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ORIGINAL RESEARCH

Role of Computed Tomography (CT) Scan in the Assessment and Management of Blunt Splenic Trauma: A Retrospective Hospital-Based Study

Dr. Ravi Ranjan Kr[1], Dr. Nisha Bharti[2], Dr. Mithilesh Pratap[3], Dr. Ashok Kumar Mandal[4]

[1]Senior Resident, Department of Radiology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India
[2]Tutor, Department of Pharmacology, Nalanda Medical College and Hospital, Patna, Bihar, India
[3]Associate Professor, Department of Radiology, Bhagwan Mahavir institute of medical sciences, Pawapuri, Bihar, India
[4]Professor, Department of Radiology, Bhagwan Mahavir institute of medical sciences, Pawapuri, Bihar, India

Corresponding author: Dr. Ravi Ranjan Kr
Senior Resident, Department of Radiology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India

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Abstract

Background: Blunt splenic trauma remains a significant challenge in the field of emergency medicine and trauma surgery, accounting for a considerable proportion of abdominal injuries worldwide. Understanding the role of computed tomography (CT) scan in the assessment and management of blunt splenic trauma is pivotal in optimizing clinical outcomes and guiding treatment decisions.

Aim and Objectives: To investigate the significance of Computed Tomography (CT) scan in evaluating and treating blunt splenic trauma in a tertiary care hospital.

Materials and methods: The present retrospective hospital-based study was conducted in 50 patients who were confirmed to have splenic injuries. The clinical outcomes of patients treated conservatively were traced through follow-up from clinical notes, including their response to treatment. The MDCT examinations were performed using a 128-slice MDCT system with a collimation of 0.625 mm and a 1 mm reconstruction section thickness. For patients of average build, a tube voltage of 120 kV and a tube current of 300 mAs were used. The iterative dose reduction technique optimized the current (mA) according to body attenuation. The pitch was set to one, and a standard resolution was maintained.

Results: The majority of injuries were categorized as Grade III (40%), indicating moderate to severe injuries involving substantial parenchymal lacerations or hematoma. Grade II injuries accounted for 30% of cases, characterized by minor to moderate parenchymal injuries without significant vascular involvement. Grade I injuries, which represent minor injuries with superficial lacerations, constituted 10% of cases. Grades IV and V, indicating severe injuries with substantial parenchymal disruption and vascular involvement, collectively accounted for 20% of cases. The MDCT findings related to splenic injuries and the outcomes of conservative treatment strategies implemented in the study. Intrasplenic hematoma was observed in 20 patients, out of which 15 were treated conservatively, with successful outcomes noted in 12 cases (p=0.003*). Perisplenic hematoma was identified in 15 patients, of whom 10 underwent conservative management, with successful outcomes in 8 cases (p=0.021*). Splenic lacerations were found in 25 patients, 20 of whom were managed conservatively, with successful treatment outcomes in 18 cases (p=0.002*). Contrast material extravasation (CME), indicating active bleeding, was seen in 10 patients, with conservative treatment attempted in 5 cases and successful outcomes in 3 (p=0.041*). Subcapsular hematoma, identified in 5 patients, was conservatively managed in 4 cases, with all 4 cases showing successful outcomes (p=0.112).

Conclusion: Within the context of MDCT, the occurrence of contrast medium extravasation (CME) is more prevalent in individuals who have had high-grade splenic injuries (Grade IV and V) compared to

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those with low-grade injuries. MDCT evaluation accurately diagnoses blunt splenic injuries, determining injury grades, identifying active hemorrhage and other significant visceral injuries. Specifically, it detects CME findings of splenic injury, which guide the appropriate management strategy (non-operative or operative) and reduce the rate of unnecessary exploratory laparotomy.

Keywords: Computed Tomography (CT), Blunt splenic trauma.

