Original Article

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Radiology Section

Role of MDCT in the Evaluation of Blunt Abdominal Trauma in Himalayan Region of Northern India

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ABSTRACT

Introduction: Blunt abdominal trauma is a major cause of morbidity and mortality in young people. Abdominal Ultrasonography (USG) can detect organ injury and free intra-abdominal fluid which provides indirect evidence of injury. Multidetector Computed Tomography (MDCT) is the modality of choice in haemodynamically stable patients as it can accurately diagnose and ascertain the severity of injuries. It can also evaluate retroperitoneum and detect arterial contrast extravasation or pseudoaneurysm which predicts the need for surgery or angioembolisation.

Aim: To study the spectrum of abdomino-pelvic injuries on MDCT and to compare the MDCT findings with operative findings wherever possible.

Materials and Methods: The prospective cohort study was conducted in the Department of Radiodiagnosis at Indira Gandhi Medical College, Shimla, Himachal Pradesh, India, from the period 1st June 2019 to 31st May 2020. Patients with history of Road Traffic Accidents, fall, or assault or other causes where clinically blunt trauma of abdomen was suspected and referred for MDCT abdomen and pelvis were included. The blunt abdominal patients who were Focused Assessment with Sonography for Trauma (FAST) positive or had clinical suspicion of abdomino-pelvic injury were evaluated with MDCT. The present study was conducted on 64 slice MDCT scanner light speed Volume Computed Tomography Xte General Electrics (VCT Xte GE) medical systems. All patients underwent CECT abdomen and pelvis in arterial (30 seconds) and porto-venous phase (60 seconds). The MDCT findings were compared with operative findings and clinical follow-up was done after three months. Data were entered into Microsoft Excel sheet and Statistical Package for the Social Sciences (SPSS) software 20.0 version was used for analysing data.

Results: Thirty five haemodynamically stable patients with blunt abdominal trauma were included in the study with mean age of 28.5±8.8 years with male predominance. Road traffic accident was the most common mechanism of injury. Visceral injury or free fluid was seen in all the 35 patients on MDCT of abdomen and pelvis. Twenty eight patients were managed conservatively while seven patients were operated. Solid organ injury was seen in 28 patients. Amongst solid organ injury, spleen was the most common organ injured followed by liver. On comparing MDCT and operative findings, pancreatic transection was found in three patients. Sigmoid perforation, renal injury and UB perforation were confirmed in one patient each. On comparing with surgical findings, MDCT had a sensitivity of 100%, specificity of 100% for detecting solid organ injury and the Positive Predictive Value (PPV) and Negative Predictive Value (NPV) were 100% and 100%, respectively. Amongst hollow visceral injury, jejunal perforation was seen in two patients while ileal perforation and Urinary Bladder (UB) perforation was seen in one patient each. However, one case of sigmoid perforation was missed on MDCT. On comparing with surgical findings, MDCT has a sensitivity of 66.66%, specificity of 100% for detecting hollow visceral injury and the PPV and NPV were 100% and 80%, respectively.

Conclusion: The MDCT is helpful in detecting solid organ injuries. The MDCT plays a major role in the management of blunt abdominal trauma and helps in making decision regarding operative and non operative treatment. Therefore, MDCT is the investigation of choice in patients with blunt abdominal trauma.

Keywords: American association for the surgery of trauma, Haemoperitoneum, Multidetector computed tomography, Ultrasonography

INTRODUCTION

Blunt abdominal trauma is a main reason for morbidity and mortality particularly in the age group of 11-40 years. Males are affected more than females. Road traffic accidents are the major mode of injury however, a comparatively higher incidence of blunt abdominal trauma due to fall is seen in a hilly state like Himachal Pradesh, India [1]. Diagnostic peritoneal lavage has the sensitivity of 95% and specificity of 99% for detecting haemoperitoneum. Being an invasive procedure, diagnostic peritoneal lavage carries a 0.6% risk of visceral injury [2]. The need for microscopic analysis can delay further management and the biggest drawback of diagnostic peritoneal lavage is the high non therapeutic laparotomy rate of upto 36% [3]. Abdominal USG is used for detecting organ injury and free intra-abdominal fluid, which in trauma is assumed to be blood or gastrointestinal contents, and provides indirect evidence of injury. USG is commonly used in emergency because it is portable, non invasive and can be used during resuscitation. The sensitivity and specificity of abdominal USG is 79% and 95.6%, respectively [4]. The sensitivity of USG is unexpectedly low for detecting both free fluid and organ injury [5].

