MULTI DETECTOR COMPUTED TOMOGRAPHY EVALUATION OF BLUNT ABDOMINAL TRAUMA

Vedaraju Kadaba Shamachar[1], Srinivas Maskal Revanna[2], Chandalingappa Kuri[3]

[1]Associate Professor, Department of Radio-diagnosis, Bangalore Medical College and Research Institute, Bangalore.
[2]Assistant Professor, Department of Radio-diagnosis, Bangalore Medical College and Research Institute, Bangalore.
[3]Post Graduate Student, Department of Radio-diagnosis, Bangalore Medical College and Research Institute, Bangalore.

ABSTRACT

AIM

The aim of our study was to assess the diagnostic role of Multi-detector computed Tomography (MDCT) in the evaluation and management of blunt abdominal trauma.

MATERIAL AND METHOD

A Prospective study of 100 patients referred to our department was conducted from January 2015 to December 2015. IV contrast and oral /rectal contrast were used. Multiplanar reformations were done. CT findings were analysed, compared and confirmed by either operative findings or follow-up CT scan.

RESULTS

100 cases with history of blunt abdominal trauma or diagnosed with ultrasonography were considered in this study. Ultrasound and MDCT of abdomen were performed. Spleen was the most common organ to be injured, USG findings and MDCT findings were compared with per operative findings. Patients who were managed conservatively were compared with repeat follow up CT findings. USG showed a sensitivity of 93.7% and specificity of 100% in solid organs injury and sensitivity of 84% and specificity of 100% in free fluid detection. MDCT showed a sensitivity of 100% and specificity of 100% in solid organs injury and 100% in haemoperitoneum.

CONCLUSION

MDCT is the modality of choice to evaluate blunt abdominal injury and to determine the appropriate management, either surgical intervention or conservative management.

KEYWORDS

Multi detector computed Tomography (MDCT), Ultrasonography (USG).

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INTRODUCTION: Imaging in abdominal trauma has seen a quantum leap with Multi Detector CT Scan (MDCT) with its three dimensional reconstruction, angiography techniques and scanning times being progressively decreased and image resolution has increased reducing motion artefacts. High resolution ultrasound USG being cost effective can detect the solid organ injury and free fluid but had limitation in evaluating injuries to pancreas, bowel, kidney, adrenal, mesentery, diaphragm, vascular and spine injury. While MDCT detect these injuries better and also detects lower thoracic injury. The accurate detection of bowel and mesenteric injuries has also improved with the development of thin section multidetector CT.[1] It also allows high quality two-and three-dimensional multiplanar reformatted images to be obtained, which aid in the diagnosis of the complex multisystem traumatic injuries and guiding the management of patients. The primary advantage of CT scanning is its high specificity and use for guiding non-operative management of solid organ injuries.

In addition, a CT scan of the abdomen can reveal other associated injuries, notably vertebral and pelvic fractures and injuries in the thoracic cavity.[2]

Objective of present study is to diagnose the injuries to the organs which are difficult to evaluate by USG. To grade the solid organ injuries which are of prognostic significance. And Comparison of USG and CT scan findings with operative findings.

MATERIAL AND METHODS: This prospective study was carried out in 100 patients, clinically suspected of having internal abdominal injuries at our institution from January 2015 to December 2015.

Detailed history and clinical examination was carried out. USG was done in all patients. MDCT is done in patients having haemoperitoneum with normal appearance of solid organs and positive history of trauma suspecting pancreas, vascular and bowel injury. No gender and age predilection was considered. The USG and MDCT findings in the patients

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Corresponding Author:
Dr. Chandalingappa Kuri,
Post Graduate Student, Department Of Radio-diagnosis,
Bangalore Medical College and Research Institute,
Bangalore-560002.
E-mail: chandu.pioneers@gmail.com
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requiring operative management were compared with intra-operative findings.