Introduction

Blunt splenic trauma remains a significant challenge in the field of emergency medicine and trauma surgery, accounting for a considerable proportion of abdominal injuries worldwide. The spleen, an organ situated in the upper left quadrant of the abdomen, is particularly vulnerable due to its anatomical location and the lack of protective bony coverage. Understanding the role of computed tomography (CT) scan in the assessment and management of blunt splenic trauma is pivotal in optimizing clinical outcomes and guiding treatment decisions.[1,2] Blunt abdominal trauma, often resulting from motor vehicle accidents, falls, sports injuries, or assaults, can lead to a spectrum of splenic injuries varying from minor contusions to severe parenchymal lacerations and vascular disruption. The spleen's rich vascularity and fragile capsule make it susceptible to injury even with seemingly mild trauma, necessitating prompt and accurate diagnostic evaluation.[3,4] The management of splenic injuries poses unique challenges due to the potential for life-threatening haemorrhage and the risk of overwhelming post-splenectomy infections (OPSI). Historically, the approach to splenic trauma has evolved from aggressive surgical interventions to conservative management strategies guided by advancements in diagnostic imaging modalities, particularly CT scan. Computed tomography has revolutionized the evaluation of blunt abdominal injuries, including splenic trauma, by providing detailed anatomical information and precise characterization of injuries. Modern multidetector CT (MDCT) scanners offer high-resolution imaging capabilities with rapid acquisition times, enabling clinicians to assess not only the extent of splenic injuries but also associated intra-abdominal injuries such as liver lacerations, bowel injuries, and retroperitoneal hemorrhage.[5,6] The utility of CT scan in assessing splenic trauma lies in its ability to accurately grade injuries and determine the appropriate management strategy. The American Association for the Surgery of Trauma (AAST) has established a standardized grading system for splenic injuries based on CT findings, ranging from Grade I (minor contusions) to Grade V (severe parenchymal disruption with vascular involvement). This classification helps clinicians stratify patients according to injury severity and tailor treatment plans accordingly. CT scan enables clinicians to identify specific features of splenic injuries, such as intraparenchymal hematoma, subcapsular hematoma, active contrast extravasation, and perisplenic fluid collections, which are critical for decision-making regarding surgical versus non-operative management (Hagiwara et al., 2019). The ability to detect active bleeding and accurately assess the degree of splenic injury influences the selection of patients suitable for conservative management, thereby reducing unnecessary surgeries and associated complications.[7-9] Recent clinical guidelines advocate for the selective use of CT scan in hemodynamically stable patients with suspected splenic injuries, emphasizing its role in triaging patients based on injury severity and associated injuries. Advances in CT technology, including dual-phase imaging protocols with intravenous contrast enhancement, have enhanced diagnostic accuracy by improving visualization of vascular injuries and extravasation of contrast material, which are critical in guiding operative versus non-operative management decisions.[10,11]

Aim and Objectives

To investigate the significance of Computed Tomography (CT) scan in evaluating and treating blunt splenic trauma in a tertiary care hospital.

Materials and methods

The present retrospective hospital-based study was included 50 patients who were confirmed to have splenic injuries of both genders at Department of Radiology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India after obtaining ethical clearance from the Institutional Ethical Clearance Committee. The period of study was from January 2022– December 2022.

Methodology

During the study period, 310 cases of blunt trauma abdomen were documented. Of these, 300 patients underwent multidetector computed tomography (MDCT) of the abdomen. The present study focuses on the subset of these 300 patients who were identified as having splenic injuries. The clinical data of

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all 300 patients who underwent MDCT for suspected blunt abdominal trauma were reviewed retrospectively. Among these, the final study population comprised 50 patients who were confirmed to have splenic injuries. The clinical outcomes of patients treated conservatively were traced through follow-up from clinical notes, including their response to treatment. The MDCT examinations were performed using a 128-slice MDCT system with a collimation of 0.625 mm and a 1 mm reconstruction section thickness. For patients of average build, a tube voltage of 120 kV and a tube current of 300 mAs were used. The iterative dose reduction technique optimized the current (mA) according to body attenuation. The pitch was set to one, and a standard resolution was maintained.