Computed Tomography (CT) is the imaging modality of choice for evaluating haemodynamically stable patients. It is found to be accurate in 98.3% of cases. It often provides the detailed study of traumatic pathology and has high specificity and is used for guiding non operative management of solid organ injuries. It can also quantify the amount of bleed in abdomen. Besides this, CT scan can also be helpful in finding other injuries which involve spine, pelvic fractures and thoracic cavity. CT scan of abdomen and retro peritoneum is the diagnostic test of choice to investigate the duodenum, pancreas and genitourinary system. It can diagnose urinary extravasation and detects the site of leak i.e. from UB, ureter or pelvicalyceal system [6]. It is however less sensitive for detecting hollow visceral injuries. Other limitations of CT include exposure to ionising radiations, allergic reactions to intravenous contrast media and in most hospitals the patient has to be moved away from the resuscitation area. Most of the studies done previously for

evaluation of blunt abdominal trauma with MDCT were performed in plain areas [7-9], present study is one of the few studies performed in the hilly region of Himalayas.

The purpose of present study was to evaluate the spectrum of abdomino-pelvic injuries, characterisation of the injuries on MDCT and comparison of MDCT findings with operative findings wherever possible.

MATERIALS AND METHODS

The prospective cohort study was conducted in the Department of Radiodiagnosis at Indira Gandhi Medical College, Shimla, Himachal Pradesh, India, from the period 1st June 2019 to 31st May 2020. Thirty five patients sustaining blunt abdominal trauma were included in the study. Proper ethical approval from the Institutional Committee was taken for the study and written informed consent was taken from the patients before the examination.

Inclusion criteria: FAST positive patients and patients with clinical suspicion of abdomino-pelvic injuries were included.

Exclusion criteria: Hemodynamically unstable patient, patients with previous history of serious allergic reactions or contrast allergy and pregnant women were excluded.

The present study was conducted on 64 slice MDCT scanner Light speed VCT XTe GE medical systems with protocol as follows: 120 kVp, mAs modulation with range of 60-450 mAs, slice thickness 5 mm, interval 5 mm, reconstruction interval 0.625 mm and pitch of 1.375:1. Patients received 1.5 mL/kg of non ionic contrast (300 mg iodine/mL) at the rate of 2.5 mL/second (for abdominal angiography -4 mL/second), followed by 20 mL of saline flush at the rate of 2.5 mL/second. Arterial phase CT was done at 30 seconds and PV phase at 60 seconds from the time of beginning of contrast injection. Delayed phase was done in patients suspected of renal, ureteric or bladder trauma. The various parameters studied were percentages, frequencies and proportions for various organ injuries. Grades of organ injury were according to American Association for the Surgery of Trauma (AAST) organ injury scale [8].

STATISTICAL ANALYSIS

Data were entered into Microsoft Excel sheet and SPSS software 20.0 version was used for analysing data. The qualitative variables were presented as, percentages, frequencies and proportions. Graphs were drawn using Microsoft Office 2010 Excel sheet and minitab 17.0 version.

RESULTS

The USG was done in all 35 patients of blunt abdominal trauma. Haemoperitoneum was detected in 34 patients. Sensitivity and specificity of USG for detecting free fluid in abdomen with CT scan as gold standard was 97.14% and 100%, respectively. Majority of the patients were in the age group of 21-30 years accounting for 42.86% (15/35) of cases followed by 31-40 years. The mean age in the study was 28.5±8.8 years [Table/Fig-1]. The male to female ratio was around 4.8:1 [Table/Fig-1]. The most common mode of injury was road traffic accidents accounting for approximately 57.14% (20/35) of cases [Table/Fig-2]. Spleen (14/35) 40% was the most common solid organ involved followed by liver 34.29% (12/35). According to AAST organ injury scale 2018 [8], grade III was the most common injury in spleen, liver and pancreas in present study which was seen in 14.29% (5/35), 17.14% (6/35) and 8.57% (3/35) of cases respectively [Table/Fig-3].

