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Original Research Article

Role of computed tomography imaging in the diagnosis of blunt and penetrating abdominal trauma injuries

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ABSTRACT

Background: The present study was conducted with the primary aim of evaluating the role of computed tomography imaging in the assessment of blunt abdominal trauma (BAT) and penetrating abdominal trauma injuries.
Methods: This prospective study comprised 53 patients with BAT and PAT injuries referred from the emergency department to the department of radio-diagnosis for ultrasonography and CT. Multidetector computed tomography scans were performed on GE Bright Speed Elite 16 slice CT Scanner. The various injuries seen on the CT images were grouped and examined based on the injury site and the organs involved.
Results: The majority of the study subjects, i.e., 17/53 (32.08%) belonged age group of 20-30 yrs. Out of the 53 study subjects, 48 had BAT and 5 had PAT. The majority of study subjects who had BAT, i.e., 26/48 RTA, was the cause of trauma, and 5 out of 5 who had PAT assault was the cause of trauma. The most common organ injured was the spleen (18), followed by the liver (17), bowel (15), Anterior abdominal wall (6), pancreas (1), Kidney (1), Uterus (2), Multiple organs (1) and Hemoperitoneum without solid organ injury (1). CT showed 100% accuracy in the diagnosis of abdominal organ injuries.
Conclusions: CT imaging plays a pivotal role in the rapid identification of life-threatening injuries and is helpful for prompt initiation of appropriate care, which leads to an increase in the chance of survival of patients with BAT and PAT injuries.

Keywords: BAT, PAT, Computed tomography, Injury

INTRODUCTION

Trauma or injury is described as bodily harm occurred due to the energy exchange with the environment that exceeds the body's capacity for resistance. It is one of the leading cause of mortality in individuals who are under the age of 45 years. In this era, trauma is considered an "Unsolved epidemic" with an estimated death toll that is reportedly equivalent to that of cancer and cardiovascular disease combined.[1] In the United States, trauma ranks fourth among all causes of death for people of all ages and is the leading mortality cause in both men and women under the age of 45 years. In the health care system, trauma also has a significant financial impact, resulting in almost a third of all visits to emergency care and more than $80 billion in annual direct medical care expenses.[2]

Trauma may result from assault, a road traffic accident, a fall from a height accidentally, a sports injury, or the

dropping of a heavy object. Seventy to eighty percent of abdominal blunt trauma is caused due to accidents in high-speed vehicles.[3] Blunt trauma can be caused by deceleration forces or compression (after a direct impact or against a fixed external object).[4] The 3rd most commonly injured organ, after the extremities and the brain, is the abdomen. The prevalence of intra-abdominal injuries is 7.7% to 65%.[5] More than 1,80,000 individuals died from trauma in 2007, and a significant portion of these deaths was caused by abdominal injuries.[2] Abdominal trauma is categorized into penetrating and blunt types. Clinical symptoms are commonly used to diagnose penetrating abdominal trauma (PAT). Whereas, blunt abdominal trauma (BAT) is usually ignored or delayed as a result of unclear clinical symptoms.[6] Therefore, it may prove problematic for individuals of all ages. It can be confusing to identify serious intra-abdominal pathology since it is challenging to identify different injuries during the first assessment and care.[3] Identification of injuries has been increased with CT scanning.

Trauma patient care is extremely challenging and needs diligence, efficiency and dedication. One of the most difficult as well as intensive aspects of acute trauma care continues to be evaluating patients who have suffered blunt abdominal trauma. Higher rates of morbidity as well as mortality are frequently caused by missed intra-abdominal injuries and concealed hemorrhages, especially in individuals who survived the initial phase of an injury. Findings of physical examination are sometimes unreliable due to various reasons such as an altered mental state, presence of distracting injuries, associated chest injuries, coexisting drug and alcohol intoxication in the patient.[7] With this scenario, in the current prospective study, we aimed to assess the role of computed tomography (CT) imaging in the diagnosis and assessment of BAT and PAT injuries with special emphasis on the importance of bowel and mesenteric injuries in BAT and PAT and to illustrate useful tips and tricks in identifying solid organ and vascular injuries on trauma CT.

METHODS

This is a prospective study conducted at the department of radiodiagnosis, Kakatiya Medical college/MGM, Warangal, with patients referred from the emergency department presented with assault, road traffic accidents, accidental fall from a height, sports injury or fall of a heavy object from the period of March 2019 to August 2020. Ethical clearance was obtained from the institutional ethics committee, Kakatiya Medical College/MGM hospital, Warangal, before the commencement of the study. Sample size was taken based on Convenience sampling technique. The study comprised 53 patients with abdominal trauma (Blunt/Penetrating) referred from the emergency department to the department of radio-diagnosis for ultrasonography (USG) and CT. Patients who fulfilled the selection criteria were informed about the nature and purpose of the study and were enrolled after obtaining written informed consent. Pregnant women and patients not willing to participate in the study were excluded from the study.

