Print ISSN: 2321-6379
Online ISSN: 2395-1893
DOI: 10.17354/SUR/2017/95

Original Article

Role of Computed Tomography in the Evaluation of Blunt Injury Abdomen

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Abstract

Background: Evaluating patients who have sustained blunt injury abdominal remains one of the most challenging and resource-intensive aspects of acute trauma care. Missed intra-abdominal injuries continue to cause preventable deaths. The objective of our study is to assess the efficacy of computed tomography (CT) scan as accurate diagnostic tool for blunt injury abdomen patients.

Materials and Methods: Sixty cases of blunt injury abdomen admitted in the Department of Surgery of Sanjay Gandhi Memorial Hospital associated with Shyam Shah Medical College, Rewa, with signs and symptoms of blunt injury abdomen during the period of 01/08/2015 to 31/07/2016 were included in the study after taking written informed consent. All these patients were thoroughly investigated. Data were included about age, sex, mode of injury, occupation, and scan results. Organ injuries were graded using the organ injury scale guidelines.

Results: The study comprised 60 patients having blunt injury abdomen. Majority of the patients were in the age group of 16-30 years. Most common mode of injury road traffic accident followed by fall. Most common organ injury was liver injury (31.91%), followed by spleen (29.78%), bowel/mesentery (19.14%), and renal (14.89%). Out of 60 patients, 52 patients were true positive, 7 patients were true negative, and 1 patient was diagnosed false negative.

Conclusion: In this study, overall sensitivity of CT scan was 98.18% and specificity was 100% for diagnosis of blunt injury abdomen. Negative CT scan discourages unnecessary urgent abdominal exploration.

Keywords: Blunt injury abdomen, Computed tomography scan, Spleen, Hemoperitoneum

INTRODUCTION

Injury or trauma has been defined as damage to the body caused by an exchange with the environment energy that is beyond the body's resilience.

Blunt injury abdomen is a leading cause of morbidity and mortality among all age groups and continues to be a frequent cause of preventable death. More than half of these fatalities are the results of motor vehicle accidents. Other common causes are falls, assaults and civilian violence, sports injuries, industrial accidents, armed conflict and injuries caused by domestic or wild animal.

Identification of serious intra-abdominal pathology is often challenging and notably inaccurate because of associated injuries, for example, head injury and poly-trauma. Many injuries may not manifest during initial assessment and treatment period.

Diagnosis of blunt abdominal injury is based on clinical examination, X-ray abdomen, diagnostic peritoneal lavage (DPL), ultrasonography (USG), focused assessment with sonography for trauma (FAST), and computed tomography (CT) scan. Assessment of hemodynamic stability is the most important initial concern in the

Access this article online

www.surgeryijss.com

Month of Submission : 02-2017
Month of Peer Review: 03-2017
Month of Acceptance : 04-2017
Month of Publishing : 05-2017

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evaluation of a patient with blunt abdominal trauma. In the hemodynamically unstable patient, a rapid evaluation for hemoperitoneum can be accomplished by means of DPL or the FAST. DPL has proven sensitive in ascertaining the presence of intraperitoneal hemorrhage and bowel perforation. However, it is unable to evaluate the retroperitoneum and is an invasive procedure with possibility of serious complications such as injury to major vessels, bowel or bladder. Abdominal USG is an efficient method assessing patients with blunt abdominal trauma. It can be performed quickly in the emergency department without interruption of resuscitation and can be repeated whenever diagnostic uncertainty exists. Radiographic studies of the abdomen are indicated in stable patients when the physical examination findings are inconclusive.

CT scan is most reliable investigation to diagnose hollow/solid organ injury. Its advantages include superior definition of injury, leading to grading of the injury and sometimes the confidence to avoid or postpone surgery. Its disadvantages include the time taken to acquire image so cannot be used to evaluate unstable patients and financial consideration limits its use in all cases. The accuracy of CT in hemodynamically stable blunt trauma patients has been well established. Sensitivity between 92% and 97.6% and specificity as high as 98.7% have been reported in patients subjected to emergency. Hence, the current study is carried out to assess the role of CT scan in a prospective, observational manner.

