e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2022; 14(7); 886-894

Original Research Article

Role of Multidetector Computed Tomography in Evaluation of Blunt Abdominal Trauma

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Received: 15-04-2022 / Revised: 20-05-2022 / Accepted: 05-06-2022
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Conflict of interest: Nil

Abstract

Background: In this study, we wanted to assess the use of multidetector computed tomography (MDCT) in recognizing intra-abdominal injuries in patients with blunt abdominal trauma and providing information that might be used to accurately identify treatment options (non-operative versus operative) and link CT findings with clinical observations, follow-up CT scans (if needed), or surgical findings (wherever applicable).

Materials and Methods: This was a prospective study conducted among 30 patients with blunt abdominal trauma over 18 months (2019 to 2021). Data for the study was gathered from patients with blunt abdominal injuries who visited / were referred to the Department of Radiodiagnosis at Konaseema Institute of Medical Sciences and Research Foundation in Amalapuram.

Results: All CT results were associated among these 4 cases that underwent laparotomy. Thus, the specificity of CT was 100%. Among 4 patients with isolated hemoperitoneum, 2 patients deteriorated clinically and were operated on for laparotomy. Both patients had bowel injuries which were not found in CT findings. Thus, sensitivity was 50% for bowel injuries.

Conclusion: The gold standard technique is MDCT in evaluating abdominal blunt trauma.

Keywords: Multidetector Computed Tomography, Blunt Injury Abdomen, Hemoperitoneum, Laparotomy

Background

In the examination of patients with blunt abdominal injuries, imaging is crucial. In addition to the global examination of abdominal trauma, CT as the sole modality allows for the evaluation of various related injuries. The routine use of computed tomography (CT) for the examination of blunt abdominal trauma (BAT) was previously met with scepticism. CT requires a patient who is cooperative and hemodynamically stable. In addition, the patient must be brought to the radiography suite from the trauma resuscitation area. Most trauma centres now have CT scanners, and with the introduction of helical scanners, scan time has been greatly reduced. As a result, CT has become a standard tool in the

traumatologist's toolbox. The solid organs – the spleen, kidney, and liver - are the most commonly damaged in traumatic injuries, followed by the intestines [1]. In the examination of intraperitoneal and retroperitoneal injuries, no diagnostic method beats CT [2].

The accuracy of CT in patients with hemodynamically stable blunt trauma is widely established. Patients who underwent emergency CT had a sensitivity of 92 percent to 97.6% and a specificity of 98.7%, according to reports [3,4].

Aims and Objectives

1. To assess the use of multidetector computed tomography (MDCT) in recognizing intra-abdominal injuries in patients with blunt abdominal trauma and providing information that might be used to accurately identify treatment options (non-operative versus operative)
2. To link CT findings with clinical observations, follow-up CT scans (if needed), or surgical findings (wherever applicable).

Materials and Methods

This was a prospective study conducted among 30 patients with blunt abdominal trauma over 18 months (2019 to 2021). Data for the study was gathered from patients with blunt abdominal injuries who visited / were referred to the Department of Radiodiagnosis at Konaseema Institute of Medical Sciences and Research Foundation in Amalapuram. They were assessed using a GE sixteen slice CT SCANNER, and results were compared to either clinical follow-up, follow-up CT scans (if necessary), or surgical findings (wherever applicable).

Criteria for Inclusion

1. Patients with clinical suspicion of intra-abdominal damage.
2. Patients with stable hemodynamics.
3. A multi-trauma patient.
4. + Ultrasonography

Criteria for Exclusion

All hemodynamically unstable patients with apparent peritoneal symptoms and progressive abdominal distension were promptly taken to surgery and eliminated from the trial.

Results

In the present study, the majority of patients (23.33%) belonged to age groups of 10 to 19 years, and 30 to 39 years each, followed by 20% belonging to the age group of less than 6 years, 13.33% belonged to 50 to 59 years, 10% belonged to 20 to 29 years, 6.67% belonged to 40 to 49 years, and 3.34% belonged to more than 60 years. The mean age of study patients was 27.6 ± 17.37 years with a minimum age of 6 years and maximum age of 62 years. In the present study, 76.67% were males and 23.33% were females.

In the present study, most patients (50%) had abdominal injuries during road traffic accidents, followed by 40% falling from height and 10% from assault. In the current study, 56.62 percent of males suffered abdominal injuries as a result of traffic accidents, 34.78% of them fell from a height and 8.7% were assaulted. 28.57% of females had abdominal injuries due to road traffic accidents, 57.14% of them suffered falls from height, and 14.29% were assaulted.

