

ORIGINAL ARTICLE

EVALUATION OF INJURY PATTERN IN BLUNT ABDOMINAL TRAUMA BY MULTIPHASIC COMPUTED TOMOGRAPHY (MDCT) AND ITS CORRELATION WITH OPERATIVE FINDINGS: A PROSPECTIVE STUDY

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ABSTRACT:

Introduction: Trauma is one of the most frequent causes of mortality and morbidity. A good chunk of these fatalities is attributable to abdominal injuries, of which blunt abdominal trauma is most challenging condition. Because, these injuries are hidden and difficult to evaluate with varying clinical presentation. **Aims and Objectives:** To analyse the role of Multiphasic CT in detecting the visceral organ injuries, their grading and correlation with operative findings in patients with blunt abdominal trauma. **Material and Methods:** A prospective study was done on patients suspected with blunt abdominal injury that were referred to department of radiodiagnosis in period from 1 Jan 2014 to 31 Dec 2014. All the scans were performed on somatom definition AS+ 128 slice CT machine by Siemens. **Results:** Out of the total 186 patients, visceral injuries or free fluid was seen in 157 patients Majority of victims were young adult males between 20-39 years of age group with M:F ratio of the study was 5.9:1. Solid organ injuries were seen in 123 patients. In most of the cases, involvement of only one organ was reported and Liver was the most common organ involved. Out of 186 patients 147 were managed conservatively and 37 patients underwent surgery On correlating CT scan findings and operative findings, hemoperitoneum was confirmed in all 37 patients, liver and splenic injuries were found in 11 patients. Bowel/mesenteric injuries were confirmed in 15 patients. 5 new cases of bowel/mesenteric injuries were found on laparotomy in which free fluid was seen on CT. The overall mortality rate in this study was 17.2% and rate of non therapeutic laprotomies was 2.7%. **CONCLUSION:** Multiphasic CT is helpful in detecting, grading organ injuries and managing them conservatively. Thus, plays important role in reducing unnecessary non therapeutic laparotomies. Multiphasic CT is accurate, detailed, relatively safe and investigation of choice in hemodynamically stable patients of blunt abdominal trauma

Key words: Laprotomy, Mesentery, Therapeutic, Trauma

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This article may be cited as: Bajwa GS, Galhotra RD, Sandhu P, Kakkar C. Evaluation of injury pattern in blunt abdominal trauma by Multiphasic Computed Tomography (MDCT) and its correlation with operative findings: A prospective study. J Adv Med Dent Scie Res 2017;5(2):134-142.

Access this article online	
Quick Response Code 	Website: www.jamdsr.com
	DOI: 10.21276/jamdsr.2017.5.2.31

INTRODUCTION

Trauma is the leading preventable causes of death in developing countries, and it affects generally the young people.^[1] There has been a steady increase in accidental trauma and a good chunk of these fatalities is attributed to blunt abdominal trauma which is a challenging condition, because, these injuries are hidden, difficult to evaluate and of varying presentation.

Blunt injury occurs most frequently with motor vehicle collisions, fall from heights, sports and assault. Road traffic accidents are among the leading causes of death worldwide. There has been a sustained increase in traffic accidents in India. About 142,485 road traffic deaths occurred in India in 2011.^[2]

A Road Traffic Accident (RTA) can be defined as, 'An event that occurs on a way or street open to public traffic; resulting in one or more persons being injured or killed, where at least one moving vehicle is involved.'^[3]

According to the World Health Organization (WHO), road traffic injuries are the sixth leading cause of death in India with a greater share of hospitalizations, deaths, disabilities and socio-economic losses in the young and middle-aged population.^[4]

The highest number of deaths due to road accidents during the year 2012 were reported in Tamil Nadu (11.6%), Uttar Pradesh (10.9%), Andhra Pradesh (10.8%) and Maharashtra (10.0%). The rate of accidental deaths per thousand vehicles was highest in Bihar and West Bengal at 1.9 each followed by Himachal Pradesh (1.8), Andhra Pradesh (1.5) and Jammu and Kashmir (1.5) as compared to 1.0 at the national level.^[5]

