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Prospective Evaluation Of Blunt Abdominal Trauma By Computed Tomography

MM KUMAR, M VENKATARAMANAPPA, I VENKATARATNAM, NV KUMAR, K BABJI

Abstract

Objectives: To evaluate the usefulness of emergency computed tomography in detection of intra-abdominal injury in patients with blunt abdominal trauma and to provide information that could accurately determine the choice of management (operative versus non-operative), thereby reducing the non-therapeutic laparotomy rates. The emphasis was to detect both free fluid (haemoperitoneum) and visceral lesions as indicators of intraabdominal injury.

Materials and methods: Two hundred and ten patients with blunt abdominal trauma were evaluated in a period of 20 months, of whom sixty-three patients were positive. The various organ injuries were graded, and scoring applied for haemoperitoneum. The management, therapeutic or otherwise was decided based on the CT findings.

Results: Patients with severe grades of injury and with large haemoperitoneum required surgeries. The overall sensitivity, specificity and positive predictive value for trauma detection by CT was 93%, 100% and 100% respectively.

Conclusion: CT quantification of haemoperitoneum and organ injury grading is helpful in guiding the surgeon towards patient management. CT is accurate, safe, and has all the attributes to make it an initial investigation of choice in haemodynamically stable patients of blunt abdominal trauma.

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Key words : - CT in Blunt Abdominal Trauma, Haemoperitoneum.

INTRODUCTION

Trauma 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 yrs).

The Indian fatality rates for trauma are 20 times that for developed countries [1]. 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.

Contrast enhanced CT, and in particular the use of faster helical CT, has revolutionalised the management of haemodynamically unstable patient. Its advent has practically eliminated the need for invasive DPL. The higher accuracy of CT in solid viscera assessment, including contained intraparenchymal organ injuries, and assessment of the retroperitoneum has defined its role in trauma.

CT as the sole modality enables evaluation of other associated injuries in addition to global evaluation of abdominal trauma in haemodynamically stable patients.

MATERIALS AND METHODS

In our study conducted, during a period of 20 months from August 2002 to March 2004, we have evaluated 210 patients suspected to have intra-abdominal injury in patients with trauma, admitted in Government General Hospital, Kakinada. All the cases were referred to us as emergencies from all the surgical and allied specialities. All the cases were evaluated on SOMATOM AR HP (SEIMENS, Erlangen, Germany) helical CT scan unit.

All the patients were also subjected to ultrasonogram on a SONOLINE ADARA (SEIMENS, Erlangen, Germany) ultrasonogram black and white machine.

From the Department of Radio diagnosis, Rangaraya Medical College & Govt. General Hospital, Kakinada, Andhra Pradesh, India - 533001

Request for Reprints: Dr. M. Mahendra Kumar, Government General Hospital, Kakinada, Andhra Pradesh, India.

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The criteria for selection for CT in patients with abdominal trauma included:

1. Clinical suspicion of intra-abdominal injury.
2. Haemodynamically stable patient.
3. Multi-trauma patients.
4. A positive ultrasonography study.

The haemodynamically unstable patients with obvious peritoneal signs and progressive abdominal distension were taken up for surgery immediately and were excluded from the study.

TECHNIQUE:

A pitch of 2 and a reconstruction interval of 8mm were used as the scanning technique. For few cases, unenhanced study was done prior to the contrast study, with delayed incorporated whenever there was suspicion of kidney or urinary tract injury.

All patients received intravenous bolus of about 100 ml of non-ionic iodinated contrast agent.

Free fluid quantification was done as a guide for decision to operate. This was done according system given by Federle and Jeffrey in 1983[2], and was graded as small, moderate or large.

Individual organ injuries were graded according to the OIS system and injury severity grades given by Mirvis et al, [3, 4] and Moore, E.E. et al [5, 6].

RESULTS

Of the 210 patients evaluated by us in the study, 166 patients were males and 44 patients were females giving a male to female ratio of about 4:1, as males have a more outdoor nature of work and more travel. The predominant age group involved between 21-30 years, constituting 31.90% of the total patients.

ETIOLOGICAL FACTORS:

Our study revealed that road traffic accidents involving both vehicle occupants and pedestrians accounted for 155 cases. Falls from a height and assaults accounted for 32 and 23 cases respectively.

CT FINDINGS:

The patients with haemoperitoneum or demonstrable abdominal visceral injury or both were considered as positive for intra abdominal injury. The patients whose examination did not reveal either visceral injury or haemoperitoneum were considered as negative for intra abdominal injury.

