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ROLE OF MULTI DETECTOR COMPUTED TOMOGRAPHY IN EVALUATION OF BLUNT ABDOMINAL TRAUMA

Radiodiagnosis

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ABSTRACT

This prospective study was conducted to evaluate the usefulness of Multidetector 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). The findings were correlated with either clinical follow-up, follow up CT scans (if required) or surgical findings (wherever applicable).

This study highlighted that motor vehicle accident was the most common cause of bunt abdominal trauma. The majority of the patients involved were in the productive age group of 21-40 years making their optimal management vital. The most commonly injured organ in this study was spleen. CT was 100% sensitive in detecting haemoperitoneum. The overall CT analysis of visceral injuries in this study directed the appropriate management protocols in the majority of our patients except for those with bowel injuries. The successful management of bowel injuries requires a multi-modal approach combining CT findings with serial assessment of the clinical status of the patient.

With an overall sensitivity of 66.7 %, specificity of 100%, positive predictive value of 100%, negative predictive value of 94.1 % and accuracy of 94.7% in this study, it is concluded that CT is a superior diagnostic modality in the diagnosis and management of blunt abdominal trauma.

KEYWORDS

Computed tomography; Blunt Abdominal Trauma; Organ injury scaling

Objectives of our study were:

1. To evaluate the usefulness of Multidetector Computed Tomography (MDCT) in the detection of intra-abdominal injury in patients with blunt abdominal trauma and to provide information that could accurately determine the choice of management (non- operative versus operative)
2. To correlate the Computed Tomography (CT) findings with either clinical observation, follow up CT scans (if required) or surgical findings (wherever applicable).

MATERIAL AND METHODS:

- **Source of data:**

Data for the study were collected from patients attending/referred the Department of Radio-Diagnosis , Alluri Sita Rama Raju Academy of Medical Sciences, Eluru.

Method of collection of data:

A descriptive correlational study was conducted over a period of two years (November 2017 to November 2019) on 75 patients with blunt abdominal trauma. They were evaluated with six slice Multidetector Computed Tomography scanner (GE REVOLUTION 32 slice) and findings were correlated with either clinical follow-up, follow up CT scans (if required) or surgical findings (wherever applicable).

Free fluid quantification was done according to the system devised by Federle and Jeffrey[79] 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. [21], and Moore E.E. et al.[80]

Inclusion criteria:

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

Exclusion criteria: All haemodynamically unstable patients with obvious peritoneal signs and progressive abdominal distention – were taken up for surgery immediately and were excluded from the study.

Technique for CT study

Preparation of the patient:

Risks of contrast administration were explained to the patients and consent was obtained prior to the contrast study.

Routine anteroposterior topogram of the abdomen was initially taken in all patients in the supine position. 500 ml of water-soluble oral contrast for suspected perforation, (1%-2% iodinated contrast material), was given before examination in all cases (30-45 minutes before, if time permitted). Axial sections of 5 mm thickness were taken from the level of lung bases to the level ischial tuberosities. Kilovolt peak: 120–140 kVp, Milliampere second: 200-250mAs for an average-sized patient (increased values for an oversized patient). Pitch: 1.5, Field of view: 240–350 mm; Collimation: 2.5 mm, Time for scan : 4-5 seconds.

Plain scans were followed by intravenous contrast scans in suspended inspiration.

For intravenous contrast enhancement 80-100ml of dynamic injection of (Ultravist - 300mg Iodine per ml) or in children, a dose of 300mg of Iodine / Kg body weight was administered and axial sections were taken. Sections were taken in arterial (30 sec) and portal venous (60 – 90 sec) phases. Delayed scanning (5-7 minutes) was not routinely performed, only in suspected cases of renal or bladder trauma.

Artifact reduction techniques

- Decompress stomach with a nasogastric tube to prevent air-fluid artefact
- Withdraw nasogastric tube into the oesophagus immediately before scanning to prevent artefact
- Remove electrocardiographic leads from the scan field
- Raise the patient's arms (if tolerated) out of the scan field
- Use a large field-of-view scan technique.

Post-study reconstructions were done at 2.5 mm. Sagittal and coronal reconstructions were made wherever necessary. Newer techniques in multislice CT like curved planar reformatting, volume rendering, Maximum and minimum intensity projections and inversion were done as and when necessary. The magnification mode was commonly employed, and the scans were reviewed on a direct display console at multiple window settings (i.e. abdomen window at 320/40; Lung window 1400/-600; Bone window of 2400/200).