Fall from height is another mode of blunt abdominal injury after road side accidents. Most of the cases of fall from height are accidental and some are suicidal.^[6]

Evidence supports the fact that timely referral to trauma centers, equipped with proper facilities to deal with serious injuries, result in reduction of mortality among

victims.^[7] Three basic mechanisms explain the damage to the abdominal organs: deceleration, external compression, and crushing injuries.^[8] The most commonly injured abdominal organs and structures are the spleen, liver, kidneys, small bowel and/or mesentery, bladder, colon and/or rectum, diaphragm, pancreas, and major vessels.^[8] Various factors determine the specific association of organs injured: the energy delivered at impact, the part of the body struck first, the body habitus, and, in the case of motor vehicle accidents, the use of a restraint device.^[9] Knowledge of mechanism of injury, site of impact, force, associations of the organs involved in trauma and other parameters are used for better evaluation of patient and interpretation of computed tomographic (CT) studies.

The problems in diagnosis are compounded by the fact that most patients with trauma are unconscious due to alcoholism, drug abuse, head injury and shock contributing to difficulty in diagnosis of blunt abdominal trauma...^[10] Diagnostic techniques used in the blunt abdominal trauma patients include USG, CT scan and DPL. CT scan provides the most detailed information. With the invention of Multiphasic CT, we can acquire images in different phases arterial phase, venous phase and delayed phase.. Multiphasic CT with its three dimensional reconstruction, angiography techniques; less scanning time and better image resolution allows high quality two-and three-dimensional multi-planar reformatted images, which aid in the diagnosis. So, prompt and accurate diagnosis is of critical importance, and the radiologist plays an important role in the decision-making process.^[11]

AIMS AND OBJECTIVES

1. To study the role of multi detector computed tomography in detecting visceral organ injuries in patients with blunt abdominal trauma and provide information that can determine the type of further management (operative and non operative).
2. To determine extent and grade of visceral organ injuries.

MATERIAL AND METHODS

This prospective study was conducted on patients suspected of abdominal injuries referred to the Department of Radiodiagnosis at Dayanand Medical

College, Ludhiana for Multiphasic CT over a period of one year. Findings of general physical and systemic examination were recorded..Injury to different organs was staged by organ injury scaling (OIS) system developed by organ injury scaling committee of the American Association for the Surgery of Trauma (AAST).^[12] Hemoperitoneum on CT were divided into three groups according to the Federle and Jeffrey System^[13] into mild, moderate and significant.

Technique of imaging the abdomen

Multiphasic CT was carried out on Somatom definition AS + 128 slice CT machine by Siemens Germany Std with a gantry rotation speed of 0.5 second, tube current of 100-350 mA, reconstruction increment of 1.0 mm and slice thickness of 5.0mm.. i/v, oral and rectal contrast was given wherever needed... The unenhanced scan was done first followed by the contrast study using “bolus tracking method “. volume of 80-85 ml of contrast with density of 300mg/ml was pushed through a 20 g peripheral cannula at the rate of 3.5 per second with the help of pressure injector followed by a saline chaser of 30 ml at the rate of 2.5 ml per second Arterial phase followed by the venous phase with a scan delay of 25 seconds..was done In case of extravasation delayed phase was taken. More delayed section was taken in case of renal injury to confirm urinoma formation. Coronal and sagittal MPR images were created using the data. The data was recorded and analyzed using descriptive statistics.

