Original Research Article

Role of M.D.C.T in Blunt Trauma Abdomen

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Abstract

The challenge in the imaging of abdominal trauma is to accurately identify injuries that require early exploration and at the same time avoid unnecessary operative intervention in cases that can be managed conservatively. To ascertain degree of trauma, a rapid, cost effective, safe and reproducible investigation used is ultrasonography. However limited information by USG limits its role in trauma. The advent of Multi Detector Computed Tomography (MDCT) is a major advancement in evaluation of patients of abdominal trauma by offering decreased scanning time, increased resolution owing to thinner collimation and reduced partial volume and motion artefacts. The aim of the present study was to assess role of Multi detector computed tomography (M.D.C.T) in evaluation of patients of blunt abdominal trauma and to assess the utility of multi planar reformations (MPR), maximum intensity projections (MIP) and 3-D reconstruction in patients of blunt trauma abdomen. At the outset of the study, a detailed history was taken, general physical examination and relevant local examination findings were recorded. Relevant laboratory examination findings were recorded. The most common mode of injury was road traffic accident (RTA) accounting for approximately 69.5% (32/46) of cases Pattern of the injuries showed that the liver was the most commonly injured organ accounting for 34.78% (16/46) of injuries The management plan of the patients prior and after MDCT examination which was guided by demographic profile like age, clinical status of the patients; time elapsed since injury and initial sonographic findings if done was studied. The use of multi detector CT in initial triage of clinically stable patients with blunt abdominal trauma results in reduction in number of unnecessary laparotomies by 91% and helps guiding initial management in emergency department in virtually every patient with high success rate of around 95%. The MDCT grade of solid organ injury does not correlate with management plan in patients with blunt abdominal trauma. The high resolution MPR, MIP, 3-D volume rendered images not only helped in displaying complex injuries but also increased diagnostic capabilities, accuracy and shortened the reporting time. The high

resolution MIP and 3-D volume rendered images gave quick and prompt diagnosis of associated vascular and bony injury.

Key words

Trauma, Abdomen, Computed Tomography, Blunt Trauma.

Introduction

Trauma or injury has been defined as damage to the body caused by exchange with environmental energy that is beyond the body's resilence [1]. It is the leading cause of death in persons under 45 years of age, with 10% of these fatalities attributable to abdominal injury. Indian statistics reveal a disproportionate involvement of younger age groups (15-25 years). The Indian fatality rates for trauma are 20 times that for developed countries [2]. About 30% of such deaths are thought to be preventable. Swift recognition of injury with prompt and appropriate treatment to reduce morbidity and mortality is the goal of modern trauma care and hence accurate diagnosis is essential.

Road traffic accidents (RTA) are the commonest cause of substantial blunt abdominal trauma (BAT) accounting for about 60% of all the cases. In patients of head or spinal trauma, intoxication or severe extra-abdominal trauma, clinical examination is unremarkable and non-invasive assessment of presence and extent of intra-abdominal injuries in these situations remains a challenge for clinicians. Patients with abdominal trauma present a frequent diagnostic dilemma because of low accuracy of physical examination and clinical diagnosis. Many of these patients have multisystem injuries resulting from high velocity mechanisms. Although abdominal injuries are often suspected in this setting, clinical diagnosis can be challenging due to lack of specific physical findings in many patients.

The challenge in the imaging of abdominal trauma is to accurately identify injuries that require early exploration and at the same time avoid unnecessary operative intervention in cases that can be managed conservatively. Laboratory tests are non-specific, plain X-ray abdomen are usually not helpful in early post injury period. For all these reasons, several diagnostic modalities have evolved till date and still they are evolving. The modalities in practice are, Abdominal Paracentesis, DPL (Diagnostic Peritoneal Lavage), X- Ray Abdomen, Ultrasound of Abdomen, Computed Tomography (CT) Scan of abdomen, Magnetic Resonance Imaging (M.R.I) of abdomen, Laparoscopic exploration of abdomen, magnetic resonance imaging (MRI) are not commonly being employed in a patient with abdominal trauma. However excess cost, limited access to the patient for monitoring and resuscitation and prolonged imaging time pose a major disadvantage to these. To ascertain degree of trauma, a rapid, cost effective, safe and reproducible investigation used is ultrasonography. FAST (focussed assessment for the sonographic examination of trauma patients) is needed in most cases nowadays to quantify the degree of abdominal trauma [3-4]. The inability of ultrasonography to detect many parenchymal injuries and assess the retroperitonium, further limits its value [5, 6].