Imaging procedure

Multidetector computed tomography (MDCT) scans were performed on GE bright speed elite 16 slice CT Scanner. Axial section of 5 mm thickness was taken from the diaphragm to symphysis pubis. In all cases, plain CT was followed by an IV contrast scan. For contrast enhancement, 110 mL of 300 mg/mL non-ionic iodinated contrast was injected using a pressure injector at the rate of 3-4 ml/s. A 5-minute delayed scan was obtained to assess the urinary system in the excretory phase to exclude trauma to the calyces and ureters. Post-study retro reconstructions were done at 0.625 mm section thickness. The various injuries seen on the CT images were grouped and examined based on the injury site and the organs involved.

American association for the surgery of trauma (AAST) injury scoring scales

The most widely accepted and used system of classifying and categorizing traumatic injuries "American association for the surgery of trauma (AAST)" injury scoring scale, was used to classify and categorize traumatic injuries as below.

RESULTS

The majority of the study subjects, i.e., 17/53 (32.08%) belonged age group of 20-30 yrs. followed by 12/53 (22.64%), 9/53 (16.98%), 7/53 (13.21%) each belonged to age group of 30-40 yrs., 0-20 yrs., and 40-50 & 50-60 yrs. respectively. However, 1/53 (1.89%) of study subjects belonged to greater than 60 years of age. Out of the 53 study subjects, 48 had BAT and 5 had PAT. The majority of study subjects who had BAT, i.e., 26/48 RTA was the cause of trauma, followed by assault (11/48), fall from height (9/48), and others (2/48). 5 out of 5 who had PAT assault was the cause of trauma (Table 1).

A total of 52 and 12 visceral organs of males and females were injured, respectively. The liver and spleen (15/52) were the major organs injured in males, followed by bowel/mesentery (12/52). In females, bowel/mesentery and spleen (3/12) were the major organs injured, followed by the spleen, liver & uterus (2/12) (Table 2). The results of distribution based on solid organ injury are represented in (Table 3). Results depicted that a total of 14 organs injured were of Grade III, followed by Grade II (13), Grade IV (7), and Grade I (6).

Table 1: Distribution of study subjects based on age and cause of trauma.

Variables	N		%	
Age distribution (years)				
0-20	9		16.98	
20-30	17		32.08	
30-40	12		22.64	
40-50	7		13.21	
50-60	7		13.21	
>60	1		1.89	
Total	53		100.00	
Cause of trauma distribution				
Cause	**BAT**	**PAT**	**BAT**	**PAT**
Assault	11	5	20.75	9.43
Fall from height	9	-	16.98	-
RTA	26	-	49.06	-
Others	2	-	3.77	-
Total	48	5	90.57	9.43

Table 2: Distribution based on visceral organ injures.

Variables	Frequency	
	Female	**Males**
Liver	2	15
Spleen	3	15
Bowel/mesentery	3	12
Stomach	-	1
Kidney	1	2
Pancreas	1	-
Uterus	2	-
Anterior Ab. wall	-	6
Isolated hemoperitoneum	-	1
Total	12	52

Bowel/mesenteric injury

Out of 53 patients, 15 had bowel injuries (12 male and 3 female), 14 had BAT and 1 had PAT. Fourteen patients had pneumoperitoneum and bowel wall defects seen in 4 patients. Furthermore, bowel wall thickening was noticed in 13 patients, and irregular wall enhancement was noticed in 11 patients (Figure 1).

Hepatic injury

Out of 53 patients, 17 had a liver injury (15 Male and 2 female); 4 patients had Grade 1 injury, followed by 9 had Grade 2 injury, and 4 had Grade 3 injuries. Eight patients had isolated liver injury, 3 had associated abdominal visceral injury, and 6 had extra-abdominal injuries.

Splenic injury

Out of 53 patients, 18 had Splenic injury (15 were male and 3 were female). One patient had a Grade 1 injury, 2 had Grade 2 injury, 9 had Grade 3 injury, and 6 had Grade 4 injury. 2 patients had associated abdominal visceral injury and 6 had extra-abdominal injuries.