Hollow visceral injury was seen in 11.43% (4/35) of cases including bowel injury in 8.57% (3/35) and UB injury was seen in 2.86% (1/35) cases of the cases. Multiple organ injuries were seen in 37.15% (13/35) of the patients. Presence of free fluid was found in every patient who had abdominal injury on MDCT. Pneumoperitoneum was found in only 8.57% (3/35) of patients. The associated findings with blunt abdominal injury seen in present study included the lung parenchymal injury 17.14% (6/35), pneumothorax 11.43% (4/35), pleural effusion 34.29% (12/35) and fractures of ribs 31.42% (11/35), spine 34.29% (12/35) and other bones 17.14% (6/35). It was observed that 80% (28/35) patients were managed conservatively and 20% (7/35) patients underwent exploratory laparotomy. The CT findings were consistent with operative findings in six out of seven patients (85.71%). One patient of sigmoid perforation was missed on MDCT [Table/Fig-4]. On comparing with surgical findings, MDCT has a sensitivity of 100%, specificity of 100% for detecting solid organ injury and the PPV and NPV were 100% and 100%, respectively. Amongst hollow visceral injury, jejunal perforation was seen in two patients while ileal perforation and UB perforation were seen in one patient each. However, one case of sigmoid perforation was missed on MDCT. On comparing with surgical findings, MDCT

Age group (years)	Male n (%)	Female n (%)	Total N (%)
<10	1 (2.86%)	-	1 (2.86%)
11-20	5 (14.29%)	1 (2.86%)	6 (17.14%)
21-30	13 (37.15%)	2 (5.71%)	15 (42.86%)
31-40	7 (20%)	2 (5.71%)	9 (25.71%)
41-50	3 (8.57%)	1 (2.86%)	4 (11.43%)
Total	29 (82.86%)	6 (17.14%)	35 (100%)

[Table/Fig-1]: Age and sex distribution.

Mode of injury	Frequency	Percentage
Road traffic accidents with vehicle rolling off the road	8	22.86%
Road traffic accidents with collision of vehicle	12	34.28%
Fall from height	14	40%
Others	1	2.86%
Total	35	100%

[Table/Fig-2]: Mode of injury.

Organ injury	Liver	Spleen	Kidney	Pancreas
Grade I	1 (2.86%)	2 (5.71%)	-	1 (2.85%)
Grade II	5 (14.29%)	4 (11.43%)	1 (2.86%)	-
Grade III	6 (17.14%)	5 (14.29%)	2 (5.71%)	3 (8.57%)
Grade IV	-	3 (8.57%)	1 (2.86%)	-
Grade V	-	-	1 (2.86%)	-
Total	12 (34.29%)	14 (40%)	5 (14.29%)	4 (11.42%)

[Table/Fig-3]: Incidence of grades of organ injury according to AAST organ injury scale [8].

No.	CT findings	Surgical findings	Concordance
Case 1	Collection in left paracolic gutter	Sigmoid perforation	Discordant
Case 2	Peripancreatic haematoma complete transection of pancreas	Peripancreatic haematoma complete transection of pancreas	Concordant
Case 3	Superior rent over right posterolateral aspect of UB with active contrast extravasation	Superior rent over right posterolateral aspect of UB	Concordant
Case 4	Peripancreatic haematoma complete transection of pancreas	Peripancreatic haematoma complete transection of pancreas	Concordant
Case 5	Peripancreatic haematoma complete transection of pancreas	Peripancreatic haematoma complete transection of pancreas	Concordant
Case 6	Jejunal wall thickening with suspicious rent and extraluminal air foci suggestive of bowel perforation	Jejunal perforation	Concordant
Case 7	Completely shattered right kidney	Completely shattered right kidney	Concordant

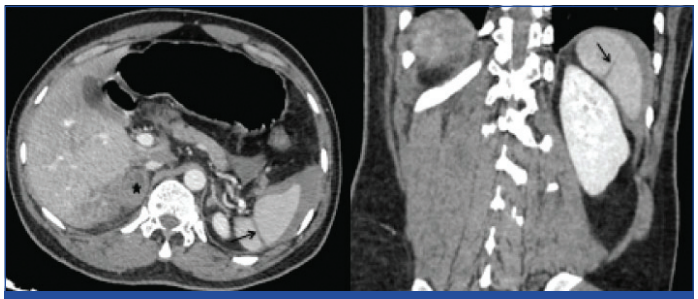
[Table/Fig-4]: Concordance between CT and surgical findings in operated cases.
UB: Urinary bladder

has a sensitivity of 66.66%, specificity of 100% for detecting hollow visceral injury and the PPV and NPV were 100% and 80% respectively, [Table/Fig-5].