Table 1: Mode of injuries according to the age of patients (n=30)

Age (years)	RTA		Fall		Assault	
	N	%	N	%	N	%
≤ 9	2	13.33	4	33.34	0	0.00
10 – 19	3	20.00	3	25.00	1	3.33
20 – 29	2	13.33	1	8.33	0	0.00

30 – 39	5	33.33	1	8.33	1	33.33
40 – 49	1	6.67	0	0.00	1	33.33
50 – 59	1	6.67	3	25.00	0	0.00
≥ 60	1	6.67	0	0.00	0	0.00
Total	15	100.00	12	100.00	3	100.00
Mean ± SD	30.27 ± 16.32 years		23.67 ± 19.67 years		30 ± 15 years	
Minimum age	9 years		6 years		15 years	
Maximum age	62 years		57 years		45 years	

In the present study among patients with abdominal injuries due to road traffic accidents, majority of cases belonged to the age group of 30 to 39 years (33.33%), followed by 20% belonging to 10 to 19 years, 13.33% each belonged to age less than 9 years and 20 to 29 years, 6.67% of cases each belonged to age 40 to 49 years, 50 to 59 years and more than 60 years with a mean age of 30.27 ± 16.32 years with a minimum age of 9 years and maximum age of 62 years.

Among patients with abdominal injuries due to falling from a height, the majority of cases belonged to the age group of less than 9 years (33.34%), followed by 25% each belonging to 10 to 19 years and 50 to 59 years, 8.33% each belonged to age 20 to 29 years and 30 to 39 years with a mean age of 23.67 ± 19.67 years with a minimum age of 6 years and maximum of 57 years. Among patients with abdominal injuries due to assault, each case belonged to age groups of 10 to 19 years, 30 to 39 years and 40 to 49 years with a mean age of 30 ± 15 years with a minimum age of 15 years and maximum age of 45 years.

In the present study, 80% of patients were positive for intra-abdominal injury, and 20% were negative for intra-abdominal injury. Patients with hemoperitoneum or visceral injury or both were considered positive for intra-abdominal injury and without visceral injury or hemoperitoneum were considered negative for intra-abdominal injury.

In the present study, 80% of patients were positive for intra-abdominal injuries. Among these 24 patients, 87.5% of patients had hemoperitoneum, and 12.5% had organ injury without hemoperitoneum. Among patients with hemoperitoneum, 80.95% of them had solid organ injuries with hemoperitoneum, whereas the remaining 19.05% of them had isolated hemoperitoneum.

In the present study, quantification of hemoperitoneum was developed by Federle and Jeffrey using computed tomography, and patients were categorized into mild, moderate and severe peritoneum. The need for laparoscopy among patients with hemoperitoneum was decided using this quantification. 33.33% of cases had mild hemoperitoneum, 38.1% had moderate hemoperitoneum, and 28.57% had severe hemoperitoneum. Among patients with mild hemoperitoneum, 57.14% were managed conservatively, and the remaining 42.86% were managed by surgical method. Among patients with moderate hemoperitoneum, all patients were managed conservatively and among patients with severe hemoperitoneum, 50% were managed conservatively and 50% by surgical methods.

In the present study, 30.0% of cases had spleen injuries, 25% had liver injuries, 10% each had renal, bladder and bowel or mesenteric injuries, and one patient had gall bladder, biliary system and pancreatic injuries.

Table 2: Distribution of cases managed by surgical procedure and their indications for surgery

	Cases detected by CT		No of cases by surgical management		Additional injuries identified during surgery
	N	%	N	%	
Isolated hemoperitoneum	4	16.7	2	33.33	Bowel injury was identified in 2 patients
Bowel or mesentery	2	8.3	1	16.67	-
Bladder (intra-peritoneal)	2	8.3	1	16.67	-
Pancreatic injury	1	4.2	1	16.67	-
Kidney injury	2	8.3	1	16.67	-
Liver	5	20.8	-	-	-
Spleen	6	25.0	-	-	-
Gall bladder	1	4.2	-	-	-
Biliary system	1	4.2	-	-	-
Total	24	100.00	6	100.00	-

Among four patients with isolated hemoperitoneum in the current investigation, two were clinically unstable and had to be operated on. The reason for solitary hemoperitoneum in an operated patient was intestinal damage. All patients with hemoperitoneum had surgery.