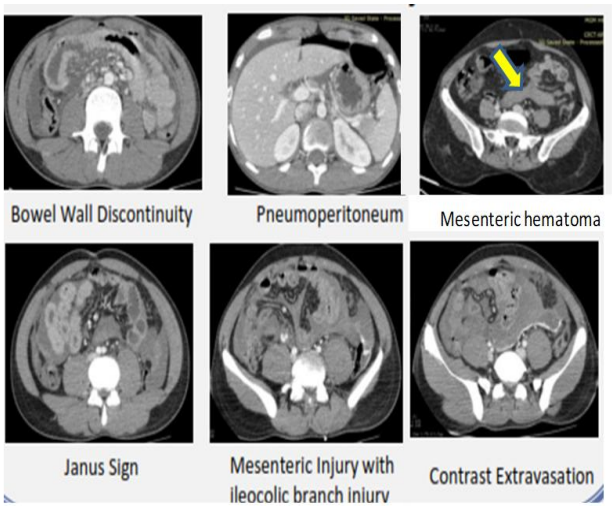

Figure 1: Various bowel and mesenteric injuries.

Pancreatic injury

Out of 53 patients, only one patient had pancreatic injury. An eight-year female child had Blunt abdominal trauma in an RTA, and she had isolated Grade 2 pancreatic injury.

Renal injury

Out of 53 patients, 3 had renal injuries (2 male and 1 female). 1 patient had Grade 1 injury, 1 had Grade 3 injury, and 1 had Grade 4 injury. One patient had isolated renal injury, and 2 had associated abdominal visceral injury.

Anterior abdominal wall injury

Out of 53 patients, 2 patients with assault history had anterior abdominal wall injury. One patient had Type 3 rectus sheath hematoma, and the other had type 1.

Table 3: Distribution based on grades of solid organ injury.

Variables	Frequency				
	Liver	**Spleen**	**Kidney**	**Pancrea**	**Total**
Grade I	4	1	1	0	6
Grade II	9	2	0	2	13
Grade	4	9	1	0	14
Grade	0	6	1	0	7
Grade V	0	0	0	0	0

Penetrating abdominal injury

Out of 53 patients, 5 patients had penetrating abdominal injuries. Three patients had isolated breach in the anterior abdominal wall. One patient had gastric serosa, and one had small bowel injuries (Figure 2).

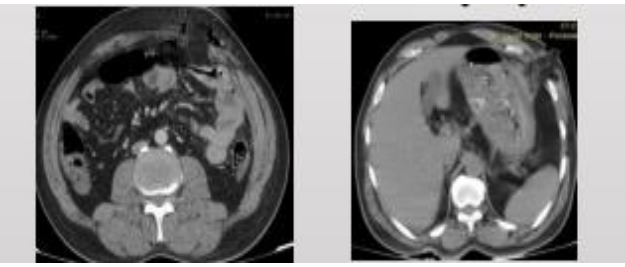

Figure 2: Penetrating abdominal injuries with gastric serosa injury.

Uterine injury

Out of 53 patients, 2 patients had uterine injuries. Both of them had blunt trauma over hypogastrium in RTA. one patient had associated bowel injury (Figure 3).

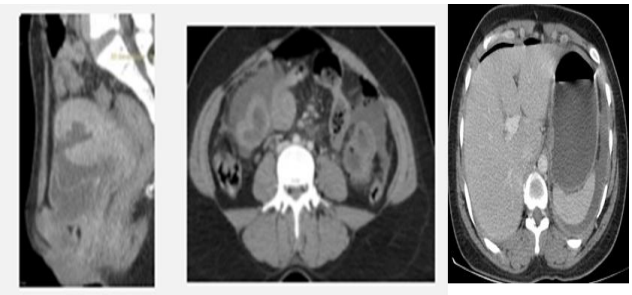

Figure 3: Uterine injury along with bowel injury.