OBSERVATIONS AND RESULTS

In this study total 186 patients included with suspicion of blunt abdominal trauma that were referred/ admitted in Dayanand Medical College and Hospital Ludhiana. Patients from nearly all age groups were involved. The maximum numbers of patients were in age group of 21-30 years (30.6%). The minimum numbers of patients were in age group of 81-90 (0.5%). Average age of the patients in this study was 34.6 year youngest patient in this study was 2 years old and oldest patient was 88 years old. Males were seen to be more frequently involved in abdominal trauma as compared to females. Out of total 186 patients, 159 patients (85.5%) were males and 27 (14.5%) were females with male: female ratio was 5.9:1.

Table 1: Mode of blunt injury to abdomen (n-186)

Mode of injury	Males		Females		Total no. patients	
	No. of cases	%age	No. of cases	%age	No. of cases	%age
MVA/RA	141	88.6	19	66.6	159	86
Fall from height/ domestic	15	9.4	9	33.3	24	12.9
Assault	2	1	0	0	2	1.1
Industrial injury	1	0.6	0	0	1	0.5
Total	159	100	27	100	186	100.0

Road side accidents involving vehicles were seen to be the most common cause of blunt abdominal trauma, seen in 160 cases (86%) followed by fall from height/domestic injury (12.9%) (table 1). Two wheelers were involved in maximum number of cases (61.6%) of cases followed by three /four wheeler (31.4%) Pedestrian were involved in 6.3% cases.

The patients with hemoperitoneum or abdominal visceral injury or both were considered as positive for intra-abdominal injury. The patients with neither visceral injury nor free fluid were considered as negative for intra abdominal injury. CT scan detected abdominal injuries/free fluid in 157 Patients, out of 186 patients.

Table 2: Distribution of positive intraabdominal injuries (n-157)

Positive BAT	Number of cases	%age
Visceral/Solid organ injury associated with Hemoperitoneum	120	76.4
Visceral injuries without hemoperitoneum	3	1.9
Isolated hemoperitoneum	34	21.6

Cases positive for blunt abdominal injury were 157 (84.4%). 120 cases had free fluid with associated visceral organ injury. 3 patients had visceral organ injury without free fluid. Free fluid was the most common finding seen in 154 patients (table2)

Table 3: Grading of hemoperitoneum (n-154)

Grade of hemoperitoneum	Number of patients
Mild	63
Moderate	75
Significant	16

Hemoperitoneum on CT were divided into three groups according to the Federle and Jeffrey system^[13] into mild, moderate and significant.(table3)

Table 4: Distribution of visceral injuries on ct in positive BTA cases (n-123)

Abdominal viscera	No. of injuries			
	Male	Female	Total	%age
Liver	55	19	65	52.85
Spleen	25	4	29	23.58
Pancreas	6	0	6	4.88
Renal	16	1	17	13.82
Bowel/Mesentery	25	3	28	21.14
Urinary bladder	5	1	6	4.88
Adrenal	15	2	17	13.82
Diaphragmatic injury	4	0	4	3.25

Out of 186 patients 29 had no visceral injury. 34 patients had hollow viscus/ mesenteric injury. Liver was the most frequently injured organ(52.85%), followed by spleen (23.58%) (table4).

Table 5: Number of grade specific liver injuries and their management (n-65)

Grade	Liver injury		Management	
	No.	%age	Conservatively	Surgical
I	6	9.2	5	1
II	13	20.0	8	5
III	14	21.5	13	1
IV	28	43.1	26	2
V	4	6.2	2	2
Total	65	100.0	54	11

Out of 65 cases of liver injury, according to AAST grading system grade 1V injury was most common (43%) (table5).

Table 6: Number of grade specific splenic injuries and their management (n=29)

Grade	Spleen injury		Management	
	No.	%age	Conservatively	Surgical
I	4	13.8	3	1
II	10	34.5	7	3
III	8	27.6	7	1
IV	5	17.2	0	5
V	2	6.9	1	1
Total	29	100.0	18	11

Out of 29 cases of splenic injuries grade II was the most common (Table 6).

