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Computed tomography evaluation in patients of blunt abdominal injury

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Abstract
Background: Blunt abdominal trauma (BAT) is a common and significant cause of morbidity and mortality, particularly in the context of motor vehicle accidents, falls, and assaults. The clinical presentation of BAT can be insidious; patients may initially appear stable only to deteriorate rapidly as internal bleeding or organ damage progresses. In the realm of diagnostic imaging, Computed Tomography (CT) has emerged as a pivotal tool in the assessment and management of BAT and is also instrumental in the ongoing assessment and monitoring of patients with BAT. Follow-up CT scans can be used to evaluate the progression or resolution of injuries, detect complications such as abscess formation or delayed hemorrhage, and guide subsequent management decisions.
Objectives: To assess the role of Computed Tomography (CT) as a primary diagnostic modality in the evaluation of blunt abdominal injury in hemodynamically stable patients, to determine the choice of management (operative versus conservative) by using the information provided from CT by grading the visceral injuries using the American Association for the Surgery of Trauma (AAST) classification and to compare intraoperative findings with CT findings by assessing the sensitivity and specificity of CT scan as a gold standard modality in blunt trauma.
Methods: A prospective study was conducted for a period of 2 years from September 2022 to August 2024, where we enrolled 50 patients presenting with a history of blunt abdominal injury Clinical and radiological data from patients with a history of blunt abdominal injury were recorded as per the pre-structured proforma. A computed tomography study using SIEMENS SOMATOM EMOTION (16 SLICE) was conducted. The data was collected and compiled in MS Excel and the significance level was fixed as 5% ($\alpha = 0.05$).
Results: This study involved 50 participants, predominantly male (66%), with an age distribution mainly between 21-50 years. Road traffic accidents were the leading cause of injury (68%), followed by falls (16%). Abdominal pain was the most common initial symptom (50%), with hemoperitoneum present in 64% of cases and varying severities influencing management decisions. Visceral injuries, notably splenic (48%) and liver (28%), were common, with 74% of cases managed conservatively. Significant associations were found between the severity of injuries (liver, splenic, and kidney) and the chosen management approach. CT scans demonstrated high diagnostic accuracy for visceral injuries, surpassing EFAST in sensitivity and specificity.
Conclusion: Our findings demonstrated that CT is highly sensitive and specific in detecting visceral injuries, with a sensitivity of 100% and specificity of 99.04%. The study also confirmed a substantial association between the grade of visceral injury, as per the American Association for the Surgery of Trauma (AAST) classification, and the choice of management approach, whether conservative or surgical.

Keywords: Blunt abdominal trauma, computed tomography, hemodynamically stable, sensitivity, specificity

Introduction

Blunt abdominal trauma (BAT) is a common and significant cause of morbidity and mortality, particularly in the context of motor vehicle accidents, falls, and assaults. Unlike penetrating trauma, where the injury mechanism and extent are often more apparent, BAT presents a unique challenge due to the potential for hidden and life-threatening internal injuries without obvious external signs. The abdomen houses several vital organs, including the liver, spleen, pancreas, kidneys, and intestines, all of which can be affected by blunt force. Consequently, the detection and management of injuries in BAT require a high degree of clinical suspicion and timely, accurate diagnostic modalities to mitigate the risk of severe complications or death [1, 2].

The problem in managing BAT lies in the difficulty of diagnosing internal injuries accurately and swiftly. BAT can lead to a range of injuries, from minor contusions to severe lacerations and organ rupture, which can result in hemorrhage, shock, and peritonitis. The clinical presentation of BAT can be insidious; patients may initially appear stable only to deteriorate rapidly as internal bleeding or organ damage progresses. The classic signs of abdominal injury, such as tenderness, bruising, and distension, may not always be present or may be delayed, further complicating timely diagnosis. This unpredictability underscores the necessity for reliable diagnostic tools that can quickly and accurately identify the extent of abdominal injuries, allowing for appropriate and timely intervention [3].

In the realm of diagnostic imaging, Computed Tomography (CT) has emerged as a pivotal tool in the assessment and management of BAT. CT imaging provides detailed cross-sectional images of the body, enabling clinicians to visualize the internal structures of the abdomen with high precision. This imaging modality surpasses traditional diagnostic methods, such as physical examination, plain radiography, and ultrasound, in detecting and characterizing the extent of internal injuries [4]. The advent of CT has revolutionized trauma care, significantly enhancing the ability to diagnose intra-abdominal injuries, guide therapeutic decisions, and improve patient outcomes [5].

CT imaging's role in BAT is multifaceted. Firstly, it allows for rapid and comprehensive assessment of the entire abdomen and pelvis, facilitating the identification of both solid organ injuries and hollow viscus perforations. The sensitivity and specificity of CT in detecting abdominal injuries are exceptionally high, making it the gold standard in trauma imaging [6]. For instance, CT can accurately diagnose liver and splenic lacerations, renal injuries, and retroperitoneal hemorrhage, conditions that might be missed on ultrasound or physical examination alone [7].