MATERIALS AND METHODS

The prospective study of the role of CT scan in case of blunt injury was carried out in patients admitted to surgical wards of the Department of Surgery, Shyam Shah Medical College and Associated Sanjay Gandhi Memorial Hospital, Rewa, during the period of 01/08/2015 to 31/07/2016.

All patients who were admitted in the hospital during the above-mentioned time with signs and symptoms of blunt injury abdomen who were hemodynamically stable were considered in the study.

Patients were enrolled in the study after taking informed written consent. All routine blood investigations were done. These includes hemoglobin, total count, differential count, blood urea, serum creatinine, liver function test, red blood cells, blood grouping. Urine, routine, and microscopic examination, chest and abdominal X-ray, and USG were done. If vital signs of patient were found stable, other related X-rays were done according to site of injury. CT scan was advised for patient in whom USG was suggestive of any abnormality or there is any clinical doubt in hemodynamically stable vital signs.

Technique of CT Scan Study

The scan done was done perpendicular to the sagittal plane of the patient in the supine position and started by the taking some basal chest cuts (looking for the accompanying chest injury) down to the level of pubic symphysis.

The conscious patients were instructed not to move during scanning to avoid motion artifact.

Precontrast scan was done to all patients followed by postcontrast scan. The patient received 100-150 ml of contrast agent (loperamide 370 mg/ml) which was given intravenously by means of automated injector at an injection rate 3.5 ml/s. Antecubital vein is used as the assess route of 18-gauge intravenous needle. For children, 1.5-2 ml/s were injected at 3-3.5 ml/s. Abdominal scanning was done at 70 s after contrast administration.

Delayed scan for renal injury patient for assessment of collecting system involvement. The scan was done at 5 min after contrast administration.

RESULTS

A total of 60 patients were enrolled in the study. Blunt abdominal injury was most common in age group of 16-30 years (35%), with male to female ratio of 3.2:1. Most common cause of injury is road traffic accident (RTA) (56.6%). Students were most commonly involved (41.66%) followed by laborers (21.66%). Most common organ injury was liver (31.91%) followed by spleen (29.78%), bowel and mesentery injury (19.14%), renal (14.89%), pancreas (6.38%), and diaphragm (2.12%). Sensitivity of CT scan in case of solid organ injury is 100% and in case of hollow viscus injury is 88.88%. Overall sensitivity of CT scan in blunt injury patient is 98.18% and specificity of CT scan in blunt injury patient is 100%.

As it is evident from Table 1 and Figure 1, the majority of the patients belong to age group of 0-15 years (31%) and 16-30 years (35%). Next common group was 31-45 years (25%) with mean age of 25.6 years, male predominance in all groups with male:female ratio of 3.2:1.

It is evident from Table 2 and Figure 2 that RTA (56.6%) is most common cause of blunt injury abdomen followed by fall (33.3%), assault (5%), and others (5%).

As it is evident from Table 3, students (41.66%) were most commonly involved, followed by laborers (21.66%), homemakers (8.3%), farmers (6.6%), and drivers (5%).

It is evident from Table 4, 18 cases of Grade I solid viscus injury and 10 cases of Grade II, 6 cases of Grade III injury,

5 cases of Grade IV, and 1 case of Grade V were identified by CT scan by organ injury grading scale (AAST Grade).

As it is evident from Table 5, liver (31.91%) was most commonly injured viscera in total followed by spleen (29.78%), bowel/mesentery (19.14), renal (14.89), pancreas (6.38), and diaphragm (2.12).

It is evident from Table 6 that sensitivity of CT scan in blunt injury abdomen patient is 98.11% and specificity is 100%, positive predictive value is 1, and negative predictive value is 0.8750. The two-sided $P < 0.0001$ was considered extremely significant; the row/column association is statistically significant.

DISCUSSION

The evaluation of the patient with blunt trauma is one of the most difficult assessments in surgery. CT has become increasingly valuable and is extensively used in early clinical management of blunt injury abdomen patient which is highly sensitive and specific method for detection of abdominal injuries. CT allows for complete scanning in a single breath hold and faster scanning speed and narrow collimation increase contrast opacification in mesenteric, retroperitoneal, and portal vessel, as well as parenchymal organ; this improves identification of organ injury and additionally sites of active bleeding. CT is now best established as an accurate non-invasive technique for the detection of entire spectrum of various abdominal injuries help decide on management, especially on decision whether to treat conservatively.