Over the last decade, Computed Tomography (CT) has gained widespread clinical acceptance in evaluation of haemodynamically stable patients with blunt abdominal trauma. CT not only allows comprehensive evaluation of presence and extent of injuries to solid organ, retroperitonium, bowel, mesentery and associated haemorrhage but also allows surgeons to reach vital decisions regarding the need of surgery routine use of CT has substantially reduced the number of additional radiographic studies as well as the need of Diagnostic peritoneal lavage [7]. The advent of Multi Detector Computed Tomography (MDCT) is a major advancement in evaluation of patients of

abdominal trauma by offering decreased scanning time, increased resolution owing to thinner collimation and reduced partial volume and motion artefacts.

Multi Detector Computed Tomography (MDCT) has clearly become imaging modality of choice to evaluate hemodynamically stable patients who have blunt trauma. Hence this study will be an attempt to assess role of Multi Detector Computed Tomography (MDCT) in evaluation of blunt abdominal trauma, its correlation with surgical findings in operated cases of trauma wherever needed and clinical outcome in conservatively managed patients. MDCT has major role on number of patients with solid organ injury and nonoperative management [8]. The combination of native and reconstructed images provides more detailed, clinically relevant information about vascular lesions than is obtained with conventional angiography, thereby obviating need for diagnostic angiography [9, 10]. Chest injuries are the most common associated extra abdominal injuries (26%) in blunt abdomen trauma patients [11].

The aim of the present study was to assess role of Multi detector computed tomography (M.D.C.T) in evaluation of patients of blunt abdominal trauma and to assess the utility of multi planar reformations (MPR), maximum intensity projections (MIP) and 3-D reconstruction in patients of blunt trauma abdomen.

Materials and methods

The present study was a prospective study which was conducted in the Department of Radiodiagnosis at GMC Srinagar from January 2016 to January 2018. A total of 46 patients of blunt abdominal trauma presenting to casualty were included.

Inclusion criteria set were that, patients with clinically suspected abdominal trauma with uncertain abdominal signs reporting to casualty of department of Surgery GMC Srinagar/ S.M.H.S Hospital. Patients aged 10 years or above who were hemodynamically stable were included in the study. Hemodynamically unstable patients who later become stable following fluid/blood replacement and other resuscitative measures were also taken up. However the exclusion criteria included the, patients who were hemodynamically unstable and were directly taken up for surgery. Agitated patients not improving by oxygen administration, patients with penetrating trauma, cases where the intra venous contrast was contraindicated.

At the outset of the study a detailed history was taken, general physical examination and relevant local examination findings were recorded. Relevant laboratory examination findings were recorded. After taking informed consent, contrast enhanced CT scan of the abdomen was performed. The dose of non-ionic iodinated contrast was tailored according to the age/ weight/ build and clinical condition of the patient. Foley's catheter was routinely clamped prior to scanning to optimize bladder filling. Examination of patients was done using 16-Slice Somaton Emotion Scanner of Seimens. After removing all extraneous artefacts from the scanning field exposure factors were selected in accordance with the build of the patient. Non contrast CT scanning was performed extending from the level of diaphragm caudally till ischial tuberosities using 10 mm thick sections and reconstruction at 1.25 mm interval. Non-ionic, iodinated contrast was administered intravenously manually and using automatic dual pressure injector as a bolus at rate of 2-3 ml/sec and 3-4 ml/sec in cases of Angiography. CT scanning was performed in the venous phase after the start of intravenous contrast bolus injection. Contrast enhanced CT scanning was performed extending from the level of the diaphragm caudally to the level of ischial tuberosities using 10 mm thick slices with reconstructions at 1.25 mm interval. Delayed CT scanning was carried out 3-5min after intravenous contrast administration in every case especially case of suspected renal or urinary tract injuries. CT cystography were performed if indicated. Multi planar reformation (MPR),

maximum intensity projection (MIP), three dimensional reconstructions was done in every case. The free fluid detected was quantified according to the Federle and Jeffery system (1994) [12].