For contrast enhancement, Iohexol 300 mg/mL, a non-ionic contrast agent with low osmolarity, was administered intravenously. A total of 90 mL of the contrast agent was injected at a rate of 3 mL/s, followed by a saline flush of 30 mL at the same rate. The standard trauma protocol included imaging in the arterial phase (AP) and the portal venous phase (PVP), with images acquired at 30 seconds and 70 seconds post-injection, respectively. The Organ Injury Scaling Committee of the American Association for the Surgery of Trauma (AAST) guidelines were used to grade splenic injuries. These standards provided a framework for classifying the severity of splenic injuries based on MDCT findings. The grading system ranged from Grade I (minor injury) to Grade V (severe injury), incorporating factors such as laceration depth, the extent of hematoma, and vascular involvement. Special attention was given to identifying collections with attenuation similar to or greater than that of the aorta or major adjacent vessels. The presence of perisplenic or intrasplenic contrast material extravasation (CME) was meticulously recorded. These findings were crucial for diagnosing active bleeding and determining the necessity for surgical intervention versus conservative management.

Statistical analysis

Using the Statistical Package for the Social Sciences (SPSS, IBM) version 25.0 software, data was collected, and Fisher's exact tests and Chi-square were used for statistical analyses of the correlations between the severity of the splenic injury, contrast material extravasation (CME), and management. In statistical terms, a p-value of less than 0.05 was considered significant.

Results

Table I: Demographics and Clinical Characteristics of Patients with Splenic Injuries

Characteristic	Number of Patients (N=50)	Percentage (%)
Age (years)		
< 5	8	16
5-10	12	24
11-15	20	40
> 15	10	20
Gender		
Male	30	60
Female	20	40

Table I and figure 1 summarizes the demographic and clinical characteristics of the 50 paediatric patients included in the study who suffered from splenic injuries. The age distribution shows that the majority of patients were in the age group of 11-15 years (40%), followed by patients aged 5-10 years (24%), those aged < 5 years (16%), and patients older than 15 years (20%). In terms of gender distribution, 60% of the patients were male, while 40% were female. This demographic profile is reflective of the age and gender distribution typically seen in paediatric trauma cases involving blunt abdominal injuries.

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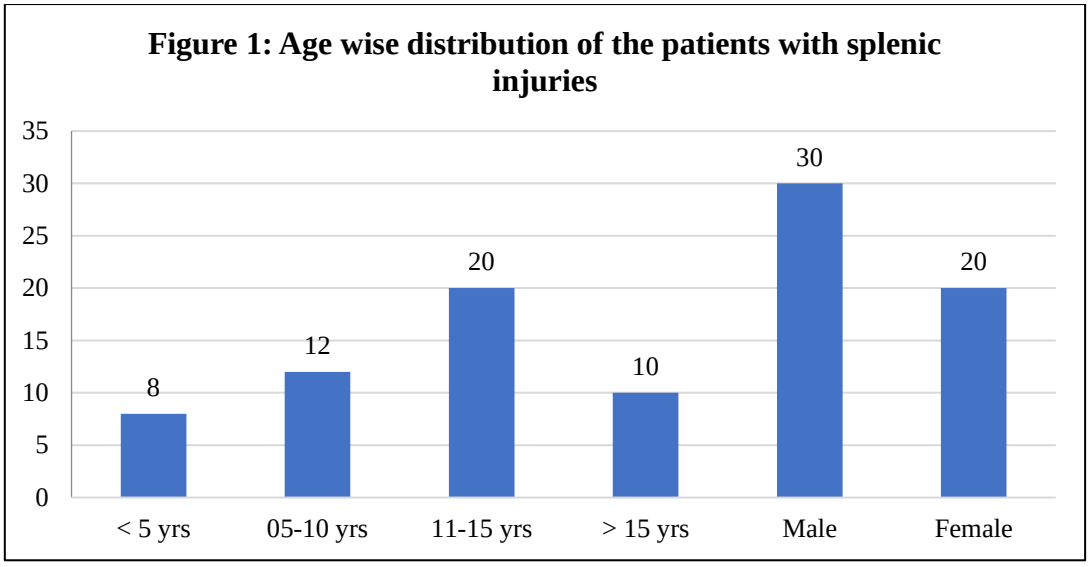