Additionally, CT imaging can provide valuable information regarding the severity of injuries, helping to stratify patients based on the need for surgical versus non-surgical management. The ability to quantify injury severity and identify active bleeding through contrast-enhanced CT scans enables trauma teams to make informed decisions about the urgency and type of intervention required [8, 9]. For example, the identification of contrast extravasation on a CT scan, indicative of active hemorrhage, may prompt immediate surgical intervention or angioembolization.

The need for faster diagnosis in BAT cannot be overstated. Delays in diagnosis and treatment are associated with increased morbidity and mortality. Rapid and accurate identification of injuries is crucial in initiating appropriate and timely interventions, which can significantly impact patient outcomes [10]. In a trauma setting, where seconds count, the efficiency of CT imaging in providing comprehensive diagnostic information swiftly is invaluable [11].

CT's role extends beyond initial diagnosis. It is also instrumental in the ongoing assessment and monitoring of patients with BAT. Follow-up CT scans can be used to evaluate the progression or resolution of injuries, detect complications such as abscess formation or delayed hemorrhage, and guide subsequent management decisions [12]. This continuous monitoring is essential in the dynamic clinical course of trauma patients, where changes can occur rapidly and unexpectedly.

Despite its numerous advantages, the use of CT in BAT is not without challenges. Concerns about radiation exposure, particularly in pediatric and young adult populations, necessitate careful consideration and judicious use of CT imaging. Advances in CT technology, such as dose-reduction techniques and the development of protocols tailored to minimize radiation exposure, are addressing these concerns and making CT a safer option for trauma imaging [13].

The necessity for this study arises from the critical role that CT imaging plays in the management of BAT and the need to continuously evaluate and optimize its use. As the landscape of trauma care evolves, it is essential to assess the effectiveness of current imaging protocols and identify areas for improvement [14, 15, 16, 17, 18]. This study aims to contribute to the body of knowledge on the role of CT in BAT, providing insights that can enhance diagnostic accuracy, improve patient outcomes, and inform clinical practice.

Objective of the study

This study was conducted to assess the role of Computed Tomography (CT) as a primary diagnostic modality in the evaluation of blunt abdominal injury in hemodynamically stable patients, to determine the choice of management (operative versus conservative) by using the information provided from CT by grading the visceral injuries using the American Association for the Surgery of Trauma (AAST) classification and to compare intraoperative findings with CT findings by assessing the sensitivity and specificity of CT scan as a gold standard modality in blunt trauma.

Materials and methodology

We conducted a prospective study for a period of 2 years from September 2022 to August 2024, where we enrolled patients presenting with a history of blunt abdominal injury at Al-Ameen Medical College and Hospital.

Informed consent of participating individuals was obtained. Clinical and radiological data from patients with a history of blunt abdominal injury were recorded as per the pre-structured proforma. A computed tomography study using SIEMENS SOMATOM EMOTION (16 SLICE) was conducted. We included 50 patients with the following criteria such as patients with equivocal findings on clinical abdominal examination or sonological findings, patients with significant pelvic fractures, patients exhibiting important signs such as guarding/rigidity which could not be adequately evaluated due to altered mental status and patients with positive ultrasound findings requiring further information regarding injury grading.

The data was collected and compiled in MS Excel. Descriptive statistics has been used to present the data. To analyse the data SPSS (Version 26.0) was used. Significance level was fixed as 5% ($\alpha = 0.05$). Qualitative variables are expressed as frequency and percentages and Quantitative variables are expressed as Mean and Standard Deviation. To compare the proportion between variables, chi-square test was used.

Results

The total sample size was 50 participants. The age distribution of the study population is as follows: 4% of participants were between 18-20 years, 26% were between 21-30 years, 24% were between 31-40 years, 26% were between 41-50 years, and 20% were between 51- 60 years. The gender distribution among the participants was 34% female and 66% male. This shows a higher prevalence of males (66%) in the study, as seen in Table 1.

The most common mechanism of injury was road traffic accidents (RTA), accounting for 68% of the cases. Falls accounted for 16%, assaults for 14%, and sports injuries for 2%.

The initial clinical findings were as follows: 50% of participants presented with abdominal pain, 34% with abdominal tenderness, 12% with abdominal distension, and 4% with both abdominal distension and pain as depicted in Table 1.

The mean GCS score was 13.32 ± 1.67, indicating that most patients had a mild level of consciousness impairment. Visceral injuries were distributed as follows: 28% had liver injuries, 48% had splenic injuries, 2% had pancreatic injuries, 16% had kidney injuries, 6% had bladder injuries, and 6% had bowel/mesenteric injuries as seen in Table 1.