In our study consisting of 210 patients, we reported 63 patients as positive for abdominal injury and 147 patients as negative.

Out of the 63 positive patients reported in our study, haemoperitoneum was detected in 56 patients, visceral injury in 47 patients and 3 patients had injury to the abdominal wall secondary to trauma without visceral injury (Table 1).

Table: 1 Distribution of visceral injuries

Abdominal viscera involved	Number of cases	Percentage
Liver	14	29.79
Spleen	17	36.17
Pancreas	2	4.25
Kidney	3	6.39
Bladder	2	4.25
Bowel / Mesentery	8	17.02
Testis	1	2.13
Total	47	100

Among the visceral injuries, spleen was the most common organ involved (36.17%) followed by the liver, which accounted for 29.79% of cases.

Table: 2 Distribution of haemoperitoneum

Hemoperitoneum	Number of cases	Percentage
Associated with visceral injury	35	62.50
Isolated hemoperitoneum	21	37.50
Total	56	100

Table: 3 CT quantification of hemoperitoneum (Federle et al) 2

Description	Estimates	Approximate amount
Fluid in only one space	Small	100-200 ml
Fluid in two or more spaces	Moderate	250-500 ml
Fluid in all spaces or pelvic fluid anterior/ superior to urinary bladder	Large	>500 ml

Location of hemoperitoneum: 1. Perisplenic space, 2. Perihepatic space, 3. Morison's pouch, 4. Left paracolic gutter, 5.Cul-de-sac in pelvis.

HAEMOPERITONEUM:

In our study 56 patients out of the 210 patients evaluated had haemoperitoneum as one of the findings (Table 2). Of these, 35 cases were associated with visceral injuries at the time of diagnosis. The other 21 cases were diagnosed as isolated hemoperitoneum, though a diagnosis of

Table: 4 Quantification of haemoperitoneum

CT quantification of hemoperitoneum	Number of cases	Number of conservatively managed patients	Number of operated patients
Small	5	5	0
Moderate	9	6	3
Large	7	0	7
Total	21	11	10

mesenteric injury was suggested in 3 cases. CT quantification was done for these cases as suggested by Federle et al. [2], and they were classified as having mild, moderate or large hemoperitoneum (Table 3, 4). This quantification was used as an indicator for the need for laparotomy in patients with haemoperitoneum. In our study, cases of haemoperitoneum showed a density of about 40 - 55 Hounsfield units, except in one case of perforation to small bowel where the density was about 25 - 30 units.

Following laparotomy, mesenteric injury was noted in 5 cases of isolated hemoperitoneum. In one case, a small hepatic laceration was seen at laparotomy along the falciform ligament which was missed at initial scan, and was diagnosed as moderate hemoperitoneum. In another case, no visceral injury was detected at laparotomy but about 500 ml of blood was drained. One case with a large collection in pelvis revealed an injury to urinary bladder at laparotomy. CT was 100% sensitive in detecting haemoperitoneum.

VISCERAL INJURY:

In our study we reported 47 cases of visceral injury. These injuries were involving either one organ or more than one viscera. 43 out of these 47 cases were associated with haemoperitoneum. Thus majority of patients (91.49%) with visceral injury had associated haemoperitoneum.

Out of the 47 cases with visceral injury 40 cases went for laparotomy and 7 cases were managed conservatively. All the cases managed conservatively had uneventful recovery during the follow up period.

Figure 1: An 8-year old female patient who met with a vehicular accident showing grade III hepatic injury with laceration (arrow).

Injuries to the hepato biliary system: (Fig 1, Table 5)

In our study we found 14 cases with hepatic injury. One case of hepatic laceration along falciform ligament was missed at diagnosis found at laparotomy. All the cases were associated with haemoperitoneum and all cases went for laparotomy in our study. Majority (65%) of the injuries were grade III. Our study showed 100% association with haemoperitoneum. No case of biliary injury was reported in our study. The sensitivity, positive predictive values are 93.3%, 100% respectively.

Table: 5 Computed Tomography Scan-Based Injury: Severity Grades for Blunt Hepatic Trauma (Mirvis et al) 3

Grade	Criteria
I	Capsular avulsion, superficial laceration(s) <1cm deep, subcapsular hematoma <1cm maximal thickness
II	Laceration(s) 1-3cm deep, central/subcapsular hematoma(s) 1-3cm in diameter
III	Lacerations >3cm deep, central/subcapsular hematoma >3cm in diameter
IV	Laceration >10cm deep; central/subcapsular hematoma >10cm; lobar maceration or devascularisation; injury extending into major hepatic vein
V	Bilobar tissue maceration; parenchymal contrast "blush"; arterial contrast extravasation beyond capsule.

