of patients was consistent with the final diagnosis in laparotomy, so diagnostic accuracy of MDCT was 100%. In 80% of patients, the management plan was conservative and follow-up ultrasound showed improvement of splenic injuries, which suggests that the diagnosis of MDCT was correct.

Conclusion
MDCT has become the imaging modality of choice for evaluation of blunt splenic injuries and provides accurate diagnosis, including injury grades, associated active bleeding, and/or other visceral injury, which is helpful in determining the proper plan for successful management strategy and decreasing the rate of unnecessary exploratory laparotomy.

Keywords:
blunt trauma, computed tomography, splenic injuries, splenic laceration

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Introduction

Originally, abdominal injuries were divided into two types: penetrating abdominal traumas and blunt abdominal traumas. Penetrating injuries are normally easy to diagnose, whereas blunt injuries are sometimes neglected because the clinical signs are less obvious [1].

A number of equipment can cause penetrating injuries and has a distinct damage pattern. Blunt trauma caused by deceleration or direct collision is still known to have serious outcomes in young people [2].

Splenic injuries are among the most common abdominal injuries induced by blunt trauma mechanisms such as road accidents, sports mishaps, and falls. Splenectomy has long been the usual therapy for splenic injuries; however, splenic salvage procedures such as splenorrhaphy or partial splenectomy are becoming more popular [3].

Computed tomography (CT) is an effective tool for identifying distinct types of blunt splenic injuries. The term ‘shattered spleen’ refers to the complete destruction of the organ. A number of CT-based indicators and damage scores have been linked to treatment outcomes to assist in evaluating patients who may be successfully handled conservatively and who may require surgery [4,5].

Patients and methods

Study setting and design

A prospective study was conducted at the Trauma Unit and Radiodiagnosis Department of Assiut

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University Hospital in the period from March 2019 to June 2019.

Material and method

The study was carried out after obtaining the permission of IRB, Faculty of Medicine, Assiut University, IRB 17101445. All patients signed informed consent forms, and the study does not affect patients' fundamental rights.

Inclusion criteria

Patients admitted to the Trauma Unit with positive ultrasound (US) and multidetector computed tomography (MDCT) findings for splenic injuries with or without undergoing laparotomy were included.

Exclusion criteria

They included (a) patients undergoing laparotomy without doing MDCT, (b) patients had conditions that were interfering with intravenous contrast administration or exposure to radiation such as history of contrast-induced hypersensitivity or pregnant women, and (c) patients with penetrating trauma.

Methods

All patients were clinically evaluated with recording of age, sex, and mode trauma. Those patients were further evaluated by the following:

The US examination as carried out via a General Electric (GE) [General Electric US machine: GE MEDICAL SYSTEMS (CHINA)] or Logic P6 US machine with curved (3.5–5 MHz) and linear (5–12 MHz) transducers.

The examination aimed to evaluate the following views: (a) subxiphoid view, to detect pericardial effusion; (b) right upper quadrant, to evaluate Morison's pouch, diaphragm, liver, and kidney; (c) left upper quadrant to assess the lienorenal interface, spleen, diaphragm, and kidney; (d) right and left flank to assess kidneys; and (e) longitudinal and axial pelvis to look for free fluid adjacent to the bladder.

The MDCT techniques were carried out using 16-row General Electric (GE medical system) or 64-row Toshiba Aquilion MDCT scanners.

It was performed in the supine position. Intravenous contrast administration was indicated, adapted to the body weight, where 120 ml to 150 ml of nonionic iodinated contrast media (300 mg iodine/ml), injected at a rate of 3 ml/s, was adequate.

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

The MDCT scans were scored for the grade of splenic injury using the modified criteria of the American Association for the Surgery of Trauma (AAST). This system grades splenic injuries from I to V on the basis of increasing severity of parenchymal damage and is based on the most accurate assessment of the radiologic (or subsequent surgical) examination as follows [6]:

Grade I: hematoma (10% surface area) or capsular tear, 1-cm parenchymal depth.

Grade II: subcapsular hematoma (10–50% of surface area) or intraparenchymal hematoma 5 cm in diameter, laceration: 1–3 cm.

Grade III

(1) Subcapsular hematoma (50% surface area or expanding; ruptured subcapsular or intraparenchymal hematoma) or intraparenchymal hematoma 5 cm.
(2) Laceration: 3-cm parenchymal depth or involves trabecular vessels.

Grade IV where laceration involves segmental or hilar vessels.

Grade V included shuttered or devascularized spleen.

Statistical analysis

Data were collected and analyzed by using SPSS (Statistical Package for the Social Sciences, version 20; IBM, Armonk, New York, USA). Continuous data were expressed in form of mean ± SD and compared with Student test or analysis of variance, whereas nominal data were expressed in the form of frequency (percentage). χ^2 test was implemented in the case of nominal data. Level of confidence was kept at 95%, and hence, *P* value was significant if less than 0.05.

