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Radiological Evaluation of Blunt Abdominal Injuries

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Abstract

Background: *Trauma is an epidemic of modernization. Clinical examination alone is not reliable especially in cases of abdominal injuries. Therefore, the radiological examination is an invaluable tool in the management of trauma. We in the current study tried to evaluate the different modes of radiological examination in blunt abdominal injuries reporting to our institute.* ***Methods:*** *This cross-sectional study was conducted in the Department of Radiology, Prathima Institute of Medical Sciences, Karimnagar. N=31 patients who were stable to undergo all three X-ray, US, and CT examinations and had at least one of these studies interpreted as positive were included in this study. Whenever possible, X-Ray and US preceded CT and the time gap between the three studies was kept to the minimum to make the studies comparable. Each X-Ray, US, and CT scans were performed in all 31 patients.* ***Results****: Out of the total 31 patients, in 14 patients US and CT showed similar findings. In 15 patients CT detected additional findings or provided additional information but did not change the management. In 4 patients CT was decisive for the management or surgical planning. However, all of the US showed the presence of free fluid. In 30 patients US showed either intra-abdominal free fluid or organ injury or both. In one patient US did not reveal any abnormality. Liver injury was later detected on CT. US had an overall sensitivity of 96%, a specificity of 100%, and an accuracy of 96%.* ***Conclusion****: US is a valuable initial modality for the evaluation of patients with abdominal trauma. CT is required in most US positive patients to delineate the exact extent of the injury and to exclude any other significant injuries. Also, in a small but significant group, CT may change the management approach. Symptomatic patients should have a CT even if the US examination is negative.*

Keywords*: Blunt abdominal injuries, Trauma, Radiological examination, CT Scan, Ultrasonography [US]*

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Introduction

Trauma is an important and outcome of modern society. An estimated loss of life from trauma equals that from cardiovascular disease and cancer combined. Trauma is the leading cause of death in people younger than 40 years. [1] Among these 10% are attributable to an abdominal injury. Traditionally, abdominal injuries can be divided into blunt trauma and penetrating trauma. Blunt abdominal trauma (BAT) usually occurs due to road traffic accidents (RTA), fall from a height, or during sports. [2] The prevalence of intra-abdominal injury varies widely, ranging from 7.7% to 65%. [3] The clinical examination does not always provide enough information about the extent of abdominal injuries. In many cases, the exact history is not available or reliable and drugs, alcohol, head trauma young age and mental retardation can all make physical examination unreliable. Plain X-ray plays a limited role in the evaluation of blunt abdominal trauma. X-rays of the chest and pelvis are often obtained to evaluate for concurrent thoracic or pelvic

injuries. Abnormal chest X-ray findings of pneumothorax and rib fractures are associated with intra-abdominal injuries and are indications for abdominal imaging if a mechanism for multisystem trauma is present. Ultrasonography (US) and computed tomography (CT) have found an increasingly important role in the evaluation of abdominal trauma since their introduction in the early seventies and early eighties respectively. Ultrasonography for blunt abdominal trauma (BAT) was first described in 1971, [4] and it is currently the primary screening examination for blunt abdominal trauma in most trauma centers. Ultrasonographic (US) examination of the abdomen for blunt trauma has been performed in India for almost 30 years. There has been particularly high interest in the use of screening US in BAT patients. Its main application is the detection of free abdominal fluid, and it plays an important role in the evaluation of pleural and pericardial fluid. Focused assessment sonography in trauma (FAST), is limited to evaluation for free intra-abdominal fluid, without organ assessment. [5] This method is regarded as a rapid diagnostic examination in the triage of victims of blunt abdominal trauma, which can lead to a reduction in the number of abdominopelvic computed tomographic (CT) and deep peritoneal lavage procedures performed. CT by its localizing nature helps in deciding surgical approach or conservative management in an appropriate clinical setting. The use of CT along with a trend towards non-operative management of many abdominal injuries has decreased the need for explorative surgery and reduced the frequency of nontherapeutic laparotomies. [6] The trend towards the conservative and non-operative treatment of many liver, spleen, and renal injuries is due in part to the ability of CT not only to define the site and extent of organ injuries but also to exclude other significant injuries, thereby avoiding unnecessary surgery. [7] The purpose of our study is to evaluate the role of X-Ray, US, and CT for the depiction of organ injury indirectly (utilizing detection of free abdominal air (pneumoperitoneum), free fluid, and directly (including parenchymal analysis) in patients with blunt abdominal trauma.