Table 1. Organ Injury Scaling for liver by Moore E.E. et al [8]

Liver injury scale (1994 revision)

Grade*	Type of Injury	Description of injury	ICD-9	AIS-90
I	Hematoma	Subcapsular, <10% surface area	864.01 864.11	2
	Laceration	Capsular tear, <1cm parenchymal depth	864.02 864.12	2
II	Hematoma	Subcapsular, 10% to 50% surface area: intraparenchymal <10 cm in diameter	864.01 864.11	2
	Laceration	Capsular tear 1-3 parenchymal depth, <10 cm in length	864.03 864.13	2
III	Hematoma	Subcapsular, >50% surface area of ruptured subcapsular or parenchymal hematoma; intraparenchymal hematoma > 10 cm or expanding		3
	Laceration	>3 cm parenchymal depth	864.04 864.14	3
IV	Laceration	Parenchymal disruption involving 25% to 75% hepatic lobe or 1-3 Couinaud's segments	864.04 864.14	4
V	Laceration	Parenchymal disruption involving >75% of hepatic lobe or >3 Couinaud's segments within a single lobe		5
	Vascular	Juxtahepatic venous injuries; ie, retrohepatic vena cava/central major hepatic veins		5
VI	Vascular	Hepatic avulsion		6

*Advance one grade for multiple injuries up to grade III

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Table 2. Organ Injury Scaling for Pancreas by Moore E.E. et al[80]

Pancreas Injury Scale

Grade*	Type of Injury	Description of Injury	ICD-9	AIS-90
I	Hematoma Laceration	Minor contusion without duct injury Superficial laceration without duct injury	863.81-863.84	2 2
II	Hematoma Laceration	Major contusion without duct injury or tissue loss Major laceration without duct injury or tissue loss	863.81-863.84	2 3
III	Laceration	Distal transection or parenchymal injury with duct injury	863.92/863.94	3
IV	Laceration	Proximal[a] transection or parenchymal injury involving ampulla	863.91	4
V	Laceration	Massive disruption of pancreatic head	863.91	5

*Advance one grade for multiple injuries up to grade III. *863.51,863.91 - head; 863.99,862.92-body;863.83,863.93-tail. [a]Proximal pancreas is to the patients' right of the superior mesenteric vein.

Table 3. Organ Injury Scaling for Spleen by Moore E.E. et al[80]

Spleen injury scale (1994 revision)

Grade*	Injury type	Description of injury	ICD-9	AIS-90
I	Hematoma	Subcapsular, <10% surface area	865-01 865.11	2
	Laceration	Capsular tear, <1cm parenchymal depth	865.02 865.12	2 2
II	Hematoma	Subcapsular, 10%-50% surface area; intraparenchymal, <5 cm in diameter	865.01 865.11	2
	Laceration	Capsular tear, 1-3cm parenchymal depth that does not involve a trabecular vessel	865.02 865.12	3
III	Hematoma	Subcapsular, >50% surface area or expanding; ruptured subcapsular or parecymal hematoma; intraparenchymal hematoma ≥ 5 cm or expanding		
	Laceration	>3 cm parenchymal depth or involving trabecular vessels	865.03 865.13	3
IV	Laceration	Laceration involving segmental or hilar vessels producing major devascularization (>25% of spleen)		4
V	Laceration Vascular	Completely shattered spleen Hilar vascular injury with devascularizes spleen	865.04 865.14	5 5

*Advance one grade for multiple injuries up to grade III.

RESULTS AND DISCUSSION

In this study, the youngest patient was 3 years old, and the oldest was aged 80 years. The maximum percentage of patients (29.3 %) were in the age range of 21 to 30 years. This was followed by patients in the age range of 31 to 40 years (22%). Majority of these patients (68%) were involved in motor vehicle accidents. Two patients (both male, in their late twenties) were involved in railway accidents. Regarding gender-wise distribution among individual modes of injury in this study:

- There were more male patients (73.3%) with blunt injury to abdomen than female patients and male patients outnumbered the female patients in all modes of injury.
- Most of the male patients involved in motor vehicle accidents were in the 21-30 year age group.
- 12 patients (16%) belonged to the pediatric age group. Equal numbers of children were involved in Motor Vehicle Accident and fall from height. No children in this study sustained a blunt injury to the abdomen by assault.

Out of 75 patients in this study, 76% (57 patients) were positive for abdominal injury and 24% (18 patients) were negative. Most of our patients sustained polytrauma with injuries involving more than one viscera or system. There was one death in this study, the patient died of associated head injuries.

Distribution of visceral injuries

Abdominal viscera involved	Number of Injuries	Percentage (%)
Liver	21	28.8
Gall bladder	1	1.4
Biliary system	1	1.4
Spleen	27	36.9
Pancreas	1	1.4
Renal	15	20.5
Bowel/Mesentery	3	4.1
Bladder	4	5.5
Total	73	100

INJURY TO HEPATOBILIARY SYSTEM:

In this study we had 21 cases of liver injuries, the majority of them (12) were grade III injuries, 57%. There was one case of injury to gall bladder which presented as minimal haemorrhage into gall bladder lumen, and one case of injury to intrahepatic biliary ducts which presented as multiple bilomas. We had one case of grade V liver injury and no case of grade VI liver injury. No hepatic injury required operative management.