As shown in Table 2, Hemoperitoneum was present in 64% of cases, with mild cases accounting for 28.1%, moderate for 50%, and severe for 21.9%. Hemoperitoneum was absent in 36% of the participants. Pneumoperitoneum was present in 6% of cases and absent in 94% of the participants. Other findings included rib fractures and pneumothorax in 8.3% of cases, hemothorax in 8.3%, pelvic fractures in 25%, and rib fractures alone in 58.3%. A total of 76% of participants had no other findings.

Abnormal CT findings were present in 92% of cases, while 8% had normal CT scans as seen in Figure 1. The management approach was conservative in 74% of cases and surgical in 26% as seen in Figure 2.

Visceral injury was present in 90% of cases and absent in 10%. There was a significant association between visceral injury and management approach (p = 0.032). Surgery was performed in 9 cases with visceral injury and 4 cases without, while conservative management was applied to 24 cases with visceral injury and 13 cases without as depicted in Table 3.

Liver injuries were managed conservatively in 13 cases and surgically in 1. Splenic injuries were managed conservatively in 21 cases and surgically in 3. Kidney injuries were managed conservatively in 5 cases and surgically in 3. Bladder and bowel/mesenteric injuries required surgical intervention in all cases (3 each) as shown in Figure 3.

Liver injuries were graded as follows: Grade I in 14.3%, Grade II in 42.9%, Grade III in 35.7%, and Grade V in 7.1% as seen in Figure 4. There was a significant association between the grade of liver injury and management (p = 0.017). All Grade I, II, and III injuries were managed conservatively, while the single Grade V injury required surgery as depicted in Table 4.

Splenic injuries were graded as follows: Grade I in 16.7%, Grade II in 37.5%, Grade III in 25%, Grade IV in 12.5%, and Grade V in 8.3% as seen in Figure 5. There was a significant association between the grade of splenic injury and management (p = 0.012). All Grade I, II, and III injuries were managed conservatively. Grade IV injuries were managed conservatively in 66.7% and surgically in 33.3%. All Grade V injuries required surgery as depicted in Table 4.

Kidney injuries were graded as follows: Grade I in 12.5%, Grade II in 37.5%, Grade III in 12.5%, and Grade V in 37.5% as seen in Figure 6. There was a significant association between the grade of kidney injury and management (p = 0.034). All Grade I, II, and III injuries were managed conservatively, while all Grade V injuries required surgery as depicted in Table 4.

Bowel perforation was found in 33.3% of cases, jejunal perforation in 33.3%, and proximal ileal perforation in 33.3%. Hemoperitoneum was present in 94% of cases with visceral injury and 6% without visceral injury.

There was a significant association between hemoperitoneum severity and management approach (p = 0.001). Mild hemoperitoneum was managed conservatively in 77.8% of cases and surgically in 22.2%. Moderate hemoperitoneum was managed conservatively in 81.3% and surgically in 18.8%. Severe hemoperitoneum required surgical management in 100% of cases.

Pneumoperitoneum was present in 66.7% of cases with visceral injury and in 33.3% without visceral injury. Postoperative findings included bladder repair with suprapubic catheter (SPC) in 6% of cases, direct vessel repair with perihepatic packing in 2%, laparotomy with patch closure in 6%, nephrectomy in 6%, and splenectomy in 6%.

CT findings for visceral injury had a sensitivity of 100%, specificity of 99.04%, positive predictive value of 95.50%, negative predictive value of 99.7%, and accuracy of 99.1%. For bowel injury, CT had a sensitivity of 100%, specificity of 99.26%, positive predictive value of 86%, negative predictive value of 93%, and accuracy of 98.4% as seen in Table 5.

Comparing CT and EFAST for diagnostic accuracy, CT had a sensitivity of 100%, specificity of 98.04%, positive predictive value of 92.5%, negative predictive value of 100%, and accuracy of 98.04%. EFAST had a sensitivity of 84.91%, specificity of 98.06%, positive predictive value of 93.75%, negative predictive value of 95%, and accuracy of 94.71% as seen in Table 6.