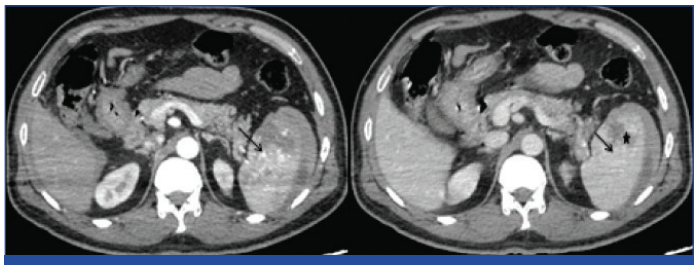
Parameters	Percentage (for solid organ)	Percentage (for hollow visceral organ)
Sensitivity	100%	66.66%
Specificity	100%	100%
PPV	100%	100%
NPV	100%	80%

[Table/Fig-5]: Various parameters of MDCT for detecting solid and hollow visceral organ injury (with Operative findings being gold standard).

In present study, out of 35 patients, 28 patients were managed conservatively and none of these patients died. The patients who were managed conservatively were haemodynamically stable and also the grade of injury was confirmed on MDCT making the surgeons more confident in continuing conservative management. Seven patients were operated out of which, two patients expired accounting for overall mortality rate of 5.71%. One patient with grade III pancreatic injury was correctly diagnosed on MDCT but however, died due to postoperative complications. Another patient of sigmoid perforation, who was reported as paracolic collection without bowel injury on CT died as there was delay in surgical intervention. MDCT images of grade III, IV and V is shown in [Table/Fig-6-10].

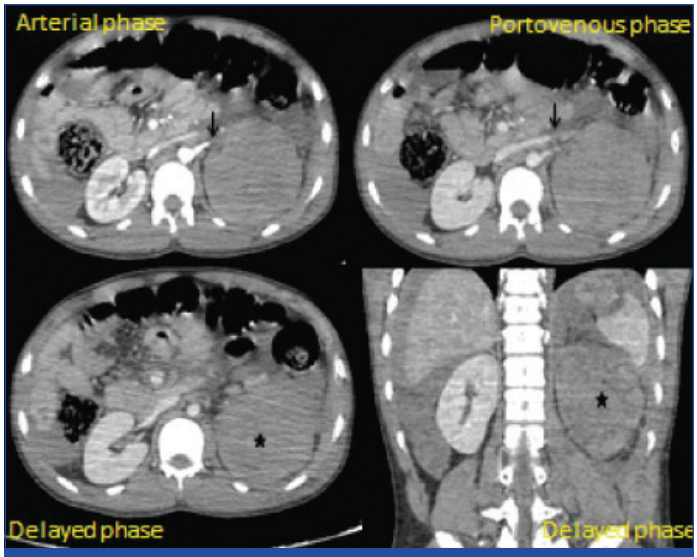


[Table/Fig-6]: Axial and coronal CT images in porto-venous phase showing linear hypodensity in spleen measuring 6cm s/o laceration (arrow) (AAST grade III) with presence of perisplenic high density free fluid s/o haemoperitomeum. There was also ill defined hypodensity in right suprarenal region s/o adrenal hematoma (star). Patient was managed conservatively.

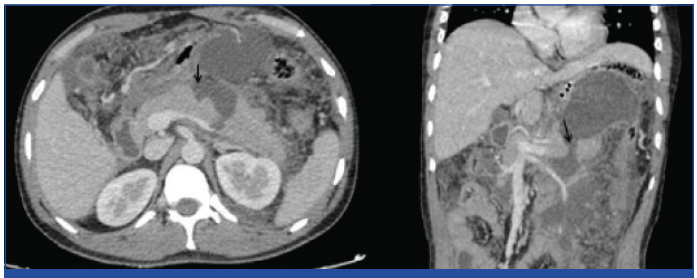


[Table/Fig-7]: Axial CT images in arterial and porto-venous phase showing multiple foci of hyperdensity in spleen in arterial phase showing wash out in porto-venous phase s/o pseudoaneurysm (arrow). There was also presence of ill defined hypodensity in spleen measuring 3.2×1.8 cm-contusion (star) (AAST grade IV) with presence of haemoperitomeum. Patient was managed conservatively.

[Table/Fig-8]: Axial and coronal CT images in porto-venous phase showing linear hypodensity(arrow) in liver measuring 4 cm following blunt abdominal trauma s/o laceration (AAST grade III) with presence of high density free fluid in abdomen s/o haemoperitomeum. Patient was managed conservatively.



