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Diagnostic accuracy of Multidetector Computed Tomography in Evaluation of Blunt Abdominal Injury

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ABSTRACT

Introduction: *Rapid detection of life-threatening abdominal injuries and promptly initiating appropriate care reduces trauma related mortality and morbidity. Accurate clinical evaluation may be difficult in altered consciousness and in severe external injuries. Computed Tomography (CT) scans are very sensitive in identifying intra-abdominal injuries and helps to avoid unwanted exploratory laparotomy. In this study, we aim to assess the pattern of abdominal visceral organ injury identified during contrast enhanced multidetector CT scan in patients with blunt abdominal trauma and the accuracy of CT scan in detecting abdominal organ injury.*

Materials and Methods: *This was a prospective observational study conducted in the department of Radiodiagnosis, from January 2013 to June 2014. All hemodynamically stable patients referred from surgery department with history of blunt abdominal trauma for triphasic CT examination after a preliminary ultrasound showing fluid in the peritoneal cavity were included in the study. Injury to abdominal visceral organs and presence of free fluid in the peritoneal cavity were recorded. Injuries to liver, spleen and kidneys were graded. The data was managed with Microsoft Excel and the descriptive analysis of abdominal injuries were presented as percentages. The sensitivity, specificity, positive predictive value and negative predictive value of CT scan for detection of individual abdominal visceral organ injuries were also calculated based on findings seen during laparotomy in 32 patients.*

Results and Conclusion: *Among the 125 patients, most common were liver and spleen injuries (29.6% each, n=37) followed by renal injuries (19.2%, n = 24). When compared with the laparotomy findings CT scan was found to be very sensitive and specific in identifying injuries to liver, spleen, kidneys and urinary bladder; however it was less sensitive in identifying bowel and pancreatic injury and retroperitoneal hematoma.*

Key words: *Blunt injury, Abdomen, Computed tomography, Liver.*

INTRODUCTION

Abdominal visceral organ injury is one of the leading causes of death in trauma. Prompt identification of life-threatening injuries with immediate appropriate care reduces trauma related mortality and morbidity. Abdominal examination

and diagnostic peritoneal lavage have been the main tools in evaluation of abdominal trauma for a long time. However, accurate clinical evaluation may be difficult in altered consciousness and in severe external injuries. Later ultrasonography and computed tomography scans have emerged as sensitive tools in assessing abdominal injury. Various studies have been conducted comparing the efficacy of ultrasound and CT scan in evaluation of abdominal trauma [1-5]. Abdominal ultrasonography is more economical, less time consuming, non-invasive and can be repeated. There are various studies which have demonstrated increased sensitivity of computed tomography in identifying intra-abdominal injuries [6,7]. Although more costly and involves radiation, computed tomography is now extensively used in hemodynamically stable patients for accurate assessment of abdominal viscera especially in continuing bleeding and identification of co-existent bony and hollow visceral injury. This has influenced the present-day trends in surgical management leading to the avoidance of unwanted exploratory laparotomy. In this study, we aim to assess the pattern of abdominal visceral organ injury identified during contrast enhanced multidetector CT scan in patients with blunt abdominal trauma and the accuracy of CT scan in detecting abdominal organ injury.

MATERIALS AND METHODS

This was a prospective observational study conducted in the department of Radiodiagnosis during a period of 18 months between January 2013 and June 2014. All hemodynamically stable patients who were referred to Radiodiagnosis department for contrast enhanced CT examination from the Surgery department, who had a history of blunt abdominal trauma and had undergone a preliminary abdominal ultrasound which showed fluid in the peritoneal cavity were included in the study. Study was started after getting approval from the institutional ethics committee. Informed consent was obtained from all the patients and confidentiality was maintained. Preliminary ultrasound examination was conducted using Mindray DC08 machine in haemodynamically stable patients using the C5 curvilinear transducer. Contrast enhanced Computed Tomography was done using Siemens Somatom Emotion – 16. Axial plain CT sections of 5mm thickness were taken on the same day or next day of doing ultrasound, from the level of lung bases to the level of hip joints followed by post-contrast scan in suspended inspiration in arterial and venous phases in craniocaudal direction. Delayed phase CT was also taken when urinary tract injury was suspected. Post study reconstructions were done at 1.5 mm intervals in axial, sagittal and coronal planes. The scans were reviewed on a direct display console at multiple window width and level settings. (abdomen window at 320/40, Lung window1400/-600, Bone window of 2400/200). Injury to liver, gall bladder, spleen, pancreas, kidneys and urinary bladder and presence of free fluid in the peritoneal cavity were recorded. The secondary signs such as pneumoperitoneum, extraluminal air, thickened bowel walls and mesenteric fluid collections were used to identify bowel and mesenteric injury. Injuries to liver, spleen and kidneys were graded according to American Association for the Surgery of Trauma injury scoring scale [8,9]. Hemoperitoneum quantified into small, moderate and large as suggested by Federle et al.[10]. The data was managed in Microsoft Excel.. The descriptive analysis of abdominal injuries were presented as percentages. The sensitivity, specificity, positive predictive value and negative predictive value of CT scan for detection of various abdominal visceral organ injuries were also calculated based on laparotomy findings in 32 patients