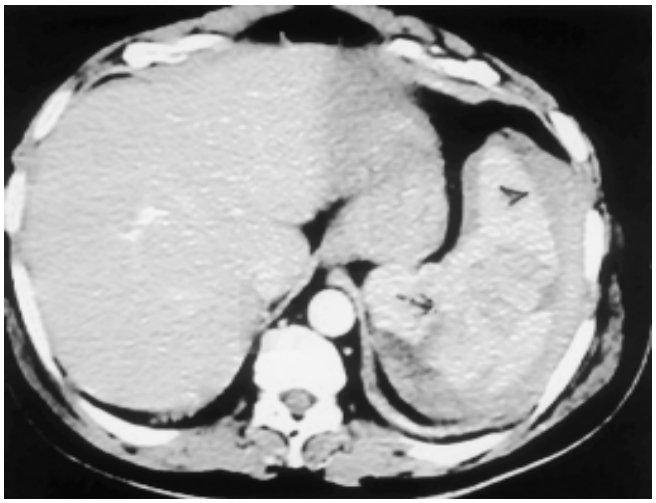

Figure 2: Grade IV splenic injury (arrow), with haemoperitoneum (arrowhead).

Splenic injury: (Fig 2, Table 6)

In our study we reported 17 cases with splenic injury. They constituted 26.98% of positive cases. One patient had an associated retroperitoneal hematoma. Most (53%) of the cases, belonged to grade III. Four patients, two belonging to grade I and one each belonging to grades II, and III were managed conservatively and the rest underwent laparotomy. A CT based score devised by Resciniti et al. [7], was applied to all these patients and those who were managed conservatively were found to have a score of less than three. Out of the 17 cases 14 were associated with haemoperitoneum giving an 82.35% association with haemoperitoneum. In our study we could diagnose all cases of splenic injuries and the sensitivity, positive predictive value and negative predictive values for splenic injuries are 100%.

Table: 6 Computed Tomography Injury Severity Grades in Blunt Splenic Injury (Mirvis et al) 4

Grade	Criteria
I	Capsular avulsion, superficial laceration(s), or subcapsular hematoma <1cm
II	Parenchymal laceration(s) 1-3cm deep, central/ subcapsular hematoma(s) <3cm
III	Lacerations >3cm deep, central/Subcapsular hematoma >3cm
IV	Parenchymal fragmentation into two or more sections
V	Intraparenchymal contrast blush or extravasation beyond capsule; progression of injury by follow-up CT; devascularized (nonenhancing) spleen

Table: 7 Grading of Splenic Injuries According to CT based Score (1-6) Referring to Parenchymal Injuries and Amount of Hemoperitoneum (Resciniti et al) 7

Finding	Points
Splenic Parenchyma:	
Laceration	1
Rupture (thick, irregular defects)	2
Shattered	3
Perisplenic fluid present	1
Any intra abdominal fluid (except perisplenic fluid) present	1
Any pelvic fluid present	1

Pancreatic and retroperitoneal injury :(Fig 3, Table 9)

We had two cases of pancreatic injury and one case of retroperitoneal haematoma. The case of retroperitoneal haematoma was associated with splenic laceration. Of the two cases of pancreatic injury, one was a case of acute pancreatitis following trauma who presented after a week of injury. This patient was managed conservatively. The other was a case of hematoma within the pancreas with a grade V injury which was not detected on initial ultrasonogram.

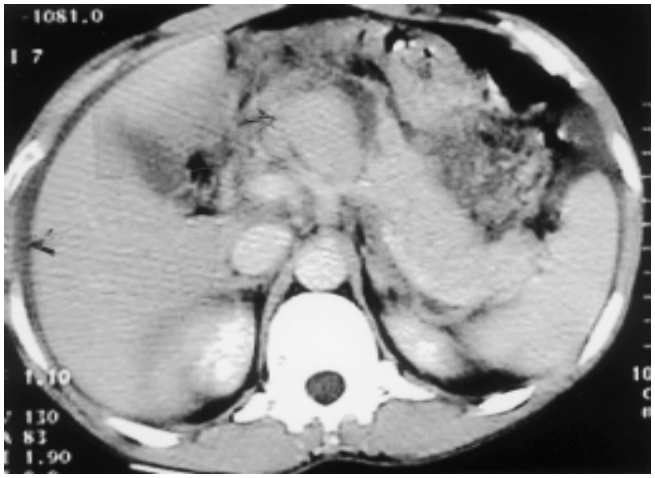

Figure 3: Grade V pancreatic injury with haematoma in the region of head of pancreas (arrow). Haemoperitoneum is also seen (arrowhead).