Table 3: Distribution of grading of visceral injuries with management

Grading of injury	Liver		Spleen		Kidneys		Pancreas	
	Conservative management	Surgical management	Conservative management	Surgical management	Conservative management	Surgical management	Conservative management	Surgical management
I	-	-	-	-	-	-	-	-
II	1	-	2	-	1	-	-	-
III	2	-	3	-	-	-	-	-
IV	1	-	1	-	1	-	-	-
V	1	-	-	-	-	1	-	1
VI	-	-	-	-	-	-	-	-
Total	5	0	6	0	2	1	0	1

In the present study, 40% of liver injuries were grade III injuries, followed by one patient each having grade III, IV, and V liver injuries. No patient had grade VI liver injury. All patients with hepatic injuries were managed conservatively.

Among patients with spleen injuries, 50% of them were grade III, followed by 33.3% of cases with grade II spleen injuries and one patient had grade IV spleen injury. All patients with splenic injuries were managed conservatively.

One patient each had grade II and IV renal injuries among patients with renal injuries. One patient with grade IV renal injury had undergone nephrectomy, whereas other renal injuries were managed conservatively. One patient had a grade V pancreatic injury and underwent surgical management.

Among cases with bladder injuries, 2 patients had an intra-peritoneal injury. One patient with intra-peritoneal injury was operated on.

Table 4: Distribution of outcomes based on computed tomography management guidelines of blunt abdominal injury

CT	Surgical Management	Conservative Management	Total
Positive	4	0	4
Negative	2	18	20
Total	6	18	24

In the present study, 20% of cases negative for intra-abdominal injuries were discharged after confirmation by CT.

According to findings from CT, surgical management was recommended for 4 patients among 24 patients with positive intra-abdominal injuries. All CT results were associated among these 4 cases that underwent laparotomy. Thus, the specificity of CT was 100%.

Among 4 patients with isolated hemoperitoneum, 2 patients deteriorated clinically, and laparotomy was performed. Both patients had bowel injuries which were not found in CT findings. Thus, sensitivity was 50% for bowel injuries.

Table 5:

Sensitivity	66.67%
Specificity	100%
Positive predictive value	100%
Negative predictive value	90%
Accuracy	91.67%

Discussion

In the present study, the majority of patients (23.33%) belonged to age groups of 10 to 19 years and 30 to 39 years each followed by 20% belonging to the age group of less than 6 years, 13.33% belonging to 50 to 59 years, 10% belonged to 20 to 29 years, 6.67% belonged to 40 to 49 years and 3.34% belonged to more than 60 years. The mean age of patients in the study was 27.6 ± 17.37 years with a minimum age of 6 years and maximum age of 62 years.

In the present study, range of age among patients was 6 years to 62 years which was similar to the study done by Bakht *et al* [5] with a range of 10 years to 60 years, Ahmed HM *et al* [6] with a range of 4 years to 53 years, Murali B *et al* [7] with a range of 5 years to 70 years and Anjana G *et al* [8] with a range of 3 years to 80 years.

Gender

In the present study, 76.67% were males and 23.33% were females. It was observed that all studies showed there was an increased incidence of blunt abdominal trauma among males when compared with females which might have been due to increased moving outside during the work.

Mode of Injury

In the present study, the majority of patients (50%) had abdominal injuries during road traffic accidents followed by 40% due to falls from height and 10% due to assault. In a study done by Murali B *et al*, other modes of injuries were observed such as bull horn or hit by a projectile object in 8% of patients and automobile vs. pedestrian injury among 10% of patients.

In a study done by Duy Hung et al, [9] it was observed that 79.1% of injuries were due to road traffic accidents, 15.1% due to workplace accidents and 5.8% due to other causes.

In a study done by Annu K *et al*, [10] it was observed that 50% of abdominal injuries were due to road traffic accidents, 13.4% due to assault, 29.3% due to falls from height and 7.3% were due to other causes.

A study done by Amina IE Elkhouly *et al* [11] showed that 505 injuries were due to road traffic accidents, 26% were due to falls from height, 14% were due to pedestrian vs. automobile accidents, 6% due to child abuse and 2% each were due to sports-related injury and cyclist injuries. A study done by Preetham *et al* [12] showed that 70% of abdominal injuries were due to RTA, 19% were due to falls from height and 11% were due to assault.

Mode of Injury and Gender

In the present study, 56.62% of males had abdominal injuries due to road traffic accidents, 34.78% due to falls from height and 8.7% due to assault. 28.57% of females had abdominal injuries due to road traffic accidents, 57.14% due to falls from height and 14.29% due to assault.