RESULTS

In this study, 125 patients were included, of which 103 (82.4%) were males and 22 (17.6%) were females. The common causes of injury were road traffic accidents in 47.2% (n=59) and fall from height in 38.4%(n=48). Liver and spleen were the most commonly injured organs [Table 1].

Table1. CT Findings in Patients with Blunt Trauma Abdomen

Organ Injury	Number of patients	Percentage of injury
Liver Injury	37	29.6%
Splenic Injury	37	29.6%
Pancreatic Injury	3	2.4%
Renal Injury	24	19.2%
Bowel And Mesenteric Injury	7	5.6%
Bladder Injury	5	4%
Retroperitoneal Haematoma	9	7.2%

Combined organ injuries were noted in 8 cases in CT. Among the 37 patients with liver injury, grade 1 injury was noted in 8.11% (n=3), grade 2 injury in 35.14% (n=13) and grade 3 injury in 56.76% (n=21). Splenic injury was seen in 37 patients of which 13.5% (n=5) were grade 1, 29.7% (n=11) were grade 2, 45.9% (n=17) were grade 3 and 10.8% (n=4) were grade 4 [Figure 1]. Among the renal injuries in 24 patients, 50% (n=12) were having grade 2 injury, 25% (n=6) had grade 3 injury, 20.83% (n=5) had grade 4 injury and 4.17 % (n=1) had grade 5 injury[Figure 2]. CT detected hemoperitoneum in 119 patients (large hemoperitoneum in 8 patients, moderate hemoperitoneum in 55 patients and small hemoperitoneum in 56 patients).

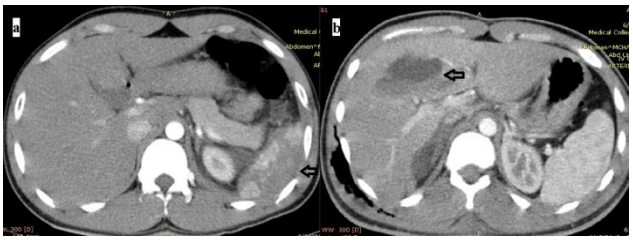

Figure 1. a) Post contrast axial CT section of abdomen showing hypodense area in spleen (arrowhead) suggesting grade 3 splenic injury with perisplenic hematoma. b) Post contrast axial CT section of abdomen showing hypodense area in liver (arrowhead) suggesting grade 3 liver injury with minimal perihepatic fluid posteriorly and subcutaneous emphysema.

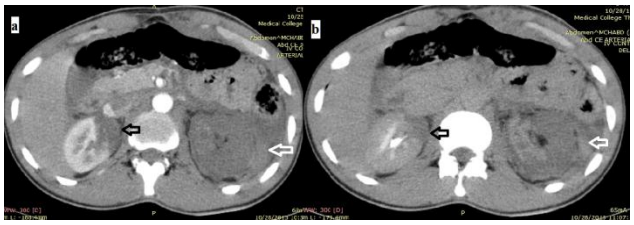

Figure 2. a) Post contrast axial CT sections in corticomedullary (a) and excretory (b) phases showing devascularised left kidney with perirenal hematoma (white arrowheads) suggesting grade 5 left renal injury and non-enhancing hypodense area suggesting segmental infarction (black arrow heads) at the superomedial aspect of right kidney (grade 4 right renal injury).

Out of the 125 patients, 74.4% (93 patients) had conservative management whereas 25.6% (32 patients) underwent laparotomy and 47 injuries were identified. On laparotomy, liver injury was seen in 8 patients, splenic injury in 9 patients, pancreatic injury in 3 patients and renal injury in 2 patients. Based on findings on laparotomy we found that CT scan was very sensitive and specific in identifying injury to liver, spleen, kidneys and urinary bladder; however it was less sensitive in identifying bowel and pancreatic injury and retroperitoneal hematoma [Table 2]. Fifteen patients had bowel injury while CT identified only 6 cases.