MDCT examinations were carried out with standard abdominal trauma protocol using intra venous non-ionic contrast media and oral/rectal contrast as and when required (for bowel trauma). Protocol included plain study, followed by intra venous contrast study (2ml/kg with flow rate of 23ml/second) in arterial phase (bolus tracking) and venous phase(70-80 seconds delay) with delayed full bladder scan was performed when required. CT angiography was done for suspected vascular injury. Penetrating injuries were excluded in this study.

RESULTS: MDCT findings were compared with operative results; follow up CT scan/USG. Specificity and sensitivity of the MDCT findings were obtained. Patients of all age group were included in our study

In this study the youngest patient was 7years old and oldest was aged 67 years (Table 1). The maximum percentage of patients 30% were in the range of 21-30 years. This was followed by patients in the range of 31-40 years (24%). Majority of these patients were involved in road traffic accident (Table 2). One patient with isolated pancreatic injury was involved in bicycle handle injury. Following gender distribution among the individuals and mode of injury were found in this study. Incidence of male preponderance accounting for (81%) compared to the female (19%) was noted with blunt injury to abdomen and males out numbed the female patients in all types of mode of injury. Most of the male patients involved in road traffic accident were in the 21-30 years of age group. 15 patients were in the paediatric age group out of which 10 were involved in road traffic accident and 5 had fall from height. In this study out of 100 patients 98 were positive for solid organ injury and 2 had Mesenteric injury. Splenic injury was most common accounting for 54% in this study. In present study abdominal sonography had a sensitivity of 97.8%, specificity of 100% and negative predictive value of 75% in diagnosing solid organ injury and abdominal MDCT had a sensitivity of 100%, specificity of 100% and negative predictive value of 100% in diagnosing solid organ injury. So our study shows MDCT is the investigation of choice for blunt abdominal organ injury. Frequency of solid organ injuries were spleen 54%, liver 32%, kidneys 24% and pancreas 5%.

CECT showed contrast extravasation indicating bladder rupture and pelvic fractures. Renal injuries were the 3rd most commonly injured organ (Table 4) accounted for (24%) cases. Out of 84 cases presented with haemoperitoneum 12 cases had gross haemoperitoneum (Table 5), 2 cases out of 12 had Mesenteric injury without other solid organ injury. Thus without evidence of solid organ injury with presence of gross haemoperitoneum suspects mesenteric injury.

Age in years	Number	Percent
0-10	05	05
11-20	12	12
21-30	30	30
31-40	24	24
41-50	15	15
51-60	10	10
61-70	04	04
Total	**100**	**100**

Table 1: Age distribution of patients studied

In this study youngest patient was 7 years and oldest was 67 years. Maximum patient were in age range of 21-30 years (table 1).

Gender	Numbers	Percentage
Male	81	81%
Female	19	19%
Total	**100**	**100%**

Table 2: Gender distribution

In this study there were more males patients (81%) with blunt injury abdomen than female patients (Table 2)

Mode of injury	Males	Females	Total
RTA	61	14	**75**
Fall from height	11	03	**14**
Assault	08	02	**10**
Stampede	01	00	**01**

Table 3: Mode of blunt injury abdomen

In this study most common mode of injury was RTA.

Abdominal visceral organ	Number
Liver	32
Spleen	54
Pancreas	05
Kidney	24
Bowel	04
Urinary bladder	02
Mesenteric injury	02

Table 4: Distribution of abdominal visceral injuries

Grade	Number
Mild (+)	30
Moderate (++)	42
Gross (+++)	12

Table 5: Haemoperitoneum

Statistics for solid organ injuries:

Total number of cases	100
Total number cases positive of solid organ injury in MDCT	98
Total number of cases without solid organ injury in MDCT	2
Ultrasound positive for solid organ injury	90
Ultrasound missed solid organ injury	6

Solid organ Injury				Total
		Positive	Negative	
Ultrasound	Positive	90	00	**90**
	Negative	06	02	**08**
Total		**96**	**02**	**98**

Table 6: Solid organ injury positivity and negativity in USG

Solid organ injury				Total
		Positive	Negative	
MDCT	Positive	98	00	**98**
	Negative	00	02	**02**
Total		**98**	**02**	**100**