Age Incidence

In the present study, 31.66% from 0 to 15 years and 35.00% from 16 to 30 years age group, whereas age of patients ranged from 3 to 90 years, with mean age being 25.6 years. In a study by Ghosh *et al*.,[1] they found the greatest number of patients in the age of 21-30 years;[2] however, Gupta *et al*.[3] in their study reported that highest number of patients was between 20 and 40 years age group with mean age being 31.0 years. The high incidence in these age groups mainly because they are mobile age group of

Table 1: Age- and sex-wise distribution

Age group (in years)	Sex *n* (%)		Total (%)
	Male	Female	
0-15	13 (68.42)	6 (31.57)	19 (31.66)
16-30	18 (85.71)	3 (14.28)	21 (35.00)
31-45	12 (80.00)	3 (20)	15 (25.00)
>45	3 (60.00)	2 (40)	5 (8.33)
Total	46 (76)	14 (30)	60 (100)

Table 2: Distribution of cases according to mode of injury

Mode of injury	Number of cases (%)
RTA	34 (56.66)
Fall from height	20 (33.33)
Assault	3 (5)
Others	3 (5)
Total	60 (100)

Table 3: Distribution of cases according to their occupation

Type of occupation	*n* (%)
Student	25 (41.66)
Homemaker	5 (8.33)
Laborer	13 (21.66)
Farmer	4 (6.66)
Driver	3 (5)
Business	4 (6.6)
Others	6 (10)
Total	60 (100)

Table 4: Findings in CT scan abdomen (*n*=40) (solid organ injury)

Organ	AAST grade					Total (%)
	I	II	III	IV	V	
Liver	7	4	3	1	0	15 (37.5)
Spleen	6	3	2	2	1	14 (35)
Kidney	3	2	1	1	0	7 (17.5)
Pancreas	2	1	0	0	0	3 (7.5)
Diaphragm	0	0	0	1	0	1 (2.5)
Total	18	10	6	5	1	40 (100)

Table 5: Distribution of cases according to visceral injury in blunt injury abdomen (*n*=47)

Organ	Solitary	Combined	Total (%)
Liver	11	04	15 (31.91)
Spleen	10	04	14 (29.78)
Bowel/Mesentery	6	03	9 (19.14)
Renal	02	05	07 (14.89)
Diaphragm	01	00	01 (02.12)
Pancreas	03	00	03 (6.38)

*Cases were calculated from intra operative finding and CT scan and autopsy records, CT: Computed tomography

Table 6: Sensitivity and specificity of abdominal CECT in trauma patients (*n*=60)

Screening test	Number of trauma patients	Number of trauma patients
CECT positive	52 (true positive)	0 (false positive)
CECT negative	1 (false negative)	7 (true negative)
Sensitivity and specificity		
Variable	Value	95% confidence interval
Sensitivity	98.11	0.8993-0.9995
Specificity	100	1.903-1.000
Positive predictive value	1.000	1.9315-1.000
Negative predictive value	0.8750	0.4733-0.9968

CECT: Contrast-enhanced computed tomography

society and more frequently at outdoors for study, occupational needs, and recreation.

Sex Incidence

Males were affected more than females in the blunt abdominal trauma in the present study. The overall ratio of the incidence in males to that in females was found to be 3.2:1. This compares favorably with that of other studies given in Table 7.

The preponderance to trauma of males is due to the fact that by virtue of their outdoor activities, they are more prone to trauma RTA.

The most common cause of blunt abdominal trauma was RTA (56.66%)[4] in the present series. This finding is similar to the findings of other studies. Griswold and Collier[5] reported automobiles to be responsible for 52% of the blunt injury abdomen and Ghosh *et al*.[1] found it to be 59.1%.

Majority of victims of RTA were age group of 16-30 years (47.05%) followed by 31-45 years (26.47%).