The solid organ injuries detected were graded according to the CT grading systems, the plan of surgical management of patients before CT scan of abdomen was compared with that after CT scan based on CT scan findings. The CT findings were correlated with surgical findings in operated cases and with clinical outcome in conservatively managed cases. Clinical follow up of all cases was performed till patient was discharged from the hospital. Follow up CT scans were performed, as and when required, depending upon the clinical course of the patient.

Data which was collected was entered in Microsoft excel sheet (Master chart). All the data was analyzed using tables and charts (Bar and Pie charts). Statistical analysis was finally carried out using 2x2, 2x3 and 3x3 tables to obtain p-values by means of Fisher's exact test, Chi-square test and McNemar Test.

Results

The most common mode of injury was road traffic accident (RTA) accounting for approximately 69.5% (32/46) of cases (**Table - 1**). Most patients with road traffic accidents were in the age group of 21-30 years. The modes of injuries classified as others include impact by a blunt object, fall on blunt object while walking and case of railway accident.

Table - 1: Mode of injury.

Mode of injury	No of cases	%
RTA	32	69.57
Fall from height (FFH)	8	17.39
Assault	5	10.87
Others	1	2.17
Total	46	100

Pattern of the injuries showed that the liver was the most commonly injured organ accounting for 34.78% (16/46) of injuries (**Table - 2**). More than 50% of hepatic injuries were grade II and grade III injuries. Hepatic injuries were associated with; injuries to other abdominal organs in 18.75% (3/16) of cases, rib fractures in 50% (8/16) patients more commonly on right side and injury to lungs either in form of lung contusion, pneumothorax, atelectasis or pleural effusion in 31.25% (5/16) patients.

Table - 2: Pattern of organ injuries on MDCT.

Organs involved	No of cases	%
Solid viscera		
Liver	16	34.78
Spleen	5	10.87
Kidneys	7	15.22
Pancreas	3	6.52
Adrenals	3	6.52
Hollow viscera		
Bowel	4	8.70
Urinary bladder	3	6.52
Urethra	2	4.35
Others		
Mesenteric injury	2	4.35
Retroperitoneal hematoma	5	10.87
Parietal wall injury	5	10.87
Multiple organs	8	17.39

Table - 3 presents the management plan of the patients prior and after MDCT examination which was guided by demographic profile like age, clinical status of the patients; time elapsed since injury and initial sonographic findings if done. The management plan prior to CT scan was conservative in around 73.9% (34/46) of the patients and operative in around 26.09 % (12/46) of the patients (**Table - 3**). Applying nonparametric Fisher's test, a significant difference was found between the management plan decided before and after MDCT scan. The MDCT diagnosis helped in avoiding unnecessary emergency laparotomy in significant number 91.2% (11/12) of patients.

Table - 4 shows the management plan after MDCT Examination. Revised management following MDCT scan was conservative in

69.5% (32/46) and operative in 30.4% (14/46) of patients. Applying non parametric McNemar test, there was a significant difference between the management plan decided before CT scan and final management plan.

Table - 3: Correlation between management plans before MDCT and final management plan.

Management plan before MDCT	**Final management plan**		**Total**	**P Value**
	Conservative	Operative		
Conservative	20	14	34	0.052 (Significant)
Operative	11	1	12	
Total	31	14	46	
Fisher's Exact test (2-tailed)				

Table - 4: Management plan after MDCT examination.

Management plan	**No of cases**	**Percentage (%)**	**P Value**
Conservative	32	69.57	0.051 (Significant)
Operative	14	30.43	
Total	46	100	
McNemar Test			

Table - 5: Correlation between management plans decided after MDCT and final management plan.