Similarly, in a study done by Preetham *et al*, 80% of abdominal injuries were observed in males and 20% in females. 63.15% of injuries due to falling from height were observed in males and 36.85% in females. 45.45% of abdominal injuries due to assault were observed in males and 54.55% were in females.

In a study done by Vedaraju KS *et al*, [13] 75.31% of males had abdominal injuries due to road traffic accidents, 13.58% due to falls from height and 9.88% due to assault and one male patient due to a stampede. 73.68% of females' abdominal injuries were due to road traffic accidents, 15.79% due to falls from height and 10.53% due to assault.

Mode of Injury and Age

In the present study among patients with abdominal injuries due to road traffic accidents, majority of cases belonged to the age group of 30 to 39 years (33.33%), followed by 20% belonging to 10 to 19 years, 13.33% each belonged to age less than 9 years and 20 to 29 years, 6.67% of cases each belonged to age 40 to 49 years, 50 to 59 years and more than 60 years with a mean age of 30.27 ± 16.32 years with a minimum age of 9 years and maximum age of 62 years. Among patients with abdominal injuries due to falling from height, majority of cases belonged to the age group of less than 9 years (33.34%), followed by 25% each belonging to 10 to 19 years and 50 to 59 years; 8.33% each belonged to age 20 to 29 years and 30 to 39 years with a mean age of 23.67 ± 19.67 years with a minimum age of 6 years and maximum of 57 years. Among patients with abdominal injuries due to assault, each case belonged to age groups of 10 to 19 years, 30 to 39 years and 40 to 49 years with a mean age of 30 ± 15 years with a minimum age of 15 years and maximum age of 45 years.

Abdominal Injuries

In the present study, 80% of patients were positive for intra-abdominal injuries, and 20% were negative for intra-abdominal injuries. Patients with hemoperitoneum or visceral injury or both were considered positive for intra-abdominal injury and without visceral injury or hemoperitoneum were considered negative for intraabdominal injury. In a study done by Preetham *et al*., it was observed that 70% of patients were positive for intra-abdominal injury, and 30% were negative for intra-abdominal injury.

In the present study, 80% of patients were positive for intra-abdominal injuries. Among these 24 patients, 87.5% of patients had hemoperitoneum, and 12.5% had organ injury without hemoperitoneum. Among patients with hemoperitoneum,

80.95% of them had solid organ injuries with hemoperitoneum, whereas the remaining 19.05% of cases had isolated hemoperitoneum. In a study done by Preetham *et al*., 72.85% of positive intra-abdominal injuries were associated with hemoperitoneum, 15.71% were organ injuries without hemoperitoneum, and 11.43% of them were diagnosed as isolated hemoperitoneum. A study done by Vedaraju KS *et al* showed that 84% of patients had hemoperitoneum, whereas 16% had organ injuries without hemoperitoneum.

Quantification of Hemoperitoneum

In the present study, quantification of hemoperitoneum was made, as developed by Federle and Jeffrey using computed tomography, and patients were categorized into mild, moderate and severe peritoneum. The need for laparoscopy among patients with hemoperitoneum was decided using this quantification. 33.33% of cases had mild hemoperitoneum, 38.1% had moderate hemoperitoneum, and 28.57% had severe hemoperitoneum. Among patients with mild hemoperitoneum, 57.14% were managed conservatively, and the remaining 42.86% were managed by surgical method. Among patients with moderate hemoperitoneum, all patients were managed conservatively.

Among patients with severe hemoperitoneum, 50% were managed conservatively and 50% by surgical methods.

A study done by Vedaraju KS *et al*. showed that 35.71% of patients had mild hemoperitoneum, 50% had moderate hemoperitoneum, and 14.29% had severe hemoperitoneum. A study done by Preetham *et al* showed that 25.42% of patients had mild hemoperitoneum, 54.24% of patients had moderate hemoperitoneum, and 20.34% of patients had severe hemoperitoneum.

Visceral Injuries

In the present study, 30.0% of cases had spleen injuries, 25% had liver injuries, 10% each had renal injuries, bladder injuries and bowel or mesenteric injuries, and one patient had gall bladder, biliary system and pancreatic injuries.