Table 2. Comparison of CT diagnosis and Laparotomy Findings in Patients with Blunt Trauma Abdomen

Organ injury	CT diagnosis	Laparotomy diagnosis	Sensitivity of CT	Specificity of CT	Positive predictive value	Negative predictive value
Liver injury	8	8	100	100	100	100
Splenic injury	11	9	100	94.74	81.82	100
Pancreatic injury	2	3	66.7	100	100	97.78
Renal injury	2	2	100	100	100	100
Bowel and mesenteric injury	6	15	40	100	100	78.05
Bladder injury	2	2	100	100	100	100
Retroperitoneal haematoma	5	8	62.5	100	100	92.86

DISCUSSION

Unrecognised abdominal injury has always been a cause of preventable death in trauma patients. With the evolution of multiphasic computed tomography, it has become very easy to detect and prognosticate the injuries in patients with blunt injury to abdomen. This has shifted the management from unnecessary, aggressive surgical intervention to conservative non-invasive approach with resultant reduced hospital costs, post-op morbidity and mortality.

In our study, we identified liver and spleen as the most commonly injured organs in blunt injury to abdomen. Liver was the most commonly involved organ (in 67% cases) in Singh M etal study [11]. The vulnerability of the liver to injury can be due to its size. Also, liver and spleen are close to the lower ribs, so any fracture of the ribs can injure them. In Thimothy VO etal study [12], Kumar MM et al study[13] and Podeanu M et al study [14], spleen was the commonly injured organ followed by liver. In Redhu N etal study [15] of blunt injury in pediatric population also, spleen was most commonly involved in 37.5% cases followed by liver in 22.5%. CT is very sensitive in identifying intraperitoneal fluid.(16). In our study of 125 patients in whom fluid was identified with preliminary ultrasound, CT detected fluid in 119 cases. Non visualization of fluid in rest of the patients (6 patients) can be due to absorption of the minimal fluid by the time CT scan is taken. The 'sentinel clot sign' which indicates clotted blood of high attenuation in the adjacent region may serve as a marker to identify the organ which causes the haemorrhage.[17] Although diagnostic peritoneal lavage is a very sensitive indicator of intraperitoneal bleed, it is unable to identify the exact source of the hemorrhage.

In our study, CT scan was very sensitive in identifying injury to liver, spleen, kidneys and urinary bladder; however it was less sensitive in identifying bowel and mesenteric injury, pancreatic injury and retroperitoneal hematoma. Study by Kumar MM etal has showed very high sensitivity for CT in identification of liver and spleen injury (93.3 % for liver and 100% for spleen), but reduced sensitivity in identification of bowel injury (33.3%) and mesenteric injury (60%). Previous studies have shown varying sensitivity of CT scan for bowel injury. In Butela et al study, CT had 64% sensitivity for bowel and mesenteric injury [18]. However, study by Pal JD et al has shown very high sensitivity (97.7%) for CT in identification of bowel injury, but this can be due to the administration of oral contrast also (19). In Atri M et al study three reviewers recorded sensitivities between 87% to 95% in diagnosis of surgically significant bowel or mesenteric injury [20]. Killeen et al also reported high sensitivity in bowel injury (94%) and mesenteric injury(96%)[21]. The bowel wall thickening and free fluid of bowel injury can be missed in early scans. Although presence of free fluid is the most sensitive finding in bowel injury, pneumoperitoneum is the most specific finding. Delayed diagnosis of bowel injury can result in various complications including sepsis and increased mortality.

The main limitation of this study was the small study population that had undergone laparotomy, hence only a few subjects were available for comparison of CT and laparotomy findings. The time interval between time of trauma and the time of CT scan was not uniform, even a small difference of a few hours would have altered the imaging findings. Also we donot have long term follow-up of these patients, hence delayed imaging manifestations and complications may be missed.

CONCLUSION

CT scan is a very sensitive imaging modality in identifying solid visceral abdominal organ injury, but has relatively less sensitivity in bowel and mesenteric injury, Liver and spleen are the commonly injured organs. Even though the decision to intervene surgically and the time to intervene is usually based on the clinical signs and symptoms rather than purely radiological findings,, the information obtained from CT scan often increases the diagnostic confidence and reduces the need for unnecessary exploratory laparotomy.

CONFLICT OF INTEREST

No conflict of interest

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