Management plan after CT	**Final management plan**		**Total**	**After CT and Final management**
	Conservative	**Operative**		
Conservative	31	1	32	1.000
Operative	0	14	14	
Total	31	15	46	

McNemar Test:

Table - 5 presents Correlation between management plans decided after MDCT and final management plan the conservative management decided on the basis of MDCT findings was not successful in 3.12% (1/32) cases. The management failed in this case as patients underwent elective laparotomy during the course of clinical follow-ups. The operative management plan on basis of MDCT findings was successful in 100% (14/14) of cases. The final management plan as directed by CT findings and clinical course of patient was conservative in 67.3% (31/46) cases and operative in 32.6% (15/46) of patients. Applying non parametric McNemar test, there was no significant difference between the management plan decided after MDCT scan and final management plan. The management plan decided after MDCT scan, therefore, has high success rate of around 96.8% (31/32) in conservatively managed patients and 100% (14/14) in operated cases of blunt abdominal trauma.

Table - 6 shows that among sixteen (16) patients with liver injury 81.25% (13/16) were managed conservatively. Grade II and grade III injuries were 100% managed conservatively. Out of five patients with grade IV injuries 60% (3/5) were managed conservatively. One patient with grade V injury was operated. The liver injury grading does not correlate with management plan as the percentage of patients managed conservatively was almost similar in grade II, III, IV (100%, 100%, and 60% respectively). Applying Chi-Square test the significance of this difference was 0.091 suggesting insignificant result. The spleen was the third most commonly injured organ after liver and kidney accounting for around 10.8%

(5/46) of injuries. Grade II injuries constituted around 80 % of splenic injuries. Among five (5) patients with splenic injury 60% (3/5) were managed conservatively. Out of the four patients with grade II injuries 50% (2/4) were managed conservatively. The splenic injury grading does not correlate with management plan as the percentage of patients managed conservatively was almost 50% in grade II and 100% in grade III splenic injuries. Applying Chi- Square test the significance of this difference was 0.643 suggesting insignificant result. The kidneys were second most commonly injured solid organ 15.2% (7/46).

Table - 6: Correlation between injury grading and management in patients.

Injury Grade	Total no of patients	No of conservatively managed cases	No of operated cases	Chi-Square Test (p-value)
Liver injury				
Grade I	1	1	Nil	**0.091**
Grade II	3	3	Nil	
Grade III	6	6	Nil	
Grade IV	5	3	2	
Grade V	1	Nil	1	
Total	16	13	3	
Splenic injury				
Grade I	Nil	Nil	Nil	**0.643**
Grade II	4	2	2	
Grade III	1	1	Nil	
Grade IV	Nil	Nil	Nil	
Total	5	3	2	
Renal injury				
Grade I	Nil	Nil	Nil	**0.286**
Grade II	Nil	Nil	Nil	
Grade III	3	3	Nil	
Grade IV	4	2	2	
Grade V	Nil	Nil	Nil	
Total	7	5	2	
pancreatic injury				
Grade I	1	1	Nil	**0.667**
Grade II	2	1	1	
Grade III	Nil	Nil	Nil	
Grade IV	Nil	Nil	Nil	
Grade V	Nil	Nil	Nil	
Total	3	2	1	
Solid organ				
Grade I	4	4	0	**0.659**
Grade II	10	7	3	
Grade III	10	10	0	
Grade IV	9	5	4	
Grade V	1	0	1	
Total	34	26	8	
Chi-Square Test				

Cases with right renal injury occurred in 57% (4/7) and left renal injury in remaining 43% (3/7) of patients with renal trauma. Grade III and grade IV injury was seen in 43% and 57% of cases respectively. There was no case with grade I and II injury. Among the seven (7) patients with renal injury 71.4% (5/7) were managed conservatively. Out of four (4) patients with grade IV injuries 50% (2/4) were managed conservatively. All cases of grade III injury were managed conservatively. The renal injury grading does not correlate with management plan as the percentage of patients managed conservatively was 100% for grade III and 50% for grade IV renal injuries. Applying Chi- Square test the significance of this difference was 0.286 suggesting insignificant result. The pancreatic injuries were observed in around 6.52% (3/46) cases. Sixty six (66%) percent of pancreatic injuries were grade II injuries and 33.3% were grade I. The pancreatic injuries were associated with injuries to; liver in 66.6% (2/3) of cases, injuries to kidneys in 66.6% (2/3) of cases involving right and left kidney separately and injuries to spleen in 33.3% (1/3) of cases. Out three patients with pancreatic injuries 66.6% (2/3) were managed conservatively. Out of two patients with grade II injuries 50% (1/2) were managed conservatively. One case of grade I injury was managed conservatively. The pancreatic injury grading does not correlate with management plan as the percentage of patients managed conservatively was about 50% in grade II injury and 100% in grade I cases. Applying Chi- Square test the significance of this difference was 0.659 suggesting insignificant result. Among thirty four (34) patients with solid organ injuries 76.4% (26/34) were managed conservatively. All patients of grade I injury and Out of ten patients with grade II injuries 70% (7/10) were managed conservatively. All patients with grade III injuries were managed conservatively. Out of nine patients with grade IV injuries 55.5% (5/9) were managed conservatively. One patient with grade V injury was operated. The solid organ injury grading does not correlate with management plan as the percentage of patients managed conservatively was almost similar and more than 50% in grade I, II, III, IV (100%, 70%, 100% and 55.5% respectively). One patient with grade V injury was operated. Applying Chi- Square test the significance of this difference was 0.659 suggesting insignificant result.