Materials and Methods

This cross-sectional study was conducted in the Department of Radiology, Prathima Institute of Medical Sciences, Karimnagar. Institutional Ethical committee Permission was obtained for the study. Patients presenting at the causality department of PIMS, following injury and suspected to have blunt abdominal trauma were investigated. The time, cause, and mode of injury were obtained whenever possible. N=31 patients who were stable to undergo all three X-ray, US, and CT examinations and had at least one of these studies interpreted as positive were included in this study. Whenever possible, X-Ray and US preceded CT and the time gap between the three studies was kept to the minimum to make the studies comparable. Each X-Ray, US, and CT scans were performed in all 31 patients. Patients having all three tests interpreted as negative and whom either did not require admission or who were discharged after a short observation without any further investigation, were not included. Diagnostic peritoneal tapping was performed in all the patients with free fluid to confirm the presence of hemoperitoneum. Plain Radiograph: X-Rays were performed on “Philips Carestream GE DR System” with patients put in an upright position (Erect Abdomen) and left lateral decubitus**.** Particular attention was paid to detecting the presence of free intraperitoneal air (pneumoperitoneum) and air-fluid levels**.** Ultrasonography: US scans were performed on the "Philips Affiniti 70 and 30 G” machine, with 2-5 and 5-10 Mhz curvilinear and linear probes. Particular attention was paid to the detection of free fluid in the abdomen and pelvis, in addition to the assessment of individual organs. The state of distension and the presence of intra-luminal echoes were looked for while scanning the gall bladder and urinary bladder. Visceral organs were evaluated for parenchymal abnormalities consisting of intraparenchymal masses, hematomas, lacerations, and/or geographic zones of echotextural heterogeneity. CT Technique: CT scans were performed on; “Philips Ingenuity 128 Slice” helical sub-second (0.75 Sec) scanner capable of 50 secs, continuous spiral run. Images were reconstructed with an 1800 linear interpolation reconstruction algorithm. Helical CT of the

entire abdomen was done from the level of dome of the diaphragm up to the inferior aspect of the ischium. Delayed CT scans were also incorporated whenever there was suspicion of kidney or urinary tract injury. Lung and bone window exposures were also obtained in addition to standard soft tissue window whenever required. Free fluid with attenuation value > 30 Hounsfield Units (HU) was labeled as hemoperitoneum. Follow up US or CT scans were obtained as dictated by the clinical course of the patients. Patients undergoing conservative management were clinically followed up.

Results

N=31 patients with a history of blunt abdominal trauma were evaluated by each X-Ray, US, and CT. There were 24 male and 7 female patients. The age of patients ranged from 8 years to 75 years. The mean age was 37.9 years. One patient was children (< 12 years). Fourteen patients were 40 years or older (Table 1).

Table 1: Age and Sex Distribution of patients

Age group	*Sex*		*No. of patients*	*Percentage (%)*
	Male	*Female*		
0-12	00	01	01	3.2
13-20	02	01	03	9.6
21-30	05	01	06	19.3
31-40	06	01	07	22.5
41-50	06	02	08	25.8
51-60	04	01	05	16.1
61-70	01	00	01	3.2
Total	24	07	31	100

Out of the total 31 patients, n=21(77.4%) cases were due to RTA, n=6(19.3%) were fall from a height, and one patient (3.2%) presented with penetrating injury along with blunt trauma due to assault. The shortest time of presentation was 1 hour and the longest time of presentation since injury was 1 day. Only eight patients were seen within four hours after injury. Of the total, 27 patients were scanned within 12 hours and 4 were scanned after more than 12 hours following injury. Indication for imaging: for suspected liver or splenic injury (n = 27). In eighteen patients, imaging was requisitioned to rule out intra-abdominal injury. Six patients were evaluated for complaints of hematuria. The number of organs injured is more because some patients showed multi-organ injuries (table 2). Individual organ injuries were graded according to the Organ Injury Scaling (OIS) system Moore et al; [8] which is an amalgamation of radiological, surgical, and pathological correlates. Of the 13 splenic injuries, grade III injuries were seen in n=5 patients. Two patients had grade I and one patient had grade II injury. Five patients had grade IV injury. The calculated sensitivity, specificity, and accuracy of US detection of splenic injuries was 58%, 100%, and 64% respectively.

Table 2: Distribution of Organ Injuries

Organ	*Frequency*	*Percentage*
Spleen	13	41.9%
Liver	17	54.8%
Kidneys	03	9.6%
Bowel & Mesentery	05	16.1%
Pancreas	02	6.4%
Urinary Bladder	01	3.2%
Diaphragm	01	3.2%

Out of the total 31 patients, in 14 patients US and CT showed similar findings. In 15 patients CT detected additional findings or provided additional information but did not change the management. In 4 patients CT was decisive for the management or surgical planning. However, all of the US showed the presence of free fluid. In 30 patients US showed either intra-abdominal free fluid or organ injury or both. In one patient US did not reveal any abnormality. Liver injury was later detected on CT. The US had an overall sensitivity of 96%, specificity of 100%, and accuracy of 96%. CT was positive (either for intra-abdominal free fluid or organ injury or both) in all the patients and thus showed an overall sensitivity, specificity, and accuracy of 100%. CT showed a distinct advantage in patients with overlying subcutaneous emphysema which prevented normal visualization of underlying structures on the US (in case no.15). The patient had a splenic injury. CT was useful in detecting associated injuries such as hemothorax-5 cases (16%), pneumothorax-1(3.2%), lung contusions-1 cases (3.2%), rib fractures -8 cases (25.8%), vertebral fractures-1 cases (3.2%), and pelvic fractures-6 cases (19.3%) thereby providing additional information in guiding the initial mode of management of such patients.