Table 7: Sex incidence

Authors	Year	Male (%)	Female (%)
Rozycki *et al*.[14]	1998	73	27
Gohil and Palekar	2006	76	24
Present study	2015	76.66	23.33

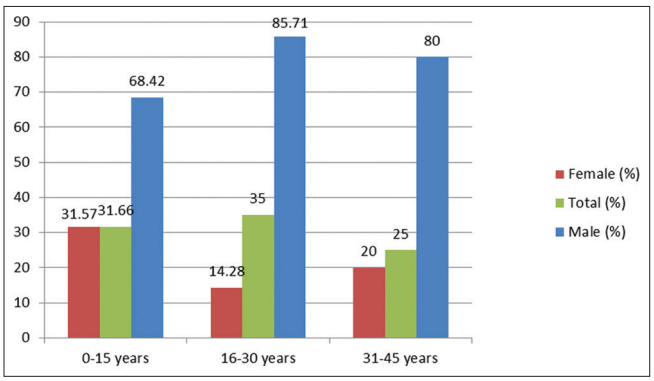

Figure 1: Age- and sex-wise distribution

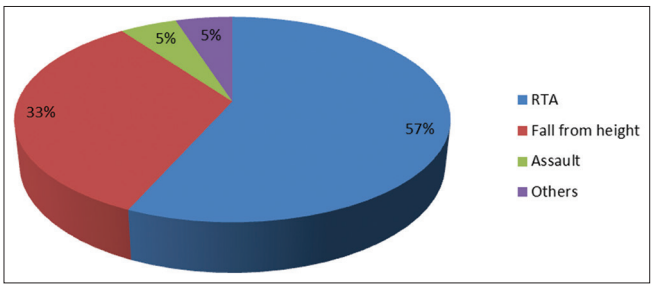

Figure 2: Distribution of cases according to mode of injury

Mode of Injury

RTA

In the present series, the incidence of RTA is quite high as stated by the Ministry of Road Transport and Highway, road accident in India 2011 and WHO,[6] road traffic injury case-sheet March 2013, which denotes the fact that in India, motor vehicle population is growing at faster rate than the economic and population growth. Increase in motorization with expansion of road network has brought with increase in road accident rate. The factors contributing to the road accidents are excessive speed, defective roads, defective layout of cross road and speed breakers, disregard to the road signals illiteracy, fatigue, and alcoholism. Nearly all factors are present in this region.

Fall

In the present study, the second most common cause of blunt injury abdomen was fall from height (33.33%). However, Ghosh *et al*.,[1] Kolkata, reported it to be 7%.

Most common age group affected in fall from height was 0-15 years (50.00%), probably due to climbing at tree, defective terrace construction, lack of parapet from which children are prone to fall.

Assault

It is another important cause of blunt injury abdomen accounts 5% in the present study.

Increase in incidence due to alcohol and drug addiction, social injustice, hectic lifestyle giving rise stress, and low level of tolerance.

Incidence according to occupation

In the present study, the most common occupation group of blunt injury abdomen victims was students (36.01%) followed by homemakers (16.6%), laborers (12.2%), and farmers (11.1%).

Gupta *et al*.[3] reported that most common occupation group of RTA victim was of students (36.07%) followed by laborer (25.41%) and farmers (20.49%). The students, laborers, and farmers are the most mobile group of the society. Students are active group meet with an accident while going to education institution/tuitions and outdoor work. Laborer class people require going to their working place daily and accidents generally occur while they are coming or going from their working place. Farmers generally need to come to the city for marketing and meet accident while coming or going to market.

CT scan of the abdomen was performed in all admitted patients with blunt injury abdomen (60 cases). The cases which did not merit immediate laparotomy on clinical ground or other investigation findings were subsequently subjected to CT scan whole abdomen for further

evaluation. It was done in 60 patients and was found to be accurate in diagnosis of solid and hollow viscous injury, free intraperitoneal blood and helped diagnose accurately associated injury to other intraperitoneal and retroperitoneal structures, which is of great clinical importance in the conservative management. Federle *et al*.[7] reported 99% accuracy of CT scan in 200 patients of blunt trauma abdomen. Matthew stated CT specificity of 99.5 % and sensitivity of 74.3%. Sutyak *et al*.[8] stated CT in 49 patients with 43 splenic injuries correlated surgically with CT findings. Stassen *et al.*[9] cited that intravenous contrast-enhanced CT scan is the diagnostic modality of choice for evaluating blunt splenic injuries.

It is evident from our study that most patients are from Grade I solid organ injury (18 cases of Grade I solid viscus injury) and 10 cases of Grade II, 6 cases of Grade III injury, 5 cases of Grade IV, and 1 case of Grade V were identified by CT scan by organ injury grading scale (AAST grade).