Table: 9 CT Grading of Blunt Pancreatic Injury (Moore, E.E., et al) 5

Grade	Criteria
I	Minor contusion or laceration without duct injury
II	Major contusion or laceration without duct injury or tissue loss
III	Distal transection or parenchymal injury with duct injury
IV	Proximal transection (to the right of mesenteric vein) or parenchymal injury involving ampulla
V	Massive disruption of pancreatic head

Renal injuries: (Fig 4, Table 10)

We detected 3 cases of renal injury in our study. They constituted about 4.76% of total positive cases for abdominal injury. One case was a grade V injury associated with retroperitoneal haematoma for which

Table: 8 CT based scoring of splenic injury

Score	Number of cases	Number of conservatively managed cases	Number of operated cases
1 - 3	5	4	1
4 - 6	12	0	12
Total	17	4	13

nephrectomy was done. The other two cases showed perinephric haematomas with grade III injuries. Open drainage was done for these two cases.

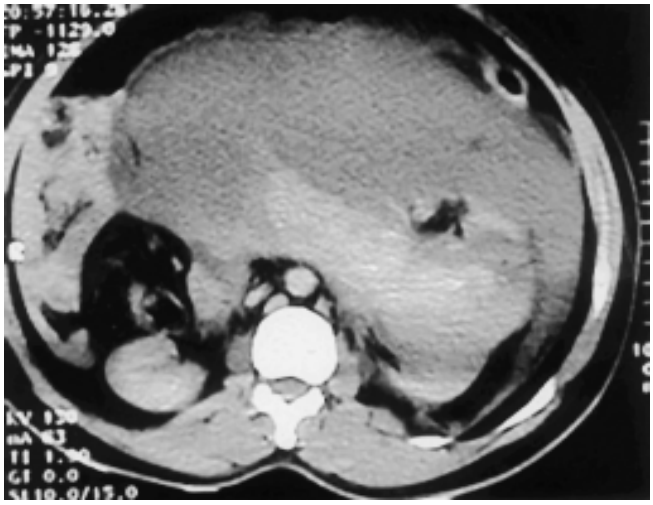

Figure 4: A patient with a road traffic accident showing grade V left renal injury with large retroperitoneal haematoma. Patient underwent nephrectomy.

Table: 10 CT Grading of Blunt Renal Injury (Moore, E.E., et al) 6

Grade	Criteria
I	Contusion or non-expanding subcapsular hematoma without laceration
II	Non-expanding perirenal hematoma or cortical laceration (<1 cm) without urinary extravasation
III	Laceration (>1 cm) without urinary extravasation, larger perinephric hematomas
IV	Laceration through the corticomedullary junction and into collecting system or segmental renal artery or vein with contained hemorrhage
V	Shattered kidney or avulsion of the renal pedicle

Bladder injuries:

We had 2 cases of bladder injury. Both of the cases were extra peritoneal bladder rupture. The diagnosis was missed in one case and laparotomy was performed for the presence of moderate to large hemoperitoneum with a hematoma in pelvis. In the other case, diagnosis was suggested by the presence of clots within the bladder. We found that CT was not as sensitive for diagnosis of bladder injuries as with other abdominal visceral injuries. Bowel and mesenteric injuries: (Table 11)

Haemoperitoneum was detected in all cases. In our study we could detect only 50% of bowel and mesenteric injury, giving sensitivity for bowel injuries as 66.7% (Table 12).

Injury to testis:

In our study, we reported one case of testicular injury which occurred following an assault. The patient had rupture of right testis with haematoma of the right hemiscrotum. His other abdominal viscera were normal. Abdominal wall injury:

We reported three cases of abdominal wall injury. Two cases were intramuscular haematomas and one case was that of a subcutaneous haematoma, occurring in the anterior and right lateral abdominal walls following blunt trauma to the abdomen.