A study done by Vedaraju KS *et al* showed that 32% of abdominal injuries were liver injuries, 54% were splenic injuries, 5% were pancreatic injuries, 24% were renal injuries, 4% were bowel injuries, 2% were bladder and mesenteric injuries each. A study done by Annu K *et al* showed that 54.8% were splenic injuries, 37.8% were liver injuries, 11% were renal injuries, and 1.2% were diaphragm and adrenal gland injuries. A study done by Praveen KJ *et al*. [14] showed that 55% were liver injuries, 42% were splenic injuries, 25% were renal injuries, and 19% were multi-organ injuries. A study done by Preetham *et al* showed that 1.43% were gall bladder injuries, biliary system and pancreatic injuries each, 4.29% were bowel or mesenteric injuries and bladder injuries each, 20% were renal injuries, 28.57% were liver injuries, and 38.57% were splenic injuries. In a study done by Murali b *et al*, 41% were splenic injuries, 23% were liver injuries, 13% were renal injuries, 9% were hollow visceral injuries, 8% were mesenteric injuries, and 2% were pancreatic, bladder and vascular injuries each.

Grading of Injuries

In the present study, 40% of liver injuries were grade III injuries, followed by one patient each having grade III, IV, and V liver injuries. No patient had grade VI liver injury. All patients with hepatic injuries were managed conservatively.

Among patients with spleen injuries, 50% of them were grade III, followed by 33.3% of cases having grade II spleen injuries, and one patient had grade IV spleen injury. All patients with splenic injuries were managed conservatively.

One patient each had grade II and IV renal injuries among patients with renal injuries. One patient with grade IV renal injury had undergone nephrectomy, whereas other renal injuries were managed conservatively.

One patient had grade V pancreatic injury and underwent surgical management. Among cases with bladder injuries, 2 patients had an intra-peritoneal injury. One patient with intra-peritoneal injury was operated on.

A study done by Amina IE *et al*, showed that 68.75% of patients had grade IV splenic injuries, one patient had grade III liver injury, and 25% had grade V splenic injury. 57.14% of patients had grade IV liver injuries, one patient had grade III liver injury, and 28.57% had grade V liver injuries. 11.11% of patients had grade III renal injuries, 45.45% had renal injuries, and 61.11% had grade V renal injuries. A study done by Ahmed HM *et al*. showed that 57.5% of spleen injuries were grade III, 22.5% were grade IV injuries, and 20% were grade II injuries. 43.8% were grade III hepatic injuries, 46.9% were grade II liver injuries, and 30% were grade IV liver injuries. Among pancreatic injuries, 85.7% were grade II injuries, and 14.3% were grade III injuries. In a study done by Preetham *et al*., it was observed that 60% were grade III liver injuries followed by 15% grade I injury, 10% were grade II and IV injuries each, and 5% were grade V injuries. Among spleen injuries, 62.96% were grade III injuries, 22.22% were grade II injuries, and 14.81% were grade I injuries. Among renal injuries, 46.15% were grade IV injuries, 30.77% were grade II injuries, 15.38% were grade III injuries, and 7.69% were grade I injuries. One patient had grade V pancreatic injury.

Outcomes from CT

In the present study, 20% of cases negative for intra-abdominal injuries were discharged after confirmation by CT. According to findings from CT, surgical management was recommended for 4 patients among 24 patients with positive intra-abdominal injuries. All CT results were associated among these 4 cases that underwent laparotomy. Thus, the specificity of CT was 100%. Among 4 patients with isolated hemoperitoneum, 2 patients deteriorated clinically, and laparotomy was performed. Both patients had bowel injuries which were not found in CT findings. Thus, sensitivity was 50% for bowel injuries. The sensitivity of MDCT was 66.67%, specificity 100%, positive predictive value 100%, negative predictive value was 90%, and accuracy was 91.67%.

Conclusion

20% of cases negative for intra-abdominal injuries were discharged after confirmation by CT. According to findings from CT, surgical management was recommended for 4 patients among 24 patients with positive intra-abdominal injuries. All CT results were associated among these 4 cases that underwent laparotomy. Thus, the specificity of CT was 100%. Among 4 patients with isolated hemoperitoneum, 2 patients deteriorated clinically, and laparotomy was performed. Both patients had bowel injuries which were not found in CT findings. Thus, sensitivity was 50% for bowel injuries. The sensitivity of MDCT was 66.67%, specificity was 100%, positive predictive value 100%, negative predictive value 90% and accuracy was 91.67%. Hence, there was high accuracy, and the gold standard technique is MDCT in evaluating abdominal blunt trauma.

Limitations

1. Small sample size.
2. Long-term follow-up of patients was not done.

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