Table 1: Characteristics of the study participants

Variables	Frequency (n=50)	Percentage
Age group		
18-20y	2	4
21-30y	13	26
31-40y	12	24
41-50y	13	26
51-60y	10	20
Gender		
Male	33	66
Female	17	34
Mechanism of injury		
RTA	34	68
Fall	8	16
Assault	7	14
Sports injury	1	2
Initial Clinical findings		
Abdominal pain	25	50.0
Abdominal tenderness	17	34.0
Abdominal distension	6	12.0
Abdominal distension & pain	2	4.0
Visceral Injury		
Liver	14	28
Spleen	24	48
Pancreas	1	2
Kidney	8	16
Bladder	3	6
Bowel/Mesentery	3	6

Table 2: Peritoneal Findings among the study participants

Findings		Frequency	Percentage
Hemoperitoneum			
Present	Mild	9	28.1
	Moderate	16	50
	Severe	7	21.9
Absent		18	36
Total		50	100
Pneumoperitoneum			
Present		3	6
Absent		47	94
Total		50	100
Other Findings			
Present	Rib Fracture & Pneumothorax	1	8.3
	Haemothorax	1	8.3
	Pelvic Fracture	3	25
	Rib Fracture	7	58.3
Absent		38	76
Total		50	100

Table 3: Association of Visceral Injury with Management

Management	Visceral Injury		Total	p value
	Present	Absent		
Surgery	9	4	13	**0.032**
Conservative	24	13	37	
Total	33	17	50	

Table 4: Association of Liver, Splenic & Kidney Injuries (AAST grade) with Management

AAST Grades		Conservative	Surgery	p value
Liver Injury				
I	Count	2	0	0.017
	%	100%	0%	
II	Count	6	0	
	%	100%	0%	
III	Count	5	0	
	%	100%	0%	
V	Count	0	1	
	%	0%	100%	
Splenic Injury				
I	Count	4	0	0.012
	%	100%	0%	
II	Count	9	0	
	%	100%	0%	
III	Count	6	0	
	%	100%	0%	
IV	Count	2	1	
	%	66.7%	33.3%	
V	Count	0	2	
	%	0%	100%	
Kidney Injury				
I	Count	1	0	0.034
	%	100%	0%	
II	Count	3	0	
	%	100%	0%	
III	Count	1	0	
	%	100%	0%	
V	Count	0	3	
	%	0%	100%	

Table 5: Visceral vs Bowel Injury in CT

CT Findings	Visceral Injury	Bowel Injury
Sensitivity	100%	100%
Specificity	99.04%	99.26%
Positive Predictive Value	95.50%	86%
Negative Predictive Value	99.7%	93%
Accuracy	99.1%	98.4%

Table 6: CT VS EFAST findings

CT Findings	CT	EFAST
Sensitivity	100%	84.91%
Specificity	98.04%	98.06%
Positive Predictive Value	92.50%	93.75%
Negative Predictive Value	100%	95%
Accuracy	98.04%	94.71%

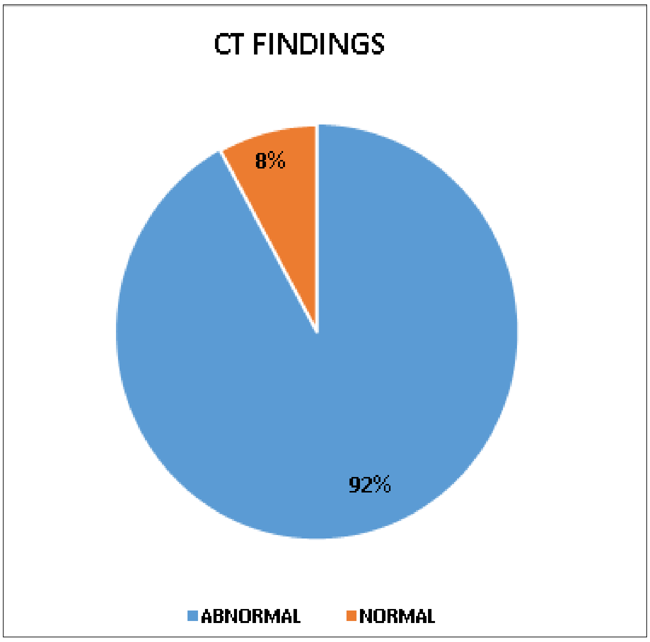

Fig 1: CT findings (n=50)

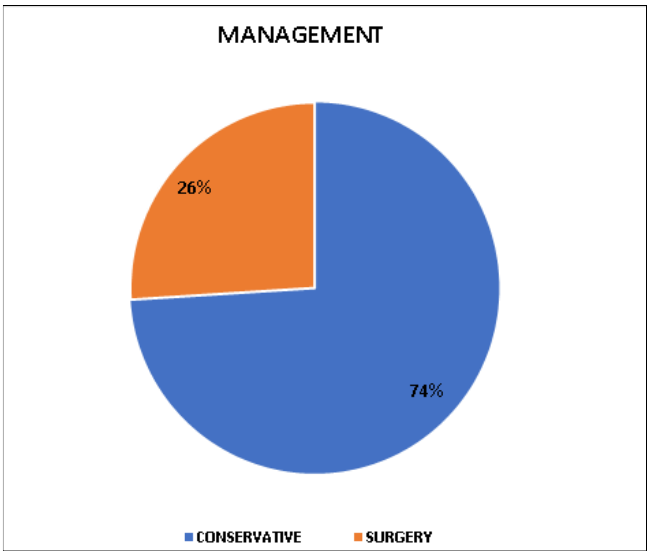

Fig 2: Management (n=50)