DISCUSSION

Trauma in general, and BAT and PAT injuries in particular, result in significant morbidity, mortality, as well as financial consequences. The early evaluation and decision-making strategy for hemodynamically stable patients who experienced abdominal trauma now include the CT examination of the head, neck, chest, abdomen, and pelvis. For the detection of significant injuries, diagnostic peritoneal lavage has almost entirely been superseded by CT. The versatility of CT for the examination of polytrauma patients has increased over the last decade due to significant hardware and software advancements in the field, particularly the introduction and development of multidetector scanners. These advancements include higher spatial resolution, quicker image capture and reconstruction, and enhanced patient safety. Hence, in the present study, we aimed to assess the role of CT imaging in the diagnosis and assessment of BAT and PAT injuries with special emphasis on the importance of bowel and mesenteric injuries in BAT and PAT and to illustrate useful tips and tricks in identifying solid organ and vascular injuries on trauma CT. In our study majority of the study subjects, 32.08% belonged age group of 20-30 yrs. followed by 22.64%, 16.98%, 13.21% each belonged to age group of 30-40 yrs., 0-20 yrs., and 40-50 & 50-60 yrs. respectively. Out of 53 study subjects, 48 had BAT and 5 had PAT. The majority of study subjects who had BAT, i.e., 26/48 RTA was the cause of trauma followed by assault (11/48), fall from height (9/48), and others (2/48). 5 out of 5 who had PAT assault was the cause of trauma. These findings were comparable with the previous studies reported in the literature wherein authors reported that 21-40 years of age are believed to be the most active live spam.[9,10] To prevent disastrous outcomes, the victims of severe injuries need to receive prompt, advanced care. Injuries to the upper abdomen and lower rib cage that damages the liver, spleen, as well as pancreas cause deaths every day in various setups.[10] The combination of organs injured depends on the location as well as the severity of impact and the victim's position at the time of the injury.[11] These serious injuries pose a life-threatening risk to the patient's life and place a heavy burden on the surgical team. The early recognition as well as effective management of these injuries are of utmost importance for patient survival and preventing future complications.[12] In our study, 15 had bowel injury; 17 had liver injury (4 patients had Grade 1 injury followed by 9 had Grade 2 injury and 4 had Grade 3 injuries); 18 had Splenic injury (1 patient had Grade 1 injury, 2 had Grade 2 injury, 9 had Grade 3 injury and 6 had Grade 4 injury); only one patient had pancreatic injury; 3 had renal injuries (1 patient had Grade 1 injury, 1 had Grade 3 injury and 1 had Grade 4 injury); 2 patients with assault history had anterior abdominal wall injury (1 had Type 3 rectus sheath hematoma and other had type 1); 5 patients had penetrating abdominal injuries (3 patients had isolated breach in the anterior abdominal wall, 1 patient had gastric serosa injury and 1 had small bowel injury); 2 patients had the uterine injury. Literature reports evidence that CT imaging has been shown to be accurate for the diagnosis of bowel and mesenteric injuries and is the diagnostic test of choice in the evaluation of blunt abdominal trauma in hemodynamically stable patients. In concurrence to CT findings of our study, Brofman et al. reported specific CT findings of bowel and mesenteric injuries, including bowel wall defect, intraperitoneal and mesenteric air, intraperitoneal extraluminal contrast material, extravasation of contrast material from mesenteric vessels, and evidence of bowel infarct.[13] Moreover, Al-Salamah et al. demarcated that CT is the diagnostic procedure of choice, as neither Facial drooping, Arm weakness, Speech difficulties and Time (FAST) nor Diagnostic Peritoneal Lavage (DPL) adequately assesses the retroperitoneum.[14] Repeated CT scanning may be beneficial for liver lacerations that involve the hilum, especially those connected to partial gall bladder avulsion.[15-17] According to various researchers, intravenous contrast-enhanced CT includes heterogeneous enhancement or focal enlargement of the pancreatic parenchyma and fluid around the pancreas, especially posteriorly, where it may separate the pancreas from the splenic vein.[18,19] These findings are comparable with our study findings. MDCT and FAST are the preferred imaging modalities for diagnosing BAT and PAT injury patients. Intravenously contrast-enhanced CT, however, continues to be the most popular and effective method for accurately classifying patients into those who

may probably be treated without surgery and those who require it. The rising preference for a nonoperative based approach necessitates lesion identification in the early stage, which is made possible by the more sophisticated CT techniques. Additionally, CT is a useful factor for patient follow-up and detecting complications that weren't diagnosed initially.[20] Furthermore, according to literature reports, the accuracy of CT scans in patients who have stabilized blunt trauma is well known in terms of hemodynamics. Additionally, among emergency CT patients, a specificity of approximately 98.7% and a sensitivity of approximately 97% & 92% have been confirmed.[21,22] Moreover, according to Kane et al., CT was performed in 44 patients of blunt trauma succeeding DPL who were hemodynamically stabilized. The scan of 16 patients revealed an important retroperitoneal or intra-abdominal wound that DPL was unable to locate. Finally, with the help of scanning reports, the treatment plan for 58% of patients was modified.[23]

Limitations

This was a single centre-based study, limited by the small number of sample size. Thus, a multi-centre-based study is required to validate more accurately and considering CT as an efficient diagnostic tool in identifying BAT and PAT injuries.

CONCLUSION

CT imaging is a highly sensitive and accurate diagnostic modality for BAT and PAT injuries, and CT scans can reveal a wide variety of injuries. Hence, CT imaging plays a pivotal role in the rapid identification of life-threatening injuries and is helpful for prompt initiation of appropriate care, which leads to an increase in the chance of survival of patients with BAT and PAT injuries.