Table 7: Number of grade specific renal injuries (n=17)

Grade	Left kidney		Right kidney		Total	
	No. of cases	%age	No. of cases	%age	No. of cases	%age
I	1	14.3	2	28.6	3	17.6
II	3	42.9	1	14.3	4	23.5
III	2	28.6	5	71.4	7	41.2
IV	1	14.3	2	28.6	3	17.6
V	0	0.0	0	0.0	0	0.0
Total	7	100.0	10	100.0	17	100.0

Out of 17 cases, of renal injuries grade II was most common (Table 7). Total 6 patients had pancreatic injuries. All were males. Out of 6 patients, 3 patients were managed conservatively and 3 were underwent surgery 6 patients had injury to the urinary bladder. Out of which 4 had intraperitoneal rupture 2 had extraperitoneal rupture.

Table 8: Number of patients with bowel/mesenteric injuries and their management (n=28)

Type of injury	Total	Management		
		Conservative	Operative	Negative on CT Positive operative findings
Perforation/ thickening	Gut 16	4	12	▪Gangrenous bowel in two cases, ▪Pneumoperitoneum and ileal perforation in one patient. ▪Adhesions with dilated small gut loops
Mesenteric hematoma	tear/ 12	9	3	▪Sigmoid mesentery hematoma in one case
Total	28	13	15	

28 (16.8%) patients had bowel/mesenteric injuries. Out of 28 patients, 12 patients had mesenteric tear or hematoma formation and 16 patients had injuries to bowel.(table8)
4 patients had injury to the diaphragm; in all cases left side was involved

Table 9: Management and outcome of patients (conservative vs surgical) (n=186)

Mode of treatment	Improved	Expired	Total
Operated	27	10	37
Conservatively	127	20	147
Advised surgery	0	2	2
Total	154	32	186

Out of 186 patients 147 patients were managed conservatively and 37 patients underwent surgery. In two patients surgery was advised but patients did not opt for surgery. Out of 147 patients who were managed conservatively, 127 patients were improved and satisfactorily discharged from hospital. Out of 37 patients who underwent surgery, 10 patients were expired (Table 9).

Table 10: Correlation of Ct findings with intra operative findings (N-37)

Indications	No. of cases detected by CT	No. of operated cases	Additional injuries detected on surgery
Hemoperitoneum	37	37	-
Bowel/Mesenteric	15	20	<ul style="list-style-type: none"> ▪Gangrenous bowel in two cases, ▪Pneumoperitoneum and ileal perforation in one patient. ▪Adhesions with dilated small gut loops ▪Sigmoid mesentery hematoma in one case
Urinary bladder rupture	4	4	-
Pancreas	3	3	-
Liver	11	11	-
Spleen	11	11	-
Renal	3	3	-

37 patients were operated. In these patients hemoperitoneum was reported on CT and these findings were confirmed by intraoperative findings. On CT 15 patients were diagnosed with bowel/mesenteric injuries which were confirmed after surgery. In total 20 patients, bowel injuries were found on surgery. 4 patients with Urinary bladder were operated. 11 patients with liver and same number of patients with splenic injury were operated. Out of 6 patients diagnosed with pancreatic injury on CT, 3 patients were operated. 3 patients with renal injuries were operated (Table 10).

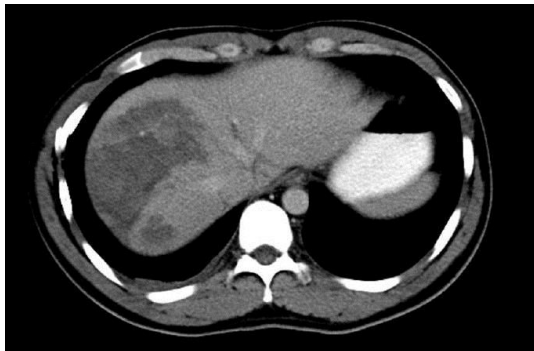


Figure 1: 52 Year old female with history of road side accident. Axial CT image shows liver injury grade IV