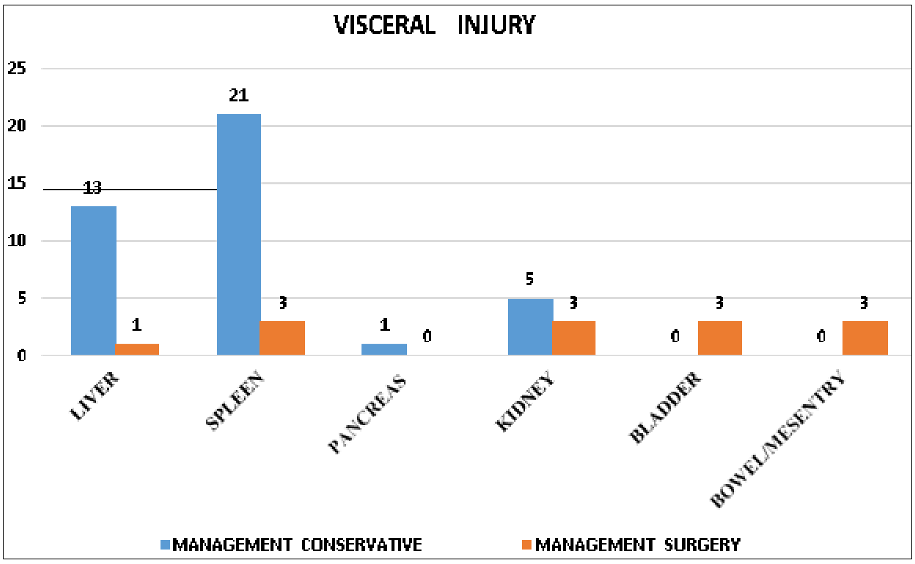

Fig 3: Association of Organ Injury with Management

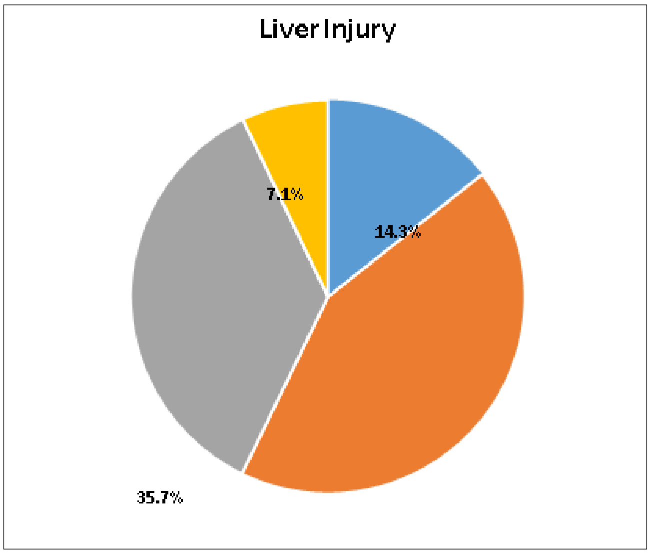

Fig 4: AAST Grade of Liver Injury (n=14)