Table 7: Solid organ injury positive and negativity in MDCT

DISCUSSION: Blunt abdominal trauma in isolation represents 5% of the trauma mortality and further contributes 15 % to mortality as part of polytrauma.[3] In our study, abdominal USG was performed as the initial imaging modality. MDCT was performed only when USG alone was not helpful for management of patients. Operative results were compared with MDCT and USG findings. Patients with conservative management were regularly followed up with MDCT/USG. The most widely used injury grading system is the American Association for the Surgery of Trauma (AAST) scale.[4] USG is a portable, economical, easily available, and fast and a bed side procedure. Though it gives lot of valuable information in trauma patients, it has its own pitfalls. USG gives basic idea regarding haemoperitoneum and organ injury, but has limitation for retroperitoneal organs, pelvic, vascular and bony injuries. In poly trauma patients timely management is very important and thus with MDCT we get complete evaluation regarding number of organs injured and grading of injuries. Thus MDCT proves to be a boon for surgeons in the management of the patient whether surgical or conservative is to be undertaken. In cases where operative management is required, it aids in planning the surgery well and vascular surgeon can be informed beforehand if the MDCT findings point towards the need for any vascular intervention.

Hemodynamically stable patients with positive USG findings may require a CT scan for defining the nature and extent of injuries. Thus high laparotomy rate can be reduced with only CT findings.

Hemodynamically stable patients with negative USG findings require close observation, serial abdominal examinations, and a follow up examination. However MDCT is strongly recommended in the patients with other associated injuries. Hemodynamically unstable patients with negative USG findings are a diagnostic challenge. Options include diagnostic peritoneal lavage, exploratory laparotomy, and non-invasive and preferred CT scan in almost all cases after aggressive resuscitation.

Splenic Trauma: Spleen is most commonly injured organ following blunt abdominal injury. Spleen is the most vascular organ of the body containing 500 to 600 ml of blood. Splenic injury is commonly associated with other organ injuries. CT is modality of choice for imaging of splenic injuries.[5] More than 70% of the patient of splenic injury are treated with conservative management. Surgical intervention is required when large perisplenic hematoma and splenic vascular injury. Splenic contusion is seen as non-enhancing hypodense area within spleen (Fig. 1a) Perisplenic hematoma seen as large hyperdence collection with haemoperitoneum (Fig. 1b)

Fig. 1a: Axial contrast enhanced CT image showing grade IV splenic laceration image

Fig. 1b: Axial contrast enhanced CT image showing laceration involving lower pole of spleen with significant subcapsular collection

Over all ultrasound has sensitivity of 63% and specificity of 80%, MDCT has sensitivity of 97% and specificity of 98%.

LIVER TRAUMA: The liver is the second most frequently injured solid abdominal organ after spleen. The right lobe is injured more frequently and severely than left (Fig. 2a), posterior segments are more frequently injured than anterior (Fig. 3b).[5] Blunt hepatic injuries in hemodynamically stable patients without other indications for exploration are best served by a conservative, non-operative approach.[6,7,8] Some small laceration s were easily controlled by sutures

and haemostatic agents. Deep lacerations should not be simply closed because of the risk of abscess formation and haemophilia. Liver contusion seen as ill-defined hypodense area without enhancement and laceration seen as linear non enhancing hypodense tract from liver parenchyma to surface (Fig. 2b) In case of active extravasation of contrast from the vessel is indicative of surgical exploration.