Discussion

The present study was undertaken to evaluate the role of Multi detector computed tomography (MDCT) in management of clinically stable patients with blunt abdominal trauma by comparing management plan prior to MDCT scan with management plan after MDCT scan.

In the present study, comprising forty six (46) clinically stable patients with blunt abdominal trauma, more than 54% of the patients were in the age group of 21 to 40 years. The male to female ratio was 4:1. The most common mode of injury was road traffic accident (69.5%) followed by fall from height (17.3%). Bony injuries (including ribs, pelvis and spine) were the most common associated injury (80%) followed by chest injury (atelectasis, pleural effusion, contusion, and pneumothorax) which was seen in 23.9% of cases.

In the present study, the liver was the most commonly injured organ accounting for 34.78% (16/46) of injuries, whereas in a study by Boone, et al. [13], liver was the second most commonly injured organ in the abdomen with damage occurring in 20-30% of blunt trauma overall. In a study by Mohapatra, et al. [11] blunt abdominal trauma accounted for 44% of all abdominal injuries. More than three fourth ($3/4^{th}$) of the victims were in the first four decades of their lives. Male-Female ratio was 7:1. Road traffic accidents (RTA) were the most common etiology (62%) mostly involving pedestrians or two wheeler riders (combined, 47%). Chest injury was the most common associated extra-abdominal injury (26%) followed by head injury and other bony injuries (21% each) [11].

In the present study, 81.25% (13/16) of patients with hepatic injuries were managed

conservatively. Grade II and grade III injuries were 100% managed conservatively. Out of five patients with grade IV injuries 60% (3/5) were managed conservatively. One patient with grade V injury was operated. In a study by Mirvis, et al. [14], 83% of patients with hepatic injury were managed conservatively. No patient who was initially decided to be managed non-operatively required delayed laparotomy due to hepatic injury unlike in present study. In a study by Croce, et al. [15] it was found that non operative management is safe for hemodynamically stable patient with blunt hepatic injury, regardless of injury severity. In present study as well it was found that non operative management was successful in 81.25% (13/16) of patients with blunt hepatic injury.

The spleen was the third most commonly injured organ accounting for around 10.8% (5/46) of injuries whereas in a study by Mirvis, et al. [16], the spleen was the most frequently injured organ accounting for around 40% of all solid organ injuries. In the present study 60% (3/5) patients with splenic injuries were managed non-operatively. The non-operative management was successful in 100% of patients with blunt splenic trauma i.e. none of the patients who were managed conservatively required delayed laparotomy. Similar results were obtained in study by Shapiro, et al. [17] who concluded that blunt splenic injury patients can be safely observed and age does not influence management of patients.

In the present study, the kidney was second most common injured organ. Renal injuries were seen in 15.2% (7/46) of cases with right renal injury occurring in 57% (4/7) and left renal injury in remaining 43% (3/7). Around 57% (4/7) of renal injuries were associated with injuries to other organs, most commonly liver in cases of right renal injury and spleen in cases of left renal injury. In a study by Smith, et al. [18]; the kidneys were injured in 10% of patients with blunt abdominal trauma and were the most frequent urinary tract organ to suffer injury.