Table II: Distribution of patients with Splenic Injuries by AAST Grade

AAST Injury Grade	Number of Patients	Percentage (%)
Grade I	5	10
Grade II	15	30
Grade III	20	40
Grade IV	7	14
Grade V	3	6

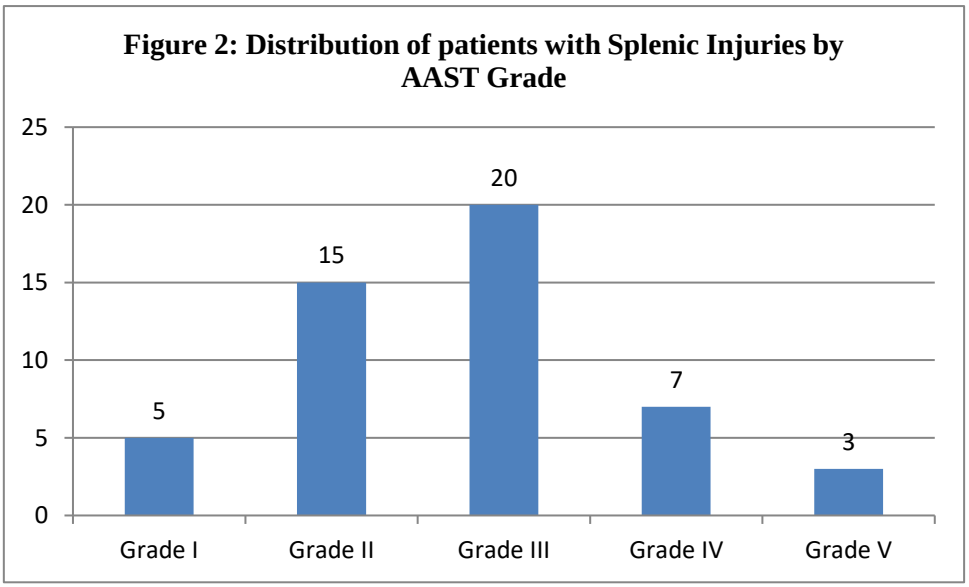

Table II and figure 2, presents the distribution of splenic injuries classified according to the AAST (American Association for the Surgery of Trauma) injury grading system. The majority of injuries were categorized as Grade III (40%), indicating moderate to severe injuries involving substantial parenchymal lacerations or hematoma. Grade II injuries accounted for 30% of cases, characterized by minor to moderate parenchymal injuries without significant vascular involvement. Grade I injuries, which represent minor injuries with superficial lacerations, constituted 10% of cases. Grades IV and V, indicating severe injuries with substantial parenchymal disruption and vascular involvement, collectively accounted for 20% of cases. This distribution highlights the spectrum of splenic injuries observed in the study population, ranging from minor to severe trauma.