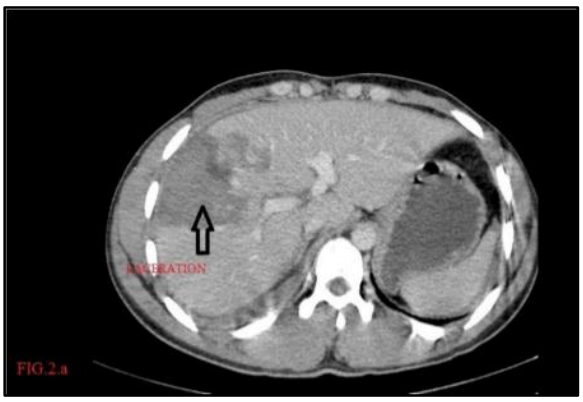

Fig. 2a: Axial contrast enhanced CT image showing liver laceration

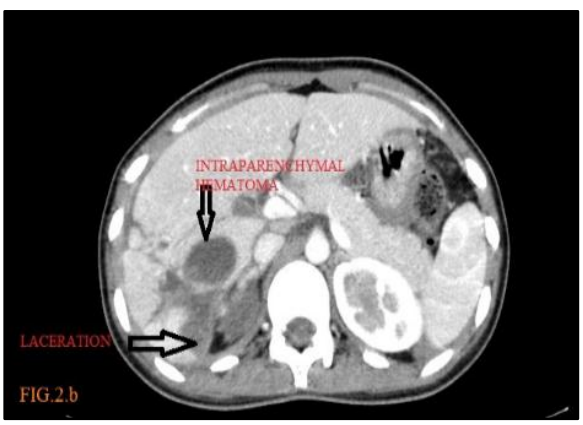

Fig. 2b: Axial contrast enhanced CT image showing liver lacerations and intra parenchymal Hematoma

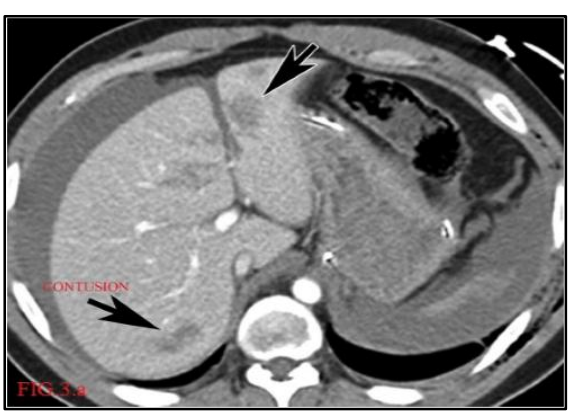

Fig. 3a: Liver Contusions

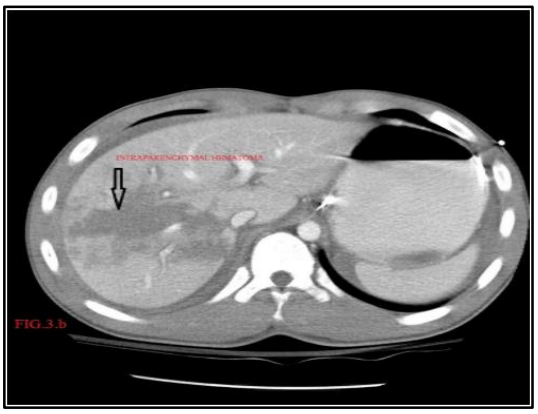

Fig. 3b: Contrast Enhanced CT- Intraparenchymal Hematoma

Over all ultrasound has sensitivity of 48% and specificity of 75%, MDCT has sensitivity of 97% and specificity of 98%.

Renal Trauma: Renal injury is common occurring in 8-10% of cases of blunt and penetrating trauma. About 90% of renal injuries result from blunt force injury. CT has become the primary diagnostic tool for the rapid and accurate assessment of acute traumatic genitourinary injuries, as well as for the diagnosis of related complications (Fig. 4a) Injuries involving renal hilum are seldom primarily and in most of the cases total nephrectomy. Blunt trauma involved minor includes contusion 85% and mostly treated with conservative management and major includes deep cortico medullary lacerations with extravasation, large perinephric hematoma, and renal pedicle injury. (Fig. 4b).