In the present study, pancreatic injuries were observed in around 6.52% (3/46) cases, in contrast to a study by Wong, et al. [19] who found pancreatic injury to be relatively uncommon, occurring in less than 2% of blunt abdominal trauma patients. Sixty six (66%) percent of pancreatic injuries were grade II injuries and 33.3% were grade I. The pancreatic injuries were associated with injuries to liver in 66.6% (2/3) of cases, injuries to kidneys in 66.6% (2/3) of cases involving right and left kidney separately and injuries to spleen in 33.3% (1/3) of cases. In a study by Bradley, et al. [20] it was observed that isolated pancreatic injuries are rare, and associated injuries, especially to the liver, stomach, duodenum, and spleen, occur in over 90% of cases.

The results of this study denote that multiplanar reformatted images (MPR) were more informative to the trauma surgeon as they found it easy to understand abdominal anatomy on MPR images in comparison to the standard axial images. Same was concluded by Lisa A. Miller and K. Shanmuganathan [8]. In the present prospective study, a statistically significant difference (p=0.052) was found between the management plan decided before and after MDCT scan (guided by CT scan findings). The CT diagnosis helped in avoiding unnecessary emergency laparotomy in 91% (11/12) of patients in whom management plan was potentially operative prior to MDCT. In a study by Wing and associates [21] evaluating clinical impact of CT for blunt abdominal trauma, it was concluded that the use of computed tomography (CT) had a tremendous impact on the evaluation and management of blunt abdominal trauma. In a retrospective study performed by Udekwu, et al. [22] to evaluate the use of computed tomography in the initial evaluation of hemodynamically stable blunt trauma patients, the sensitivity of CT for patients with visceral injury was 92.4%, specificity was 99.5%, and overall accuracy was 97.6%.

In the present study, among thirty four (34) patients with solid organ injuries, 76.4% (26/34)

were managed conservatively. All patients of grade I injury were managed conservatively. Out of ten patients with grade II injuries 70% (7/10) were managed conservatively. All patients with grade III injuries were managed conservatively. In the same study by Mallik, et al. [23] comparatively evaluating ultrasound and CT in patients with blunt abdominal trauma the overall likelihood of surgical management increased with higher organ injury grading of solid organ injuries. In a study by Becker, et al. [24]; it was concluded that CT findings cannot be used to determine reliably which patients with splenic injuries require surgery and which patients can be treated conservatively. Hackam, et al. [25] and Shapiro, et al. [26] in their studies regarding correlation between solid organ injury grading and management plan concluded that although useful for epidemiologic studies, CT grading of liver and spleen injuries based on morphology of wounds does not reliably predict the specific outcome in individual cases.

In the present study, as guided by the MDCT scan findings 67.3% (31/46) of patients were decided to be managed conservatively on basis of MDCT findings, out of which 96.7% (30/31) showed clinical improvement during first week, suggested by improvement in hemodynamic status, symptomatic relief and reappearing bowel sounds. Hence clinical outcome of 96.7% was noted in first week, one patient (1/31) showed less signs of clinical improvement, but subsequently improved in second week. In study by George A Giannopoulos, et al. [30]; 13.6 % of failure rate was observed in conservatively managed patients of blunt abdominal trauma.

Conclusion

1. The use of multi detector CT in initial triage of clinically stable patients with blunt abdominal trauma results in reduction in number of unnecessary laparotomies by 91% and helps guiding initial management in emergency department in virtually every patient with high success rate of around 95%.
2. The MDCT grade of solid organ injury does not correlate with management plan in patients with blunt abdominal trauma.
3. The high resolution MPR, MIP, 3-D volume rendered images not only helped in displaying complex injuries but also increased diagnostic capabilities, accuracy and shortened the reporting time.
4. The high resolution MIP and 3-D volume rendered images gave quick and prompt diagnosis of associated vascular and bony injury.
5. The clinically unsuspected findings (adenopathy, adnexal cysts, hip dislocations, cholelithiasis, ectopic kidney, hepatomagaly and hydronephrosis) detected on MDCT scan in 28.2% cases although not useful for the initial decision making regarding management of patients, guide further management of these patients during follow up. These findings may prompt further investigation and therapeutic intervention.

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