INJURY TO SPLEEN:

The most commonly injured organ in this study was spleen. 27 cases of the 49 with hemoperitoneum had splenic injury. Majority of them (17) were grade III injuries, 63%. No splenic injury required operative management.

RENAL INJURIES

Renal injuries were the third most commonly injured organ in this study, there were 15 cases. Out of them 6 were grade IV injuries (40%). There was one case of grade V injury for which nephrectomy was done. However, all the rest of the cases managed conservatively did well on follow up.

PANCREATIC INJURIES

There was one case of pancreatic injury in our study. There was complete transaction of the pancreas at the neck. This patient underwent surgery.

BOWEL AND MESENTERIC INJURIES

3 cases of bowel Injury were diagnosed based on CT findings of pneumoperitoneum in one case, pneumoperitoneum and extravasation of oral contrast in the second case and suspicious bowel wall thickening in the third case. In addition, 3 cases of bowel injury was additionally diagnosed in the clinically unstable cases of isolated hemoperitoneum taken up for surgery. In this study, we could detect only 50 % of the bowel (3 out of the 6 cases). The direct CT signs of bowel Injury are Pneumoperitoneum without known source, intramural/intra-mesenteric/retroperitoneal air without known sources, direct bowel wall discontinuity and extraluminal faeces. The Indirect CT signs are bowel wall thickening > 4 mm, retroperitoneal fluid, especially anterior pararenal, fluid between folds of mesentery ("Triangles") and irregular bowel wall enhancement.

BLADDER INJURIES

This study had 4 bladder injuries, 3 extraperitoneal and 1 intraperitoneal. All cases of bladder injuries were associated with pelvic fractures. The intraperitoneal bladder injury was taken up for surgery CT quantification of hemoperitoneum was done as devised by Federle and Jeffrey[77], and they were classified as having mild, moderate or large hemoperitoneum. 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 45 to 65 Hounsfield units.

All the CT findings of hemoperitoneum and/or solid organ injury were confirmed in the 9 cases taken up for surgery in this study; however, bowel injury was additionally noted in 3 cases of isolated hemoperitoneum and one case of renal injury was upgraded from grade II to III. CT was 100% sensitive in detecting haemoperitoneum.

CONCLUSION-

The challenge in imaging 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. Most of our cases, 68% (51 out of 75) of blunt injury to the abdomen were secondary to motor vehicle accidents. Majority of the patients (51.3%) were in the age group of 21 to 40 years, representing the younger generation who make a major contribution to society.

76% of the cases (57 of 75) were positive for intra-abdominal injury and most were polytrauma patients with injuries involving more than one viscera or system. In these patients, CT was simultaneously also able to diagnose associated injuries to the head, thorax, spine and extremities.

CT was 100% sensitive in detecting haemoperitoneum. All the CT findings of hemoperitoneum and/or solid organ injury were confirmed in the 9 cases (15.8%) taken up for surgery, with 3 additional cases of bowel injury detected on laparotomy and one case of renal injury upgraded from grade II to III.

Spleen was the most commonly injured organ in this study, followed by liver and kidney. In this study, we could detect only 50% of bowel and mesenteric injuries. CT scan findings in bowel and mesenteric injuries can be subtle and non-specific. Surgical exploration should be considered in patients with more than one suspicious finding for bowel or mesenteric injury on CT scan. Since no single diagnostic modality has proven superior in reliably diagnosing bowel injuries, the successful diagnosis requires a multi-modal approach, taking into account the mechanism of injury, clinical status, serial physical examination, pertinent laboratory data, and the appropriately selected diagnostic imaging modalities.Pancreatic injuries are clinically important because death occurs in 16- 20% cases of pancreatic trauma. Since pancreatic injuries are uncommon and we had only one case of pancreatic injury which was not missed on CT, we cannot effectively judge the accuracy of CT in pancreatic injuries based on a single case.

Hence, in the overall analysis of visceral injuries in our study, OIS grading in isolation appeared to predict the management protocols in the majority of our patients except for those with bowel injuries.

Even a negative CT scan is of as much value as a positive one since it will discourage unnecessary admission or emergency abdominal exploration. This is particularly important in patients with multiple injuries such as severe cranial or extremity injuries in whom the additional stress of abdominal surgery would be undesirable.

In conclusion, CT is a superior diagnostic modality in the diagnosis and management of blunt abdominal trauma

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