Results

Baseline data of studied patients

The mean age of patients was 21.40 ± 14.39 years, and the majority (85%) of them was males. The most frequent forms of trauma were motor car accidents (42.5%), falling down stairs (20%), followed by fall from height (17.5%) and motor bike accidents (15%) (Table 1).

Based on baseline assessment of studied patients, 30 (75%) patients were hemodynamically stable, whereas the other patients were unstable. All patients had intraperitoneal fluid collection regarding US assessment, whereas 21 patients had splenic hematoma and nine patients had splenic laceration.

Findings in multidetector computed tomography in studied patients

According to description finding of MDCT, splenic hematoma presented in 16 (37.5%) patients, and one of them was associated with vascular extravasation. A total of 17 (42.5%) patients had splenic laceration: less than 3 cm in seven (17.5%) and more than 3 cm in 10 (25%) patients. Shattered spleen presented in seven (17.5%), and one of them was associated with vascular extravasation (Table 2).

Grades I, II, III, IV, and V splenic injuries were presented in seven (17.5%), six (15%), 19 (47.5%), two (5%), and six (15%) patients, respectively, according to AAST.

Regarding associated injuries, it was noticed that five (12.5%) patients had lung contusions, whereas only one patient had pneumomediastinum. Three patients had hepatic injuries in the form of contusion, laceration, and hematoma. Regarding renal injuries, three patients had perinephric hematoma and one patient had renal laceration. One patient had pelvic fracture (Fig. 1).

Management of splenic injuries based on grade of injuries

The majority (80%) of injuries was managed conservatively, whereas eight (20%) injuries were surgically managed with splenectomy. Based on splenic injury grading by AAST splenic injury scale, it was noticed that all splenic injuries grades I, II, and III were treated conservatively, and their follow-up US showed improvement in splenic lesions, whereas the other grades required splenectomy with their findings consistent with the findings of laparotomy (Table 3).

Age and types of trauma based on grades of splenic injuries

Different grades of splenic injuries had no significant differences regarding the mode of trauma (Tables 4 and 5).

Cases

Case 1

Fig. 2.

Table 1 Baseline data of the studied patients

	n=40
Age (years)	21.40±14.39
Range	3-55
Sex	
Male	34 (85)
Female	6 (15)
Mode of trauma	
Motor car accidents	17 (42.5)
Falling down stairs	8 (20)
Fall from height	7 (17.5)
Motor bike accident	6 (15)
Assault from others	2 (5)
Stability	
Unstable	10 (25)
Stable	30 (75)
US findings	
Intraperitoneal collection	
Less than mild collection	16 (35)
Mild collection	22 (55)
Moderate collection	2 (5)
Splenic hematoma	21 (52.5)
Splenic laceration	9 (22.5)

Data were expressed in the form of mean±SD and *n* (%).

Table 2 Findings in multidetector computed tomography in the studied patients

	n=40
Splenic hematoma	16 (40)
Splenic laceration	
<3 cm	7 (17.5)
>3 cm	10 (25)
Shattered spleen	7 (17.5)
Vascular extravasation	2 (5)
Grade of splenic injuries	
Grade I	7 (17.5)
Grade II	6 (15)
Grade III	19 (47.5)
Grade IV	2 (5)
Grade V	6 (15)
Associated injuries	
Intraperitoneal collection	40 (100)
Lung contusion	5 (12.5)
Pneumomediastinum	1 (2.5)
Hepatic injuries	3 (7.5)
Renal injuries	4 (10)
Pelvic fracture	1 (2.5)

Data were expressed in the form of *n* (%).

Case 2

Fig. 3.

Discussion

In addition to the spleen's crucial functions, splenic preservation following trauma has been a frequently debated topic in recent years. Sepsis following splenectomy is still common, with a mortality rate of 2.25% and can occur up to 15 years after the procedure [7].

Table 3 Type of management based on grade of splenic injuries

Grade of splenic injuries	Type of management	
	Conservative	Splenectomy
Grade I	7 (17.5)	0
Grade II	6 (40.1)	0
Grade III	19 (59.4)	0
Grade IV	0	2 (5)
Grade V	0	6 (15)
P	<0.001	

Data were expressed as *n* (%). *P*<0.05.