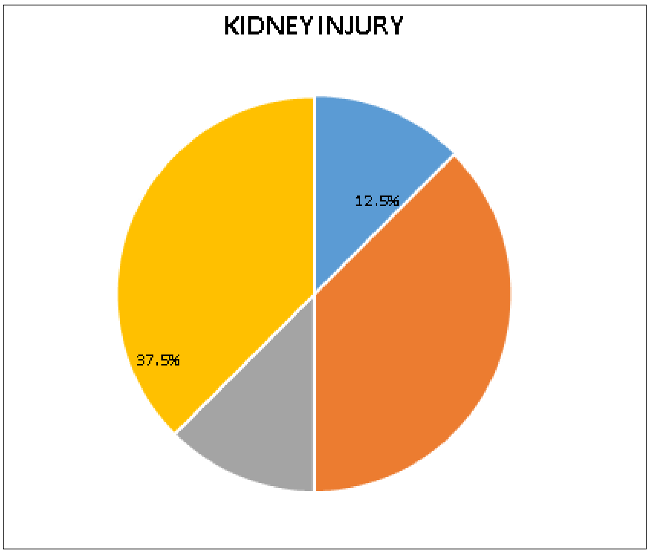

Fig 6: AAST Grade of Kidney Injury

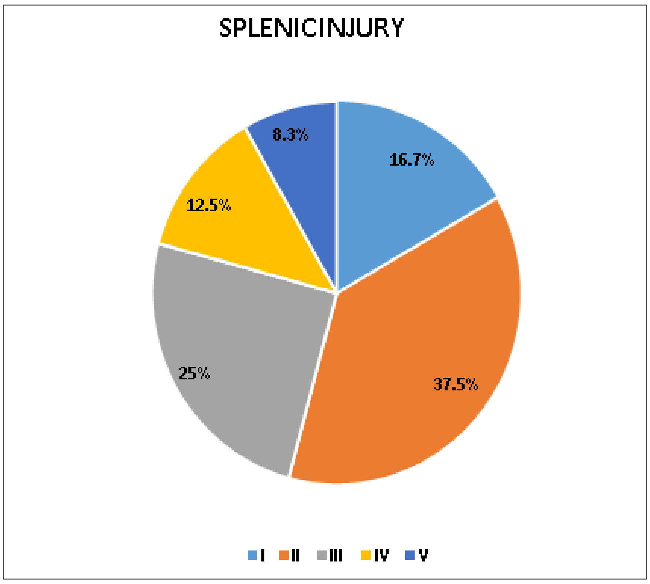

Fig 5: AAST Grade of Splenic Injury

Discussion

Substantial consequences arise from trauma, specifically blunt abdominal trauma, in terms of morbidity, death, and economic expenditures. In hemodynamically stable patients who have experienced abdominal trauma, the "panscan," or computed tomographic [CT] examination of the head, neck, chest, abdomen, and pelvis, has become a crucial part of the early evaluation and decision-making process. For the purpose of identifying significant injuries, CT has essentially taken the position of diagnostic peritoneal lavage. Increased spatial resolution, quicker image acquisition and reconstruction, and enhanced patient safety are just a few of the ways that the last ten years have seen significant advancements in CT hardware and software, particularly with the introduction and improvement of multidetector scanners [19].

There are two types of abdominal trauma, penetrating and blunt. Clinical signs are often used to diagnose penetrating abdominal trauma. Conversely, the lack of apparent clinical indications causes blunt trauma to be overlooked or delayed [20].

This study was conducted to assess the role of Computed tomography as a primary diagnostic modality in the evaluation of blunt abdominal injury in hemodynamically stable patients, to determine the choice of management (Operative versus conservative) by using the information provided from CT by grading the visceral injuries using The American Association for the Surgery ofTrauma (AAST) classification and to compare intra operative findings with CT findings to assess the sensitivity and specificity of CT scan as a gold standard modality in blunt trauma.

The total sample size was 50 participants in the present study. The age distribution of our study population revealed that the largest group of participants, accounting for 26%, were between 21-30 years, closely followed by those aged 41-50 years, also at 26%. Participants between 31-40 years constituted 24% of the population, while those aged 51-60 years made up 20%. The smallest group, comprising 4%, were aged 18-20 years. In contrary to our study, Almaramhy *et al* [22]. involved 7 pediatric patients, with 5 males and 2 females and the mean age was 7 years (range 5-12 years). Also, Kandel Kadeem *et al*. [23] reported an age range of 7 to 64 years in their study.

The gender distribution among the participants was 34% female and 66% male. This shows a higher prevalence of males in the study which was similar with the Mukherjee *et al* [21]. study where they had 73% of males in their research. Also, Kandel Kadeem *et al*. [23] reported 60% males in their study which was similar to our findings.

Road traffic accidents are fourth among the world's top causes of mortality, accounting for roughly 9% of fatalities and 16% of impairments. Abdominal trauma accounts for 13% of all injuries, with a fatality rate of 8% [21].

In our study, the most common mechanism of injury was road traffic accidents (RTA), accounting for 68% of the cases. Falls accounted for 16%, assaults for 14%, and sports injuries for 2% in our study. Similar to our study, Kandel Kadeem *et al*. [23] observed Road traffic accidents (80%) as the commonest followed by falls from height (6.7%), fighting (5%), animal trauma (3.3%). Comparatively, Mukherjee *et al*. [21] reported six main mechanisms: accelerating injury (32%), decelerating injury, kicks and blows (17%), compression injury, high velocity penetrating injuries, and low velocity penetrating injuries (10%). However, Almaramhy *et al*. [22] observed the commonest mechanism as falls from height (71%), followed by traffic accidents (14%) and cycle handlebar injuries (14%).

We found the initial clinical findings as 50% of participants presented with abdominal pain, 34% with abdominal tenderness, 12% with abdominal distension, and 4% with both abdominal distension and pain. The mean GCS score in our study was 13.32 ± 1.67, indicating that most patients had a mild level of consciousness impairment.