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Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Prasad GV, Sarvottam A, Singh R. Comparative study of ultrasound and computed tomography in the evaluation of abdominal trauma. J Evid Med Hlthcare. 2015;2:2151-65.
2. Soto JA, Anderson SW. Multidetector CT of blunt abdominal trauma. Radiology. 2012;265(3):678-93.
3. Brasel KJ, Olson CJ, Stafford RE, Johnson TJ. Incidence and significance of free fluid on abdominal computed tomographic scan in blunt trauma. J Trauma Acute Care Surg. 1998;44(5):889-92.
4. Dauterive AH, Flancbaum L, Cox EF. Blunt intestinal trauma. A modern-day review. Ann surg. 1985;201(2):198.
5. Leung E, Wong L, Taylor J. Nonoperative management for blunt splenic trauma in children: An updated literature review. Surg Prac. 2007;11:29-35.
6. Jansen JO, Yule SR, Loudon MA. Investigation of blunt abdominal trauma. BMJ. 2008;336(7650):938-42.
7. Gopalakrishnan V, Anandaraja S, Rengan V, Ravindra C. Comprehensive study of blunt injury abdomen in medical college, Chennai, India. Int Surg J. 2018;5(12):3909-12.
8. Rumack CM, Wilson SR, Charboneay JW. Diagnostic ultrasound. 3rd edn. Missouri: Mosby-Year Book Inc; 1992:1;137-9.
9. Mirvis SE, Whitley No, Gens DR. Blunt splenic trauma in adults: CT based classification and correlation with prognosis and treatment. Radiology. 1989;171:33-9.
10. Goldman LI, De Laurentis DA, Rosemond GP. Penetrating abdominal wounds in a civilian population. Am J Surg. 1962;104(1):46-51.
11. Holmes JF, Offerman SR, Chang CH, Randel BE, Hahn DD, Frankovsky MJ, Wisner DH. Performance of helical computed tomography without oral contrast for the detection of gastrointestinal injuries. Ann Emerg Med. 2004;43(1):120-8.
12. Jolley S, Upadhyay M, Jain RL. Blunt abdominal trauma. A clinical study of 100 cases. Ind J Sur. 1993:209-3.
13. Brofman N, Atri M, Hanson JM, Grinblat L, Chughtai T, Brenneman F. Evaluation of bowel and mesenteric blunt trauma with multidetector CT. Radiographics. 2006;26(4):1119-31.
14. Al-Salamah SM, Mirza SM, Ahmad SN. Role of ultrasonography, computed tomography and diagnostic peritoneal lavage in abdominal blunt trauma. Saudi Med J. 2002;23:1350-5.
15. Gupta A, Stuhlfaut JW, Fleming KW, Lucey BC, Soto JA. Blunt trauma of the pancreas and biliary tract: a multimodality imaging approach to diagnosis. Radiographics. 2004;24(5):1381-95.
16. Benedict MD, Rafal R. Finding of CT and MR evaluation of gallbladder hemobilia. Emerg Radiol. 2003;10(1):46-8.
17. Kohler R, Millin R, Bonner B, Louw A. Laparoscopic treatment of an isolated gallbladder rupture following blunt abdominal trauma in a schoolboy rugby player. Br J Sports Med. 2002; 36(5):378-9.
18. Jayaraman MV, Mayo-Smith WW, Movson JS, Dupuy DE, Wallach MT. CT of the duodenum: an overlooked segment gets its due. Radiographics. 2001;21(1): S147-60.
19. Becker CD, Mentha G, Schmidlin F, Terrier F. Blunt abdominal trauma in adults: role of CT in the diagnosis and management of visceral injuries Part 2: Gastrointestinal tract and retroperitoneal organs. Eur Radiol. 1998;8(5):772-80.
20. Stanescu AL, Gross JA, Bittle M, Mann FA. Imaging of blunt abdominal trauma. Seminn Roentgenol. 2006;41(3):196-208.

21. Peitzman AB, Makaroun MS, Slasky BS, Ritter PA. Prospective study of computed tomography in initial management of blunt abdominal trauma. J Trauma. 1986;26(7):585-92.
22. Webster VJ. Abdominal trauma: pre-operative assessment and postoperative problems in intensive care. Anaesth Intens Care. 1985;13(3):258-62.
23. Kane NM, Dorfman GS, Cronan JJ. Efficacy of CT following peritoneal lavage in abdominal trauma. J Comput Assist Tomog. 1987;11(6):998-1002.

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