Table 3: USG and CT detection of injuries with sensitivity, specificity, and accuracy

Injuries	*False-negative*	*False-positive*	*True positive*	*Sensitivity*	*Specificity*	*Accuracy*
Spleen	5	0	7	58	100	64
Liver	3	0	14	83	100	84
Kidney	2	0	1	33.3	100	60
Pancreas	2	0	0	The US did not detect injury due to bowel gas		
Bowel and mesentery	4	0	1	20	100	42.8
Pelvic fracture and associated injuries	5	0	1	16.67	100	28.57
Pneumoperitoneum	2	0	1	33.3	100	60

Discussion

Trauma is one of the commonest causes of health problems and death. The abdomen has been reported to be the third most common region of injury after the head and extremities. Blunt abdominal trauma is difficult to diagnose due to the absence of clinical signs as opposed to penetrating trauma, which can be seen and easily diagnosed. In most studies, the major mechanisms of injury are road traffic accidents (RTA), followed by falls. [9] In the present study, RTA accounted for 77.4% of injuries and 19.3% of patients sustained injuries due to fall from height. The prevalence of trauma was more in males (77%) as reported in earlier studies. [10] Although the overall value of plain radiography in the evaluation of patients with blunt abdominal trauma is limited, plain films can demonstrate numerous findings. The chest radiograph may aid in the diagnosis of abdominal injuries such as ruptured hemidiaphragm (eg, a nasogastric tube seen in the chest) or pneumoperitoneum. The pelvic or chest radiograph can demonstrate fractures of the thoracolumbar spine. The presence of transverse fractures of the vertebral bodies (Chance fractures) suggests a higher likelihood of blunt injuries to the bowel. In our study X-Ray showed an overall sensitivity, specificity, and accuracy of 33%, 100%, and 60% respectively and CT accurately diagnosed all three cases. The sensitivity of 33% in our study is similar to that found by Stapakis JC et al; [11] in detecting free air on an abdominal radiograph in comparison with CT. Focused abdominal sonography for trauma (FAST) is a fast examination method that could demonstrate intraperitoneal fluid. Radwan et al. [12] evaluated the role of FAST and CT in BAT patients. The importance of CT in the diagnosis of abdominal trauma lies in its accuracy in identifying injuries that require early exploration and provides an assessment of the severity of the injury which helps to decide the management. The rate of negative laparotomy is reduced by avoiding surgical intervention in cases that can be managed conservatively. Though the US is sensitive and a widely available preliminary investigative modality, it is inferior in detecting retroperitoneal and bowel injuries and is operator dependent. Hemoperitoneum is cited to be the most frequent sign of abdominal injury. Out of the total n=31 patients in our study, hemoperitoneum was detected in n=30 patients on CT (96.7%). N=26 was detected by the US, had a sensitivity of 83.8%, the specificity of 100%, and an accuracy of 84% in the detection of hemoperitoneum. Many studies have shown US has a high specificity of US in the detection of intraperitoneal free fluid. S.M. Boutros et al; [13] showed 93% sensitivity and 99% specificity in the detection of intraperitoneal fluid by Focused abdominal sonography for trauma (FAST) examination. The results in our study are similar to that of Khsitish M et al; [9] Spleen is the most common intra-abdominal organ injured in blunt abdominal trauma and the second most frequently injured organ in our study with an incidence of 41.9%. Splenic injuries account for about 40% of all intraabdominal injuries49. The presence of pulp tissue and poorly developed mesenchymal supporting structure predisposes the spleen to injury. In our study spleen was the commonest organ injured with an incidence of 32%. There were 7 cases of splenic trauma detected in the US which is 22% among all the cases of blunt injury to the abdomen in this study. CT detected 13 cases of splenic trauma which is 41.93% among all the cases of blunt injury to the abdomen in this series. In the US, the specificity of 100% in our study is similar to that found by Jyothi P et al; [15] (100%). However, our study had a lower sensitivity of 58.3% compared with

73% in their study. Asher et al; [14] showed a sensitivity of 80% in their study of splenic injuries in the US. If the US would have been the only modality used in our patients, the 18 false-negative results in our study would have led to 6 cases of missed injuries requiring surgery (2 cases were conservatively managed). Significant hemoperitoneum was not however missed on US. The missed injuries were five splenic, three liver, two pancreatic, two renal injuries, four bowel, and mesenteric injuries, one diaphragmatic injury and bladder injury, and one retroperitoneal hematoma.

Conclusion

US is a valuable initial modality for the evaluation of patients with abdominal trauma. CT is required in most US positive patients to delineate the exact extent of the injury and to exclude any other significant injuries. Also, in a small but significant group, CT may change the management approach. Symptomatic patients should have a CT even if the US examination is negative. Inadequate US evaluation in the presence of gaseous distension or overlying surgical emphysema should be followed by CT. US or CT quantification of hemoperitoneum or grading of injury does not always dictate whether the management should be conservative or surgical. However, they reflect the severity of the injury, and injuries of severe grade with large free fluid are more likely to require a laparotomy.

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