In the current study, visceral injuries were distributed as follows: the most common were splenic injuries, occurring in 48% of the cases, followed by liver injuries in 28% of the cases. Kidney injuries accounted for 16%, while bladder injuries and bowel/mesenteric injuries each constituted 6%. The least common were pancreatic injuries, seen in 2% of the cases in our study. This is consistent with the study done by Radhiana Hassan *et al* [27] who encountered pancreatic injury in only 3% of the cases. However, the Mukherjee *et al*. [21] study reported Liver injuries (72%) as the most common, followed by splenic injuries (19%), retroperitoneum (12%), kidney (9%), small intestine (8%), genitourinary (7%), colon (5%), pancreas and duodenum (4%) in their trial.

Also, Almaramhy *et al*. [22] focused on pancreatic injuries, with grades distributed as follows: Grade I (14%), Grade II (14%), Grade III (42%), and Grade V (28%). Associated injuries included splenic lacerations (2 patients) and ureteropelvic disruption of the left kidney (1 patient) in their research. Kandel Kadeem *et al*. [23] observed the most common injuries in liver (37.5%), spleen (32.5%), with associated injuries in 42% of cases of their participants.

In our study, Hemoperitoneum was present in 64% of cases, with mild cases accounting for 28.1%, moderate for 50%, and severe for 21.9%. Hemoperitoneum was absent in 36% of the participants. Pneumoperitoneum was present in 6% of cases and absent in 94% of the participants. Other findings included rib fractures alone in 58.3% of cases, pelvic fractures in 25%, rib fractures and pneumothorax in 8.3%, and hemothorax in 8.3%. A total of 76% of participants had no other findings. However, Mukherjee *et al*. [21] found only around 10% of patients having pelvic fractures, with other injuries to intestines, colon, pancreas, and duodenum.

We observed abnormal CT findings were present in 92% of cases, while 8% had normal CT scans. The management approach was conservative in 74% of cases and surgical in 26%. Visceral injury was present in 90% of cases in our study.

We found a significant association between visceral injury and management approach ($p = 0.032$) in our study. Surgery was performed in 9 cases with visceral injury and 4 cases without, while conservative management was applied to 24 cases with visceral injury and 13 cases without. This is superior to the study done by MM Kumar *et al* [28] in which 40 out of 47 visceral injury cases were taken up for surgery. This may be due to more conservative approach towards blunt abdominal injury cases with appropriate monitoring and follow up in the present era.

In the present study, Liver injuries were managed conservatively in 13 cases and surgically in 1. Splenic injuries were managed conservatively in 21 cases and surgically in 3. Kidney injuries were managed conservatively in 5 cases and surgically in 3. Bladder and bowel/mesenteric injuries required surgical intervention in all cases (3 each).

In the current study, Liver injuries were graded (AAST) as follows: Grade I in 14.3%, Grade II in 42.9%, Grade III in 35.7%, and Grade V in 7.1%. There was a significant association between the grade of liver injury and management ($p = 0.017$). All Grade I, II, and III injuries were managed conservatively, while the single Grade V injury required surgery.

Regarding hepatic injuries, Soto and Anderson1 described the role of CT in assessing liver trauma, emphasizing the importance of identifying active bleeding and vascular injuries for guiding management decisions. Our study's findings were consistent with this, as we also observed that hepatic injuries with significant bleeding or vascular involvement required more aggressive management strategies. Soto and Anderson1 noted that while CT-based grading systems are useful, they may not fully predict the need for surgical intervention or the risk of complications.

This was reflected in our study, where we found that the presence of large hemoperitoneum and active bleeding influenced the decision to opt for surgical exploration over conservative management.

In the present study, Splenic injuries were graded (AAST) as follows: Grade I in 16.7%, Grade II in 37.5%, Grade III in 25%, Grade IV in 12.5%, and Grade V in 8.3%. There was a significant association between the grade of splenic injury and management (p = 0.012). All Grade I, II, and III injuries were managed conservatively. Grade IV injuries were managed conservatively in 66.7% and surgically in 33.3%. All Grade V injuries required surgery.

In the context of splenic injuries, Soto and Anderson19 discussed the role of CT in assessing splenic trauma, noting that the spleen is frequently injured in blunt abdominal trauma. They stressed the importance of accurate injury grading and the challenges of predicting nonsurgical management success. Our study's findings corroborated their observations, as we also noted that splenic injuries often required careful evaluation to determine the appropriate management approach. We observed a range of injury grades, with higher-grade injuries being more likely to necessitate surgical intervention. Soto and Anderson's1 review also highlighted that while CT grading is helpful, it had limitations in predicting outcomes, which aligned with our study's experience where the clinical decision-making process also considered factors beyond CT grading, such as the patient's hemodynamic stability and the presence of associated injuries.

In our study, Kidney injuries were graded (AAST) as follows: Grade I in 12.5%, Grade II in 37.5%, Grade III in 12.5%, and Grade V in 37.5%. There was a significant association between the grade of kidney injury and management (p = 0.034). All Grade I, II, and III injuries were managed conservatively, while all Grade V injuries required surgery.