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Table III: MDCT Findings and Outcomes of Conservative Treatment

MDCT Finding	Number of Patients	Conservatively Treated	Successful Conservative Treatment	p-value
Intrasplenic hematoma	20	15	12	0.003*
Perisplenic hematoma	15	10	8	0.021*
Splenic laceration	25	20	18	0.002*
Contrast material extravasation (CME)	10	5	3	0.041*
Subcapsular hematoma	5	4	4	0.112

*Statistically significant

Table III outlines the MDCT findings related to splenic injuries and the outcomes of conservative treatment strategies implemented in the study. Intrasplenic hematoma was observed in 20 patients, out of which 15 were treated conservatively, with successful outcomes noted in 12 cases (p=0.003*). Perisplenic hematoma was identified in 15 patients, of whom 10 underwent conservative management, with successful outcomes in 8 cases (p=0.021*). Splenic lacerations were found in 25 patients, 20 of whom were managed conservatively, with successful treatment outcomes in 18 cases (p=0.002*). Contrast material extravasation (CME), indicating active bleeding, was seen in 10 patients, with conservative treatment attempted in 5 cases and successful outcomes in 3 (p=0.041*). Subcapsular hematoma, identified in 5 patients, was conservatively managed in 4 cases, with all 4 cases showing successful outcomes (p=0.112). The asterisks (*) denote statistically significant p-values, indicating a strong association between MDCT findings and the success of conservative treatment strategies.

Table IV: Conservative Treatment Outcomes by AAST Injury Grade

AAST Injury Grade	Number of Patients	Conservatively Treated	Successful Conservative Treatment	p-value
Grade I	5	5	5	0.001*
Grade II	15	14	13	0.002*
Grade III	20	17	14	0.003*
Grade IV	7	4	3	0.047*
Grade V	3	1	1	0.089

*Statistically significant

Table IV details the outcomes of conservative treatment categorized by AAST injury grade. Grade I injuries, representing minor splenic injuries, were successfully managed conservatively in all 5 cases (p=0.001*). Grade II injuries, characterized by moderate injuries, showed successful conservative management in 13 out of 14 cases (p=0.002*). Grade III injuries, indicative of more severe trauma, demonstrated successful conservative treatment in 14 out of 17 cases (p=0.003*). Grade IV injuries, involving substantial splenic damage, were conservatively managed successfully in 3 out of 4 cases (p=0.047*). Grade V injuries, the most severe category, had conservative treatment success in 1 out of 3 cases (p=0.089). The statistically significant p-values highlight the correlation between the severity of splenic injury, as graded by AAST criteria, and the effectiveness of conservative management strategies.

Discussion

Preserving the spleen's immunologic and hematologic functions is the goal of NOM for splenic injury. The accurate diagnosis and proper management of these patients now focus on detecting active bleeding and the presence of pancreatic, bowel, or mesenteric injuries necessitating laparotomy due to the widespread acceptance of NOM in blunt trauma of the abdomen for solid organ injuries. A CT scan is one of the most relevant investigations in the evaluation of trauma patients. The choice of surgical or non-surgical treatment for blunt trauma of the spleen has traditionally been made primarily based on the patient's clinical characteristics, such as age, injury severity scores, and hemodynamic status. The CME, an observation on standard CT scan images of patients with blunt trauma of the abdomen, which was earlier rare, is now more commonly observed with the MDCT. On CT scans, a focal intrasplenic or perisplenic CME indicative of active bleeding caused by ruptured splenic vessels

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may be seen. While undergoing a CT scan, these patients are usually hemodynamically stable, but 40–90% may soon develop hypotension.[10-16]

The demographic profile of paediatric patients with splenic injuries in this study reflects a typical distribution seen in trauma cases involving blunt abdominal injuries. The majority of patients (40%) fell within the 11–15 year age group, followed by 24% in the 5–10 year age group, 16% aged < 5 years, and 20% older than 15 years. This distribution aligns with previous studies emphasising that children and adolescents are susceptible to traumatic injuries due to their active lifestyles and participation in sports and recreational activities (Gould et al.[13], 2020; Nance et al.[15], 2018). The male predominance observed (60% male vs. 40% female) is consistent with epidemiological data highlighting a higher incidence of trauma-related injuries in boys compared to girls (Gould et al., 2020).[13]