Fig. 4a: Axial contrast enhanced CT image showing grade IV renal injury with Peri renal collection

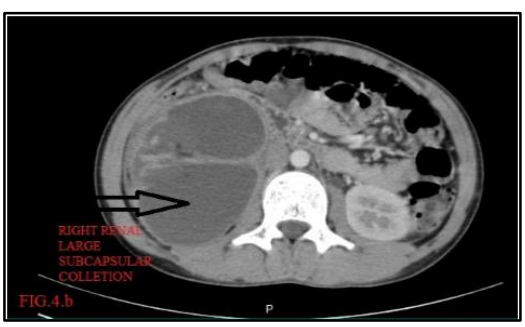

Fig. 4b: Axial contrast enhanced CT image showing large hypodense collection in sub capsular location of right kidney with multiple enhancing septations- infected urinoma

Over all ultrasound has sensitivity of 63% and specificity of 78%, MDCT has sensitivity of 97% and specificity of 97%.

Bowel Trauma: The diagnosis of intestinal injury is one of the most difficult and controversial aspects of trauma care. A delay in diagnosis of bowel injury of only 8 hours has been shown to increase morbidity and mortality.[9,10] A delay may result in peritonitis, ongoing haemorrhage, bowel ischemia, and necrosis. Rupture of a hollow viscus may produce free air either in the peritoneal cavity (Fig. 5), but may also occur following pneumothorax and mechanical ventilation.[11] Additional findings of free intraperitoneal fluid may be seen. Contrast studies employing water soluble contrast media are useful in detecting perforation and intraluminal obstruction in stable patients. MDCT is the diagnostic modality of the choice for detection of bowel and mesenteric injuries and has been shown to be more sensitive and specific than clinical examination, diagnostic peritoneal lavage and abdominal ultrasound. Negative abdominal CT results are inadequate to safely rule out a perforated small bowel injury.[9] The sign of bowel injury are frequently subtle. The most specific sign of bowel injury are.

Pneumoperitoneum or Pnuemo-retroperitoneum-Extravasation of oral contrast material -Low attenuation fluid between loops-Bowel wall discontinuity.

MDCT is very helpful when retroperitoneal bowel is perforated, which is masked by x-ray and USG. Clinical suspicion about such injury is many times diagnosed by oral and rectal contrast CT scan. Early evaluation of colon injury much more important to prevent ischemia. Mesenteric tear may or may not associated with bowel injury. Haemoperitoneum without any solid organ injury suggest possibility of mesenteric injury.

The sensitivity of CT to traumatic bowel injury varies from 69% to 92% and CT is 94%–100% specific for the diagnosis of bowel and mesenteric injuries. CT findings can include focal bowel wall thickening, mesenteric infiltration, free air, the presence of intraperitoneal fluid without solid organ injuries and extravasated contrast material. Free air adjacent to bowel segment is more sensitive for perforation of that segment of bowel.

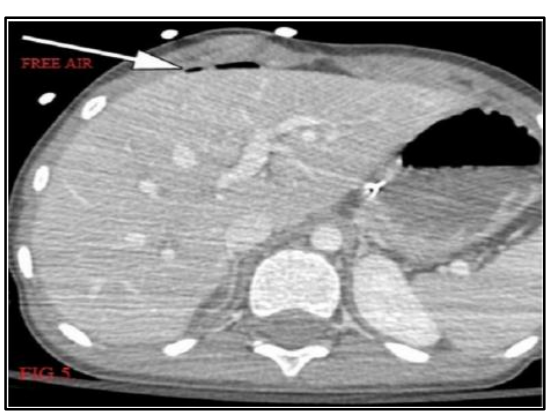

Fig. 5: Axial CT image showing pneumoperitoneum

MDCT in detecting bowel trauma is 87% and specificity is 84%

Pancreatic Trauma: The pancreas is the least commonly injured solid organ, accounting for 3.12% of all abdominal injuries. This injury occurs after a sudden force that compresses the pancreatic neck against lumbar spine (Fig. 6), e.g. in motor vehicle accidents in adults and bicycle accidents in children. Pancreatic injuries are difficult to diagnose.[5] Initial CT findings may be normal, even with pancreatic transaction, because the elastic pancreatic parenchyma resumes its normal contour. A repeated CT abdominal scan at 24 to 48 hours can help reveal evolving injuries. A delay in diagnosis can often result in recurrent pancreatitis, pseudocyst, and fistula or abscess formation.