Figure 2: 17 Year old male with history of road side accident. CT axial section shows transaction of the pancreas involving neck and proximal body



Figure 3: 34 Year old male with history of road side accident. CT axial section of pelvis shows extravasation of intraluminal contrast from UB into pelvis outlining the gut loops s/o intraperitoneal rupture of UB



Figure 4: 20 Year old female with history of road side accident. CT coronal section (a) shows extraperitoneal rupture of UB, sagittal section (b) shows hyperdense intraluminal contrast into extraperitoneal space

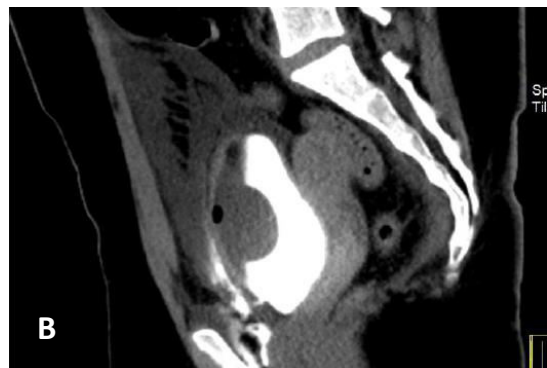




Figure 5: 65 Year old male with history of road side accident. CT coronal section shows mesenteric hematoma in left lumbar region



Figure 6: 23 Year old male with history of road side accident. Coronal CT sections shows thickening of the terminal ileum and ascending colon. Operative findings showed gangrene of the terminal and ascending colon



Figure 7: 22 Year old male with history of road side accident. CT axial section shows diaphragmatic hernia on left side

DISCUSSION

Abdominal trauma continues to be a major cause of trauma admissions and contributes significantly to high morbidity and mortality. Rapid diagnosis, appropriate diagnostic work up and treatment are critical to ensure patient survival. Physical examination and Plain radiographs are regarded as non specific and insensitive to diagnose abdominal injuries. Recent trend of management is in favor of non operative management with availability of non invasive radiological modalities for assessment of injury. USG is the first imaging study done in blunt abdominal trauma. Basic limitations of the USG are operator's experience, patient's immobility, excessive gas shadows and presence of surgical emphysema. CT has become an integral part of the evaluation of patients with blunt abdominal trauma and accurate in defining solid and hollow visceral injuries and associated hemoperitoneum.

In our study road side accidents were the most common cause of blunt abdominal trauma (85.4%) which was consistent with study Surendra et al.^[14] (72.7%) and Maurice A et al^[15] (83.6%). Similar findings were noted by Naveen KG et al,^[16] Prasad GV et al^[17] and Pierre A et al.^[18] The increased percentage of road side accidents involved in blunt abdominal trauma is due to poor road conditions, congestion on roads and non implementation of traffic rules. Our research shows that two wheeler occupants are commonest victims. These finding can be attributed to direct impact and exposure while riding a two wheeler. This is in congruence with study by Chalya PL et al^[19]

In our study, maximum number of patients were in the age group of 21-30 years (30.6%) with. Average age of 34.6 by Surendra K et al^[14] (28%) and Chalya PL et al (2013)^[19] In most of the studies, age group 21-30 years and 31-40 years were involved and is probably due to the fact that it reflects most active age group of life and involve traveling and vehicle driving.

Majority of patients in our study were males (85.5%) with 14.5% female patients. Male: female ratio was 5.9:1 comparable with study by Naveen K G et al^[16] (4.9:1) by Surendra et al^[14] (4.23:1) and by Maurice Asuquo et al^[15] (5.3:1). Reason for more number of males involved in trauma is because in Asia specifically in southeast Asia the male are usually bread earner of the family and playing main role/ work outside the home and are at increased risk to accidental trauma.