Table 4 Types of trauma and grades of splenic injuries

Mode of trauma	Grades of injuries				
	I	II	III	IV	V
Assault from other	1 (14.3)	0	1 (5.3)	0	0
Falling down stairs	1 (14.3)	2 (33.3)	4 (21.1)	0	1 (16.7)
Fall from height	0	3 (50)	3 (15.8)	0	1 (16.7)
Motor bike accident	0	0	3 (15.8)	2 (100)	1 (16.7)
Motor car accidents	5 (71.5)	1 (16.7)	8 (42.1)	0	3 (50)
P			0.11		

Data were expressed as *n* (%). *P*<0.05.

Table 5 Mean age in different grades of splenic injuries

Grade of splenic injuries	Mean ± SD
Grade I	14.56 ± 4.78
Grade II	12.33 ± 5.49
Grade III	22.01 ± 9.56
Grade IV	21.50 ± 3.53
Grade V	28.33 ± 8.77

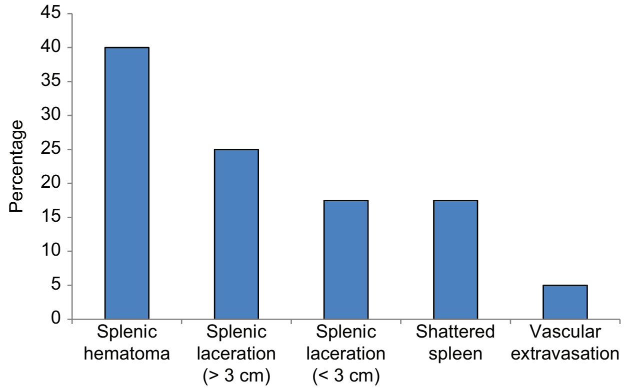
Data expressed as mean (SD). *P* value was significant if < 0.05.

US is currently the most used way of screening patients with acute abdominal injuries all over the world. However, some earlier published evidence suggests that false-negative findings when screening with US are uncommon (1%) [8]. Some abdominal injuries, including as retroperitoneal (pancreatic and adrenal), vascular injuries, and diaphragmatic rupture, appear to be underdiagnosed as a result of US screening, which may have a detrimental effect on the patient's fate [9].

Per the earlier studies, the majority of the harm associated with gastrointestinal tract injury is owing to delayed diagnosis. Diagnostic imaging plays a critical role in detecting and assessing solid organ damage in the setting of forceful abdominal trauma. Although injuries to the liver, spleen, kidneys, pancreas, colon, and mesentery have many similarities, each has its own set of issues that the radiologist must address [10].

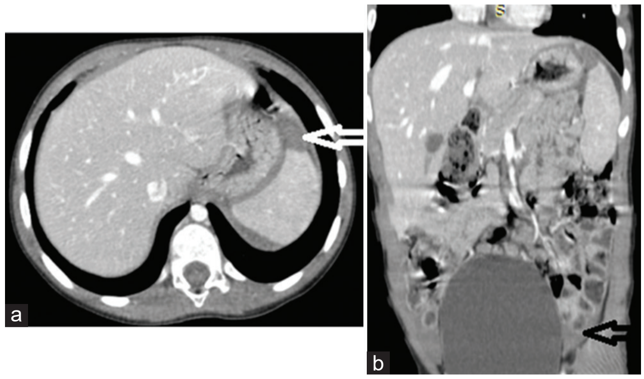
In serial studies, US can be used to show injury-related abnormalities in the solid organ parenchyma. Studies have revealed that the sensitivity of US in detecting solid organ injury is limited, with two studies indicating sensitivities of 41 and 44% [11].

Figure 1



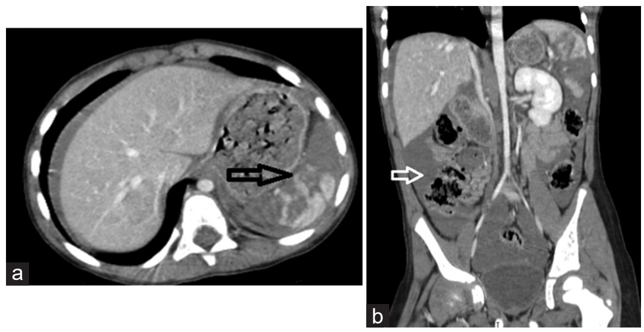
Splenic injuries in the studied patients based on MDCT. MDCT, multidetector computed tomography.

Figure 2



A 6-year-old male patient with trauma after falling down stairs. Axial and coronal MSCT (a and b) obtained in the portovenous phase showing upper polar small irregular low attenuation area (white arrow) within the enhanced parenchyma measuring 0.8 × 1.3 cm with 53 HU, representing parenchymal splenic hematoma, with minimal free IPF collection (splenic injury grade I).

Figure 3



A 5-year-old female patient with trauma after fall from height. Axial and coronal (a, b) MSCT with contrast obtained in portovenous and delayed phases, respectively, revealed multiple irregular linear hypodense lesions involving whole splenic parenchyma suggesting shattered spleen (black arrow), no extravasation, and marked IPF collection (white arrow) (splenic injury grade V).