[Table/Fig-9]: Axial and coronal CT images in arterial, porto-venous phase and delayed phases showing non opacification of left renal artery and renal vein (arrows) few centimeters after its origin along with large and completely devascularised left kidney(star). (AAST grade V). There was high density free fluid in abdomen s/o haemoperitomeum. The patient underwent left nephrectomy.



[Table/Fig-10]: Axial and coronal CT images in porto-venous phase showing hypodensity (arrow) in the region of body of pancreas s/o complete pancreatic laceration (AAST grade III) with presence of well defined high density collection in relation to body of pancreas s/o haematoma. There was also presence of high density free fluid in abdomen s/o haemoperitomeum. Patient was operated.

DISCUSSION

Fast USG and correlation with CT findings: Authors performed USG in all 35 patients of blunt abdominal trauma. Haemoperitoneum was detected in 34 patients. While in one patient, USG was inconclusive as this patient had subcutaneous emphysema. The limiting factors for USG are the presence of ileus, subcutaneous emphysema and poor echo window due to obesity. In present study, the sensitivity and specificity of USG for detecting free fluid in abdomen with CT scan as gold standard was 97.14% and 100%, respectively which is similar to the study done by John PK et al., [10]. In present study, USG was found to have a very good sensitivity and specificity for detecting free fluid in the abdomen and pelvis in the patients of blunt abdominal trauma but USG was not able to detect the site of injury. CT has become an integral part in the evaluation of patients with blunt abdominal trauma and is accurate in defining solid and hollow visceral injuries as well as associated haemoperitoneum.

In present study, maximum number of patients were in the age group of 21-30 years which comprised of 42.86% of the total patients followed by age group of 31-40 years (25.71%) similar to the previous study [10,11]. This was probably due to the fact that this is the most active age group and is also involved in travelling and rash vehicle driving. Majority of patients in present study were males 82.86% (29/35). Male:Female ratio in present study was 4.8:1 similar to past studies [9-14]. This was due to the fact that in Asia, specifically in Southeast Asia, males are more involved in outdoor activities so they are at increased risk to accidental trauma.

Distribution of positive intra-abdominal injuries: Haemoperitoneum was the most common finding in present study which was present in all 35 patients on MDCT. The CT was 100%

sensitive in detecting haemoperitoneum which was similar to the study done by Vadodariya KD et al., [15]. Most cases of splenic, hepatic, renal and pancreatic injuries were severe and were of grade III because relatively higher number of patients were injured due to road traffic accidents and fall from height which had led to more severe injuries.

Splenic injury: Spleen was the most common organ injured in present study which was consistent with other studies [12,14,16]. Most cases of splenic injuries were of grade III 14.29% (5/35) followed by grade II 11.43% (4/35) which was similar to the study conducted by John PK et al., [10]. In a study conducted by El Wakeel AM et al., grade II was the most common grade [9]. Grade IV injury accounted for 8.57% (3/35) of cases. These patients showed multiple foci of hyperdensity in spleen in arterial phase which showed wash out in porto-venous phase suggestive of (s/o) pseudoaneurysm [Table/Fig-6,7].

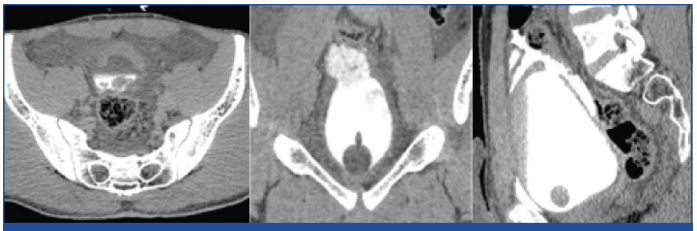
Liver injury: Liver was the second most common organ injured (34.29%) in present study and was comparable to other studies [12,16]. Most cases of liver injuries were of grade III, 17.14% (6/35) followed by grade II, 14.29% (5/35) similar to the study conducted by John PK et al., [10]. In a study conducted by El Wakeel AM et al., grade II was the most common grade [9]. All patients with liver injury in present study were managed conservatively. However, few studies have found liver to be the most commonly injured solid organ [10,11,17]. Liver and spleen were the two most commonly injured organs in most of the studies. The reason for the variability in most common organ injured is likely due to the difference in the proportion of various modes of injuries in various studies [Table/Fig-8].