Out of 186 patients abdominal injuries/free fluid is seen in 157 (84.4%) patients consistent with study by Vadodariya K et al^[20] (95%); by Ming et al^[21] (71%).

Hemoperitoneum was the most common finding which was present in 154/186 and it was associated with other visceral/solid organ injury in 120 patients. In 34 (22%) patients isolated hemoperitoneum was detected, Kumar MM et al^[32] also reported isolated hemoperitoneum in 37.5% of cases. CT findings of hemoperitoneum were confirmed in 37 patients taken up for surgery and was 100% sensitive in detecting hemoperitoneum similar to the study done by Vadodariya KD.^[20] Hemoperitoneum was divided into three groups according to the Federle

and Jeffrey system^[13] into mild, moderate and significant. 40% patients had mild, 48.7% had moderate and 10.3% had significant hemoperitoneum. Findings were similar to the study by Naveen et al^[16] and Study by Vadodariya et al.^[20]

Liver was the commonest organ injured and was seen in 65 (52%) with maximum number of injuries belonging to grade IV (fig 1) comparable to Mausami et al^[22] and Reina K et al.^[23] Willmann et al.^[24] and Surendra K et al^[14] also reported similar findings In their study grade II was the most common type of grade followed by grade III.

Although protected under the bony rib cage, in most of the studies the spleen remains a most commonly affected organ in blunt injury While some references occasionally document liver injuries as being more common as in our study. Reason for the variability in most common organ injured is likely due to site of impact which was mostly on the right side and anterior aspect of abdomen in present study. Liver is largest of all organs with large surface area and more anteriorly placed, thus more susceptible to trauma and came out most common injured organ in present study.

Splenic injuries were seen in 29 (23%) cases with maximum number of patient in grade II injury. It was consistent with Study by Surendra K et al^[14] (36.36%) and Reina K et al^[23] (30%) Similar finding was also reported by Mousami Singh et al^[22] (30.9%) cases and Chalya PL et al.^[19]

Renal injuries were seen in 17 (14%) cases with maximum cases of grade III injury. Surendra K et al^[14] reported renal injuries in 40 (36.36%) and Reina K et al^[23] (16%) Mousami Singh et al^[22] (18.18%), Naveen K G et al^[16] (20%) with maximum patients having grade II injuries. In our study 14 cases were managed conservatively and 3 underwent surgery. Which was agreed upon by Adam J et al^[25] who mentioned that majority of the renal injuries can be managed by non operatively.

CT is not a sensitive modality for the detection of pancreatic injury. Many examples of normal CT scans with missed pancreatic injury have been documented. The pancreas is the least commonly injured solid organ, comprising 3-12% of all abdominal injuries.^[26] In our study total 6(3.9%) patients had pancreatic injuries and all were males...Pancreatic injury rarely occurred as an isolated injury.^[27] (Fig 2). Our study also showed that all the 6 patients had pancreatic injury was associated with liver, splenic or gut injury.

6 (4.88%) patients had injury to the urinary bladder. 4 had intraperitoneal rupture/ tear and 2 patients had extraperitoneal injury Intraperitoneal rupture injuries mostly occur with distended bladder and diagnosed by presence of luminal contrast into paracolic gutters and between small bowel loops (fig 3). Extraperitoneal rupture of the urinary bladder is associated with pelvic fractures and diagnosed by presence/extravasation of intraluminal contrast into perivesical space/ thigh/perineum or scrotum. Intraperitoneal urinary bladder rupture is seen in the dome / superior aspect of

UB because this region is the weakest portion of UB (Fig. 4)