Bowel perforation was found in 33.3% of cases, jejunal perforation in 33.3%, and proximal ileal perforation in 33.3%.

Hemoperitoneum was present in 94% of cases with visceral injury and 6% without visceral injury. There was a significant association between hemoperitoneum severity and management approach (p = 0.001). Mild hemoperitoneum was managed conservatively in 77.8% of cases and surgically in 22.2%. Moderate hemoperitoneum was managed conservatively in 81.3% and surgically in 18.8%. Severe hemoperitoneum required surgical management in 100% of cases. Comparatively, Kandel Kadeem *et al.* [23] reported that large hemoperitoneum required surgical exploration in all cases, small fluid collections were managed conservatively unless associated with severe head or chest injuries. In moderate fluid collection, 68% underwent surgery due to instability or deterioration in their research.

In our study, we observed that patients with varying degrees of hemoperitoneum were managed differently based on the severity and volume of the fluid detected. Similarly, Soto and Anderson's review19 highlights that free peritoneal fluid in the absence of clear visceral injury often presents a diagnostic challenge. They emphasize that non-clotted blood, typically with attenuation values of 30–45 HU, can fill the peritoneal cavity and may not always indicate a significant injury on its own. In contrast, our study focused on the clinical decisions made based on the presence of hemoperitoneum and fluid collection, noting that large hemoperitoneum often necessitates surgical intervention, while smaller fluid collections can sometimes be managed conservatively. This aligns with Soto and Anderson's19 recommendation for a more conservative approach, especially with isolated free fluid, where close observation and repeat imaging are advised rather than immediate surgical exploration.

We also observed Pneumoperitoneum in 66.7% of cases with visceral injury. Postoperative findings included bladder repair with suprapubic catheter (SPC) in 6% of cases, direct vessel repair with perihepatic packing in 2%, laparotomy with patch closure in 6%, nephrectomy in 6%, and splenectomy in 6% in the current study.

Given the advances in imaging technology and growing CT experience widely, the Pal *et al*. [24] study postulated that CT is a valid and trustworthy diagnostic tool for patients who are hemodynamically stable but have a low degree of consciousness. After reviewing their experience in this clinical setting, they discovered that CT had a 99.4% overall accuracy rate, a 98.5% specificity, and a 97.7% sensitivity in their research. Also, another investigation by Killeen *et al*. [25] examined all hemodynamically stable blunt trauma patients' helical CT images, irrespective of their state of consciousness and with a sensitivity of 94%, CT was able to identify 64 out of 68 intestinal injuries in their investigation. But in their investigation, CT's accuracy was only 86%.

Similarly in our study, the CT findings for visceral injury had a sensitivity of 100%, specificity of 99.04%, positive predictive value of 95.50%, negative predictive value of 99.7%, and accuracy of 99.1%. For bowel injury, CT had a sensitivity of 100%, specificity of 99.26%, positive predictive value of 86%, negative predictive value of 93%, and accuracy of 98.4%.

Real-time hemothorax, hemoperitoneum, pneumothorax, and hemopericardium detection is made easier by the EFAST. Studies carried out across many nations have demonstrated that EFAST possesses exceptional sensitivity and specificity in excluding free blood within the pericardial, pleural, and peritoneal cavities, in addition to its ability to diagnose pneumothorax in trauma survivors [26].

In our study, we compared the CT and EFAST for diagnostic accuracy, CT had a sensitivity of 100%, specificity of 98.04%, positive predictive value of 92.5%, negative predictive value of 100%, and accuracy of 98.04%. EFAST had a sensitivity of 84.91%, specificity of 98.06%, positive predictive value of 93.75%, negative predictive value of 95%, and accuracy of 94.71%. Similar to our study, EFAST had a sensitivity, specificity, and positive predictive value of 94.8%, 99.5%, and 98.21%, respectively, in the Basnet *et al*. [26] investigation.

Conclusion

Our study highlighted the significant role of Computed Tomography (CT) as a primary diagnostic modality in evaluating blunt abdominal injury in hemodynamically stable patients. The findings demonstrated that CT is highly sensitive and specific in detecting visceral injuries, with a sensitivity of 100% and specificity of 99.04%. The study also confirmed a substantial association between the grade of visceral injury, as per the American Association for the Surgery of Trauma (AAST) classification, and the choice of management approach, whether conservative or surgical.

Our results emphasized the importance of CT in guiding clinical decisions, reducing unnecessary surgeries, and improving patient outcomes. Furthermore, CT was shown to have superior diagnostic accuracy compared to EFAST, underscoring its value as the gold standard modality in blunt trauma assessment. Despite the limitations, the study provides valuable insights into the effective use of CT in blunt abdominal trauma and supports its continued use in clinical practice to enhance diagnostic precision and patient care.

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