Renal injury: Renal injuries were seen in 14.29% (5/35) cases which was comparable to past studies [9,11,12,17]. However, John PK et al., found slightly higher incidence of renal injuries (28%) in their study done on 39 patients [10]. In present study, grade III renal injury was most common which was similar to study done by John PK et al., [10]. Only one patient 2.86% (1/35) had grade V, 2.86% (1/35) injury. El Wakeel AM et al., found grade I and II to be the most common grade of injury for kidney [9]. This patient showed non opacification of left renal artery and renal vein in the arterial and porto-venous phase respectively along with large and completely devascularised left kidney. The patient underwent nephrectomy. The rest of the patients were managed conservatively [Table/Fig-9].

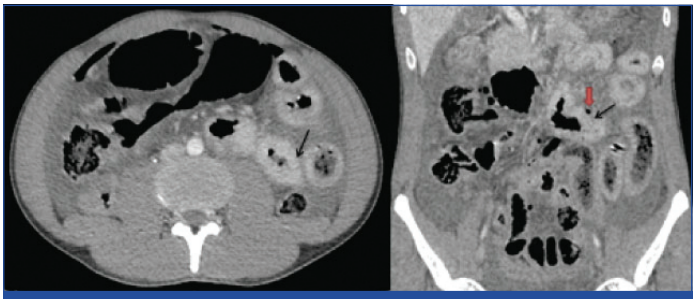
Pancreatic injury: Which was slightly higher when compared to other studies [9-12,17,18]. The maximum number of pancreatic injury patients was of grade III , 8.57% (3/35) followed by grade I, 2.86% (1/35) which was similar to study conducted by John PK et al., [10]. The reason for relatively higher percentage of pancreatic injury in present study could be attributed to small sample size. Pancreatic injuries were mostly managed surgically as maximum patients had grade III injuries [Table/Fig-10].

Urinary bladder injury: In present study, 1/35 (2.86%) case of intraperitoneal urinary bladder rupture was seen in the dome/superior aspect of UB because this region is the weakest portion of UB. This was consistent with other studies [11,12,18]. The patient was managed surgically. The CT findings were confirmed on surgery [Table/Fig-11].

Bowel and mesenteric injury: In present study, 8.57% (3/35) patients were reported to have bowel injury on MDCT as also found in other studies [11,12,17]. Two of these patients were managed conservatively. One patient was correctly diagnosed as jejunal perforation on MDCT which was confirmed on surgery. One patient with sigmoid bowel injury was missed on MDCT in present study. In this case, a well-defined collection was seen in the left paracolic gutter. The bowel injury was missed because oral contrast was not used [Table/Fig-12].



[Table/Fig-11]: Axial, coronal and sagittal CT images of a patient presenting with blunt abdominal trauma in delayed phase showing rent in right postero-superior aspect of urinary bladder with contrast extravasation into peritoneal cavity s/o intraperitoneal rupture. There was presence of high density free fluid in abdomen and pelvis s/o haemoperitomeum. The patient was operated.



[Table/Fig-12]: Axial and coronal CT images in porto-venous phase showing jejunal wall thickening (black arrow) measuring upto 12 mm with suspicious rent and extraluminal air foci (red arrow) suggestive of bowel perforation. There was also presence of free fluid in abdomen and pelvis. The patient was managed conservatively.

The CT failed to localise the site of bowel injury because pneumoperitoneum was not seen in this case of bowel perforation and CT signs of bowel injury were not specific. On comparing with surgical findings, MDCT has a sensitivity of 100%, specificity of 100% for detecting solid organ injury and the PPV and NPV were 100% and 100% respectively while MDCT has a sensitivity of 66.66%, specificity of 100% for detecting hollow visceral injury and the PPV and NPV were 100% and 80%, respectively. These findings were consistent with the study done by John PK et al., [10]. The other reason for false negative CT scan for bowel injury in present study can be attributed to the non usage of oral contrast. So, proper clinical judgement has to be used and CT scan may be repeated if clinical symptoms persist in the patients with normal CT scan findings.

Limitation(s)

Small sample size and non usage of oral contrast for the suspected bowel injury were the limitations of our study.

CONCLUSION(S)

The MDCT is the gold standard for detecting solid organ injuries. The MDCT can determine the source of haemorrhage unlike Diagnostic Peritoneal Lavage (DPL) or FAST. The MDCT plays a major role in the management of blunt abdominal trauma and helps in making decision regarding operative and non operative treatment and thus avoiding unnecessary surgery in these patients. Due to its high specificity, it can be used as a reliable investigation for blunt abdominal trauma and can also be useful in final treatment planning.

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- iThenticate Software: Oct 21, 2021 (9%)

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