The role of CT specifically in the diagnosis of acute splenic injury has also been well established. In addition to demonstrating the presence or absence of splenic injury, CT can also characterize type, depth, and location of the injury, as well as quantify the extent of intraperitoneal hemorrhage [12].

Buntain *et al.* [13] studied 46 individuals with splenic injury using their grading system and found that CT correctly identified splenic injury in 28 of 30 patients who had surgery. However, they did not demonstrate that CT was as successful in enabling the prediction of the real nature and amount of the injury in these circumstances. CT scans revealed the full extent of the injuries in six (20%) out of the eight patients [13].

Although it is true that CT scans in 16 nonsurgical patients showed splenic injury, it is unclear how the authors were able to confirm this because the patients never had surgical investigations. There were recommendations for nonsurgical therapy for patients with injury classes I and some II, as well as early laparotomy for patients with severe injury classes II, III, and class IV [13].

In this study, we examined 40 patients with blunt abdominal trauma. We were aiming to predict the role of MDCT scan in patients with blunt splenic injury.

There was a male predominance in the current study (85%). Moreover, we found that the middle age group was the most frequently injured, with a mean age of patients of 21.40 ± 14.39 years. Similar finding was reported by Selim and Albroumi [14], who included 44 patients of either sex with abdominal trauma, where 72.7% were male and 27.3% were female, with a mean age of 29 years and median of 26 years.

A similar finding was also reported by the study of Maqsood *et al.* [15], who studied 46 patients with blunt abdominal injury. They found that 80% of patients were males, and the age of 54% was between 21 and 40 years.

In our study, motor car accident was the most common mode of injury (42.5%) followed by falling down stairs (20%), falling from height (17.5%), motor bike accident (15%), and assault from others (5%), with similar findings reported in the study of Maqsood *et al.* [15].

The current study revealed the associated injuries as follows: lung contusion (n = 5), pneumomediastinum (n = 1), liver injury (n = 3), kidney injury (n = 4), and/or pelvic fracture (n = 1). This is slightly different from the study of Selim and Albroumi [14] of 44 patients with splenic injury. They found that 68.2% had splenic injuries. Other injuries were reported as follows: hepatic (n = 13), renal (n = 12), intestinal (n = 8), gastric (n = 1), and/or pancreatic (n = 1) injuries.

The most common associated extra-abdominal injury in our study was chest injury (lung contusion, pneumomediastinum, rib fracture, and surgical emphysema), which was seen in 15% of cases, and pelvic fracture was seen in one case, but different findings were reported in the study by Maqsood *et al.* [15], where 80 and 23.9% patients had bone and chest involvements, respectively.

Regarding the AAST for organ injury scaling, seven cases had grade I splenic injury, grade II was detected in another six patients, whereas grades II, IV, and V were observed in 19, two, and six patients, respectively.

Similarly, the study by Selim and Albroumi [14] showed that six patients were diagnosed with grade I, 12 patients were diagnosed with grade II, 11 patients were diagnosed with grade III, nine patients were diagnosed with grade IV, and six patients were diagnosed with grade V splenic injury.

In another different study that included 25 patients with positive splenic injury by MSCT from the overall 65 patients included in this study, it was found that three, nine, nine, one, and three patients had grades I, II, III, IV, and V splenic injuries, respectively [16].

In our study, 32 patients were managed conservative and eight patients underwent splenectomy. These findings were in agreement with the study by Selim and Albroumi [14], where seven (15.9%) of 44 patients were operatively managed. Many previous studies found that CT had low accuracy in discrimination between those patients who could be managed with surgery or just follow-up [17–19].

In our study, all of the eight patients who underwent laparotomy, the CT finding was correct, and CT scan had high sensitivity for splenic injury in about 100% of these eight cases. According to Wing *et al.* [20], the use of CT had a significant effect on the evaluation and treatment of blunt abdominal trauma.

Udekwu *et al.* [21] stated that CT had 97.6% accuracy in patients with visceral injury. Salimi *et al.* [22] reported that CT scan had 100 and 86.6% sensitivities for detection of hepatic and splenic affections, respectively.

Limitation of study

The limitation of our study is that most patients with splenic injury were managed conservatively, so we cannot compare the MDCT finding with laparotomy finding regarding these cases.

Conclusion

In conclusion, MDCT is now the imaging method of choice for evaluating blunt splenic injuries and providing precise diagnoses that are useful in selecting the correct strategy for successful therapy and minimizing the rate of needless exploratory laparotomy.

Conflicts of interest

There are no conflicts of interest.

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