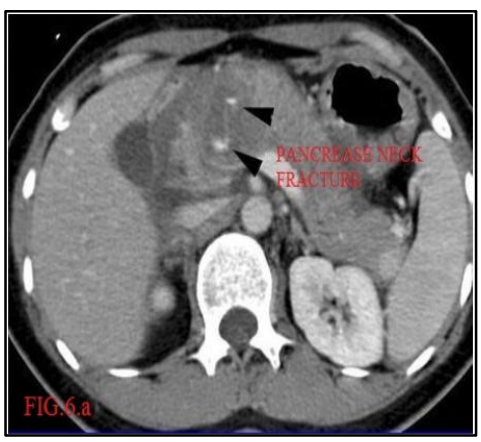

Fig. 6: Pancreatic neck fracture with active extravasation

Over all ultrasound has sensitivity of 38% and specificity of 25%, MDCT has sensitivity of 88% and specificity of 99%.

Urinary Bladder Trauma: Bladder injuries may be due to blunt, penetrating or iatrogenic trauma. Majority of the patients of bladder trauma have associated fracture of pelvis most commonly of the anterior pubic arch. A distended bladder is more prone to injury. The patient presents with suprapubic pain or tenderness and/or haematuria (Fig. 7) Differentiation between intraperitoneal and extraperitoneal rupture is very important for management. Extraperitoneal rupture is mostly managed by conservative approach or in some cases operative management was done after patient stable. While in case of intraperitoneal rupture operative management is required. A classification of bladder injury after blunt abdominal trauma has been described by Sandler et al.[12]

Fig. 7: Haemorrhagic content in bladder

Over all ultrasound has sensitivity of 81% and specificity of 77%, MDCT has sensitivity of 92% and specificity of 90% in UB trauma.

Free Fluid: The dependent portions of the abdomen and pelvis should be scrutinized thoroughly in trauma patient to detect small quantities of fluid that may indicate a subtle intraperitonealinjury.[13]

CT has high sensitivity and specificity for the detection of blood in the peritoneal cavity. (Fig. 8).

Haemoperitoneum starts near the site of injury and spreads along the expected anatomic pathways.

Over all ultrasound has sensitivity of 95% and specificity of 100% in free fluid detection these is comparable with study by K. A. Lentz, M. G. Mc Kenney, D. B. Nunez which shows sensitivity 85% and specificity 95%.

Fig. 8: Axial CECT section of pelvis - high dense collection in pelvis - haemoperitoneum

Retroperitoneal Injury: The most commonly injured structures are the adrenals, pancreas, major vessels, gastrointestinal tract, genitourinary tract and musculoskeletal system.[14] Over all ultrasound has sensitivity of 50% and specificity of 50%, MDCT has sensitivity of 98% and specificity of 67%.

Diaphragmatic Injury: Blunt trauma and penetrating wounds of the chest are the most frequent causes of traumatic diaphragmatic rupture. In blunt trauma, the tear is left sided in 70-90 percent of all cases and right sided in 10-30 percent. This is probably due to the protective function of the liver(15). The stomach is the most commonly herniating organ, but bowel, spleen, liver, and omentum can also herniated into the chest.

Abdominal Wall Trauma: Abdominal wall injuries are easily overlooked if not specifically seen. Intramuscular hematomas appear as collection with expansion of intramuscular plane of abdominal wall. Subcutaneous hematoma and occasionally bowel herniation can occur.[16]

The most important concern of non-operative management is the potential for missed injuries, particularly hollow viscus perforations. Delay in diagnosing a hollow viscus injury is associated with significant morbidity and increased mortality.[17]

CONCLUSION: MDCT is the modality of choice for blunt abdominal trauma management as sensitivity and specificity is very high with MDCT than USG. Availability and cost is only limiting factor in developing countries, but for better management of patients having blunt abdominal trauma MDCT is very helpful.

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