In the present study, sensitivity of CT scan in case of solid organ injury is 100% and in case of hollow viscus injury is 88.88%. Overall sensitivity of CT scan in blunt injury patient is 98.18%. Specificity of CT scan in blunt injury patient is 100%.

Organ Injuries

In the present study, liver injury is most common (31.91%) followed by spleen (29.78%), bowel and mesentery (19.14%), and renal (14.89%). Our study is comparable with others studies in relation to organ injuries.

Liver

Despite being in a relatively protected location, the liver is the most frequently injured intra-abdominal organ (Patcher HL 1996).

Smith *et al*.[10] found that 220 out of 969 (22.7%) cases with blunt abdominal trauma had hepatic injuries.

In their study, Gupta *et al*.[3] reported that liver was the second most common organ in blunt injury abdomen (29.79%).

Spleen

Blunt trauma accounts for 66-75% of all splenic traumas in adults and up to 97% in children (Wilson RH, Moorhead RJ, 1992).[11]

Spleen is most frequently injured in blunt trauma (Hoyt *et al*. 2005).[12] (Khan *et al*. 2006)[13] report that in their series of 100 consecutive blunt abdominal trauma cases, 32% cases[14] had splenic injuries. Kumar *et al*. (2005) and Singh *et al*.[10] (2012) found that incidence of splenic trauma in their study was 22-36%.

Kidney

Severe renal injury is however uncommon accounting for only 10-15% of patients injured (Fowler *et al*. 1982). Renal trauma occurs in 8-10% of all blunt injuries (Dobrowolski *et al*. 2002).[15]

Mesentery

Although the exact incidence of mesenteric injuries is unknown; relative incidence of 10 and 13 5% has been reported in patients undergoing emergency laparotomy (Cox 1984; McAnena *et al*. 1990).[16] Mesenteric injuries account for 5% of all blunt trauma cases reported (Rizzo *et al*., 1984).

In their study, Xeropotamos *et al*. (2001)[17] reported 31 (9%) patients with mesenteric injuries out of 333 who required operations for blunt abdominal trauma.

Small bowel

Small bowel injury caused by blunt abdominal trauma is rare although it has been reported to be the third most common injury in blunt abdominal trauma.[18] The first case of intestinal rupture secondary to blunt trauma was reported by Samuel Annan in 1837.

In their series of 63 cases of blunt trauma abdomen, Gupta and Talwar (1995)[3] found that small bowel injuries incidence was 17.5%.

However, according to Smith *et al*.,[10] small bowel injury following blunt abdominal trauma was 1.65%.

Gohil and Palekar (2006)[19] found that incidence of small bowel injury in their study was 8%.

Isolated jejunal perforation occurs in less than 1% of blunt trauma abdomen patients.

Thomson (2005)[20] found that incidence of small bowel injury appears to be lower in children than in adults.

CONCLUSION

CT scan of the abdomen has largely replaced other imaging modalities in the evaluation of the hemodynamically stable patients of blunt injury abdomen. It is performed in patients where abdomen cannot be evaluated adequately by clinical examination because of altered mental status (e.g. ethanol, drug abuse, head injury); in those patients where the finding of clinical examination is equivocal; and in those patients with significant pelvic fracture.

CT scan should not be performed in hemodynamically unstable patients and in patients with obvious signs of peritonitis or gas under right dome of diaphragm in X-ray abdomen who required immediate surgery.

The use of CT scan in the examination of patient with blunt injury abdomen, along with a trend toward non-operative management of many abdominal injuries, has decreased the need for the exploratory surgery and reduced the frequency nontherapeutic laparotomies. In fact, the trend toward conservative and non-operative treatment of many liver, spleen, and kidney injury is due in part to the ability of CT not only define the injury but also exclude significant injury, thereby avoiding unnecessary surgery.

The final discussion to operate should be based on CT finding in conjunction with entire clinical picture and judgment of the attending trauma surgeon.

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How to cite this article: Jayant V, Sharma P, Nayak A, Ghaharwar APS, Kurrey LK, Kumar S. Role of Computed Tomography in the Evaluation of Blunt Injury Abdomen. IJSS Journal of Surgery 2017;3(3):34-39.

Source of Support: Nil, **Conflict of Interest:** None declared.