DISCUSSION

The importance of CT in the diagnosis of abdominal trauma lies in its accuracy of identifying injuries that require early exploration and provides assessment of the severity of

Table 11: Computed Tomography Signs of Bowel Injury 8

Diagnostic	Suspicious
Pneumoperitoneum without known source	Bowel wall thickening >4 mm
Intramural, intramesenteric retroperitoneal air without known sources	Retroperitoneal fluid, especially anterior paraenal
Direct bowel wall discontinuity	Fluid between folds of mesentery (“Triangles”)
Extraluminal feces	Irregular bowel wall enhancement

Table: 12 Distribution of Bowel/Mesenteric injuries

Type of injury	Diagnosed	Missed	Total	Percentage of diagnosis
Bowel perforation	1	2	3	33.34
Mesenteric injury	3	2	5	60.00
Total	4	4	8	50.00

Table: 13 CT-OIS grading and management of solid organ injuries

Grade	Total number of cases	Number of conservatively managed cases	Number of operated cases
I	3	3	0
II	6	1	5
III	21	4	17
IV	4	0	4
V	2	0	2
Total	36	8	28

the injury which helps deciding the management. The rate of negative laparotomy is reduced by avoiding surgical intervention in cases that can be managed conservatively.

Though US is sensitive and a widely available preliminary investigative modality, it is inferior in detecting retroperitoneal and bowel injuries, and is operator dependent. Availability of CT is still limited, but it is diagnostically superior to US with its biggest advantage being the ability to assess the severity of trauma and providing a guide to further management. CT can also simultaneously assess other injuries related to trauma. Haemodynamic instability of the patient is a major deterrent for CT examination, although this forms an indication for operative intervention in patients with abdominal trauma.

CT findings:

Our study results reveal that 30% of the patients who were referred to us were positive for intra-abdominal injury, and 70% of the patients were negative. Udekwu PO et al [9] in 1996 reported 24.2% positive cases in their evaluation of 256 cases with abdominal trauma.

Haemoperitoneum:

Our study revealed haemoperitoneum in 56 (about 89%) of 63 positive cases. 21 (37.50%) of these cases were diagnosed as isolated hemoperitoneum, without solid organ injury. A quantification system devised by Federle et al [2] was used to grade the haemoperitoneum in these cases. This grading was used as an indicator to predict the need for laparotomy in patients with haemoperitoneum. In a study by Brasel KJ et al (1998), [10] there were 6 small bowel injuries detected out of 13 cases of hemoperitoneum without solid organ injury at laparotomy, which is about 46%. In another study by Mallik Kshitish, et al (2000), [11] 13 cases out of 21 were managed conservatively based on CT quantification of haemoperitoneum. Our findings correlated with their study in that we found good correlation of CT quantification of hemoperitoneum with management approach.

According to study of 256 cases by Udekwu PO et al (1996), [9] injury-specific sensitivities were lowest in injuries of the pancreas (0%), intestinal tract (41.6%), and bladder (50%). We recorded a similar sensitivity in cases of bowel and bladder injuries.

Nolan BW, (1995), [12] concluded in their study that CT scan is insufficient diagnostic modality and may result in missed injuries to mesentery and small bowel. In our study we had a similar experience and could detect only 50% of bowel and mesenteric injury.

The CT-OIS is reliable system that helps in deciding patient management, in that injuries with grade I and II can be manged conservatively and rarely require laparotomy (Table 13).

A scoring system devised by Resciniti et al was applied and it was inferred that patients who were managed conservatively had a score of less than three. However, according to a study by Umlas and Cronan, (1991), [13] this system is not completely reliable in predicting the outcome of nonsurgical management, 63 whereas we found the scoring system to be a useful guide for management.

Of all the 147 cases reported as negative none of them required surgery, giving CT 100% accuracy in reporting a negative study, thus making it a highly specific investigation. All these patients were discharged following an uneventful follow up. Our study results correlated well with the studies conducted by Udekwu et al [9] in 1996 (reported 97.6% accuracy).

To conclude, in our evaluation of blunt abdominal trauma in 210 patients we observed a sensitivity of 93% in detection of visceral lesions and haemoperitoneum, the specificity was 100% and the positive predictive value was 100%. Peitzman AB (1986) [14], Sriussadaporn (1993) [15], Udekwu PO (1996) [9] reported similar experience. CT also proved to be decisive in predicting the need for surgery in trauma patients. CT quantification of haemoperitoneum and organ injury grading is helpful in guiding the surgeon towards patient management. The extent of visceral injury was better appreciable on CT than on ultrasonogram.

The main pitfalls include its lower accuracy in detection of bowel and mesenteric injuries and bladder injuries. CT also has limitations in being an expensive investigation and requiring radiation exposure and can only be routinely done in haemodynamically stable patients.

CT has a very high negative predictive value and a low false negative rate. A negative CT scan needs only observation of the patient.

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BET VALUE