28 (16.8%) patients had bowel/mesenteric injuries. Out of 28 patients 12 had mesenteric tear or hematoma formation (Fig. 5). Out of 37 operated cases bowel/mesenteric injuries were seen in 20 cases of which 15 cases were localized on CT scan. In these 15 patients intraoperative findings and CT findings correlated well and were regarded as true positive. Other 5 cases regarded as false negative. They include two patients who had internal abdominal hernia and gangrenous gut intraoperatively with a normal bowel in CT scan images. However these patients were operated 2-3 days after CT scan. One patient with perivesical hematoma reported on CT scan and an associated sigmoid injury was picked up intraoperatively (Fig. 6). One patient was diagnosed to have ileal perforation with pneumoperitoneum intraoperatively was reported normal at CT scan. However, very early CT scan after abdominal trauma can be the cause. One patient with diagnosis of prominent small gut loops and large bowel secondary to paralytic ileus was found to have small bowel obstruction intraoperatively. Rest 13 patients of bowel/mesenteric injuries were managed conservatively. Out of which one patient was reported as small gut perforation due to pneumoperitoneum, this patient is regarded as false positive.

In our study the sensitivity and specificity of the bowel/mesenteric injuries requiring surgery are 87.5% and 94%. Study done by Butela ST^[28] showed sensitivity 64%, an accuracy 82%, and a specificity 97%. Stuhlfaut JW et al^[29] reported sensitivity 82% (nine of 11 patients; 95% CI: 52%, 95%), specificity was 99%.

Four patients were reported with diaphragmatic injury; in all patients injury was present on left side. Which was congruent with study of Vaishnav KU et al,^[2] Chen et al.^[30] Ravinder Kaur et al^[31] also reported same findings Left sided injury are more common due to protective role of liver on right side and area of congenital weakness in posterolateral aspect on left side (Fig. 7).

In 186 patients 147 patients were managed conservatively and 37 underwent surgery. Two patients surgery was advised but patients did not opt for surgery. Majority of patients were treated conservatively. Patients with liver injury and splenic injury with grade I to II were mostly managed conservatively as compared to patients with grade III to V consistent with study by Kumar MM et al.^[32] Vadodariya K et al^[20] found in their study that organ injury grading and quantification of hemoperitoneum can predict the management protocols in the majority of patients. Knudson MM et al^[33] also suggested that patients with injuries to the solid organs and who are hemodynamically stable should be managed non-operatively.

The rate of non-therapeutic laparotomy was 2.7% in our study. Prasad et al^[17] reported non-therapeutic laparotomy rate 8.5%. Chalya PL et al^[19] reported non-therapeutic laparotomy rate of 7.8% The decrease in the

percentage of non-therapeutic laparotomy reflects the improvement in patient selection and when to operate on patients with abdominal injuries and also appropriate facilities

Out of 186, 32 patients expired with overall mortality rate in this study was 17.2%. Mortality rate in operated cases was 37% as compared to 12.7% in patients managed conservatively. The reason is as injuries requiring surgical intervention are more severe and there is also risk of increased complications in these patients. Bowel injuries and high grade liver injuries mainly contributed to the mortality rate in present study which is also mentioned by Polat et al^[34] and Hildebrande F et al^[35] respectively. Mortality rate is similar to the 17.9% study done by Chalya PL et al.^[19] Mortality rate was significantly associated with age of patients, presence of associated extra-abdominal injuries, severity of injury, hypotension, and presence of postoperative complications mainly surgical site infections..

CONCLUSION

To summarise road traffic accidents are the most common mode of blunt trauma abdomen with major chunk by two wheeler vehicles. Majority of victims are young adult male. Hemoperitoneum is the most common finding. Involvement of only one organ is reported in most of cases with liver injury being the commonest. Most common cause of death in the hospital was shock, hemorrhage, multi organ failure and associated injuries

Multiphasic computed tomography is the standard for detecting solid organ injuries and provides excellent imaging of pancreas, duodenum and genitourinary system.. It plays a major a role in the management of blunt abdominal trauma and helps in making decision regarding operative and non operative treatment. With the introduction of the Multiphasic CT there is marked reduction in the unnecessary laparotomies.

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Source of support: Nil

Conflict of interest: None declared

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