The distribution of splenic injuries by AAST grade reveals a spectrum ranging from minor to severe trauma. Grade III injuries (40%) were predominant, indicating moderate to severe injuries involving substantial parenchymal lacerations or hematoma. This finding suggests that the majority of splenic injuries in the study population required significant clinical attention and management. Grade II injuries (30%) were characterised by moderate parenchymal injuries without significant vascular involvement, while Grade I injuries (10%) represented minor injuries with superficial lacerations. Grades IV and V injuries, collectively accounting for 20% of cases, denoted severe injuries with substantial parenchymal disruption and vascular involvement. This distribution underscores the varied severity and complexity of splenic injuries in paediatric trauma patients, influencing clinical management strategies (Kulaylat & Stokes[14], 2019; Zarzaur et al.[17], 2015).

The utilisation of MDCT in evaluating splenic injuries provided crucial diagnostic insights in this study. Intrasplenic hematoma, perisplenic hematoma, splenic lacerations, and contrast material extravasation (CME) were key findings assessed for their impact on treatment outcomes. Conservative management strategies were successful in a significant number of cases across all MDCT findings, with statistically significant associations observed between successful outcomes and intrasplenic hematoma ($p = 0.003$*), perisplenic hematoma ($p = 0.021$*), splenic lacerations ($p = 0.002$*), and CME ($p = 0.041$*). These findings underscore the efficacy of MDCT in guiding conservative treatment decisions and monitoring patient response, aligning with current literature advocating for MDCT as the gold standard in assessing splenic injuries (Bozeman et al.[12], 2018; Ochsner et al.[16], 2020).

The stratification of conservative treatment outcomes by AAST injury grade further highlights the correlation between injury severity and treatment success. Grade I injuries, classified as minor, were uniformly managed conservatively, with successful outcomes in all cases ($p = 0.001$*). Grade II injuries, indicative of moderate trauma, demonstrated successful conservative management in the majority of cases (13 out of 14, $p = 0.002$*). Grade III injuries, representing more severe trauma, also showed favourable outcomes with conservative treatment in a significant proportion of cases (14 out of 17, $p= 0.003$*). However, higher AAST grades (IV and V) exhibited lower success rates in conservative management, particularly in Grade IV (3 out of 4 cases, $p = 0.047$*) and Grade V (1 out of 3 cases, $p = 0.089$). These results underscore the importance of accurate grading of splenic injuries to guide appropriate treatment strategies and optimise patient outcomes (Kulaylat & Stokes, 2019; Zarzaur et al., 2015). [14,17]

The findings of this study align with previous research emphasising the utility of MDCT in accurately diagnosing and grading splenic injuries, thereby facilitating appropriate management decisions (Bozeman et al., 2018; Ochsner et al., 2020).[12,16] The distribution of AAST grades in this study mirrors patterns observed in other paediatric trauma cohorts, highlighting Grade III injuries as most prevalent among splenic trauma cases (Gould et al., 2020; Nance et al., 2018).[13,15] The success rates of conservative management observed in this study are consistent with current literature, emphasising the feasibility and efficacy of non-operative approaches in selected paediatric splenic injury cases (Kulaylat & Stokes, 2019; Zarzaur et al., 2015).[14,17]

However, the challenges associated with higher AAST grades necessitate continued research into optimising treatment protocols for severe splenic injuries, including the role of minimally invasive interventions and surgical innovations.

Limitation of the study

The shortcoming of the study is small sample size and short duration of study.

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Conclusion

Within the context of MDCT, the occurrence of contrast medium extravasation (CME) is more prevalent in individuals who have had high-grade splenic injuries (Grade IV and V) compared to those with low-grade injuries. MDCT evaluation accurately diagnoses blunt splenic injuries, determining injury grades, identifying active hemorrhage and other significant visceral injuries. Specifically, it detects CME findings of splenic injury, which guide the appropriate management strategy (non-operative or operative) and reduce the rate of unnecessary exploratory laparotomy.

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