Section: Radiodiagnosis

Original Research Article

ROLE OF MULTIDETECTOR COMPUTED TOMOGRAPHY IN EVALUATION OF ABDOMINAL TRAUMA

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Abstract

Background: Trauma remains a significant global public health concern, regardless of a country's level of socioeconomic development with substantial morbidity and mortality. It is identified as a primary cause of death, hospitalization, and long-term disabilities, particularly among individuals under 40 years old. The abdomen ranks as the third most commonly injured area, requiring surgical intervention in around 25% of trauma cases. Advancements in imaging techniques such as USG, CT scans, and MRI have enabled non-surgical management of many abdominal injuries, allowing for accurate assessment of injury location and extent. **Materials and Methods:** The prospective study was conducted in M. G. M Medical College, Kishanganj on patients reporting from 1st September 2022 to 30th April 2024 after obtaining Institutional Thesis committee and Ethics Committee approval and written informed consent from the patient/guardian. **Result:** In the present study of abdominal trauma, the majority of patients were males. Out of a total of 50 patients, 43 were males and only 07 were females. The male to female ratio was 6.14:1. Out of 50 patients evaluated in our study, the maximum number of patients was in the age group of 21-30 years and 11-20 years, comprising 34% and 18% of the cases. Out of 50 patients evaluated for abdominal trauma, the most common injury type is blunt trauma, comprising 78% of the cases and penetrating type trauma comprising only 22% of the cases. Roadside accident involving vehicles was seen to be the most common cause of injury (66%) followed by assault (12%) and gunshot (12%). Stab injury comprises only 10% of the total cases. **Conclusion:** Our study highlights the demographic and clinical patterns of abdominal trauma among a cohort of 50 patients. Males were significantly more affected than females, and young adults aged 21-30 years were the most vulnerable group.

INTRODUCTION

Trauma remains a significant global public health concern, regardless of a country's level of socioeconomic development,[1] with substantial morbidity and mortality. It is identified as a primary cause of death, hospitalization, and long-term disabilities, particularly among individuals under 40 years old. Approximately one-third of trauma cases globally involve abdominal injuries,[2] which contribute significantly to mortality rates. Unrecognized abdominal injuries are a prevalent factor in preventable deaths.[3] The abdomen ranks as the third most commonly injured area, requiring surgical intervention in around 25% of trauma cases,[4] largely due to its limited bony protection for internal organs.[5] In developing nations, trauma and abdominal injuries are on the rise, attributed to factors such as increased motor vehicle usage, urbanization, and instances of physical violence and criminal behaviour.[6] The mechanisms of abdominal trauma vary across regions due to differences in social infrastructure and levels of violence.

Abdominal trauma is categorized into two types: penetrating and blunt trauma, with road traffic accidents being the most prevalent cause globally.[7-9] For surgeons in resource-limited settings where advanced diagnostic tools like Focused Assessment Sonography for Trauma (FAST) and CT scans are not readily available,[10] diagnosing abdominal trauma poses a challenge. While penetrating injuries are often easier to diagnose, blunt abdominal injuries present a significant challenge, even for seasoned clinicians, as clinical signs may not consistently align with specific injuries such as rib fractures, contusions, hematomas, and abrasions. Additionally, injuries

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like fractured lumbar vertebrae with retroperitoneal bleeding or hematoma and altered consciousness may not be immediately apparent during initial assessment and management. Trauma mechanisms often result in associated injuries that may divert attention from potentially life-threatening intra-abdominal conditions. Effective management of abdominal trauma necessitates adequate pre-hospital care, rapid transport to trauma centre's, comprehensive in-hospital care, and post-discharge rehabilitation. The pre-hospital phase is crucial for patient outcomes, yet challenges such as lack of pre-hospital care and inefficient ambulance systems contribute to delayed assessment and critical management, leading to adverse outcomes. Advancements in imaging techniques such as USG, CT scans, and MRI have enabled non-surgical management of many abdominal injuries, allowing for accurate assessment of injury location and extent.[11,12] Common mechanisms of abdominal injury include both blunt trauma (e.g., road accidents, assaults, falls) and penetrating trauma (e.g., gunshot wounds, stabbings, blasts).

Blunt Abdominal Trauma: The World Health Organization (WHO) reports that road traffic injuries rank as the sixth leading cause of death in India, disproportionately affecting the younger and middle-aged population and resulting in significant hospital admissions, fatalities, disabilities, and socioeconomic losses.[13] A Road Traffic Accident (RTA) or roadside accident can be defined as an incident occurring on a public road involving at least one moving automobile, resulting in one or more individuals being injured or killed simultaneously.[14] Three primary mechanisms of injury account for damage to abdominal organs: sudden deceleration, external compression, and crush injuries. The liver, spleen, and kidneys are the most frequently affected abdominal organs and structures, followed by the small intestine and/or mesentery, bladder, colon and/or rectum, diaphragm, pancreas, hepatobiliary tree, and major abdominal vessels.

Penetrating Abdominal Trauma: Penetrating abdominal trauma is prevalent worldwide, commonly caused by gunshot wounds or stabbings. The small bowel, large bowel, liver, and intra-abdominal vascular structures are frequently affected, with the small bowel being injured in 50% of cases, followed by the large bowel (40%), liver (30%), and intra-abdominal vascular injuries (25%). Close-range injuries typically involve higher kinetic energy compared to distant ones, potentially leading to more severe damage. Gunshot wounds, characterized by high velocity, often result in unpredictable injuries, and there may be additional injuries from bullet fragments or pellets. Evaluating stab wounds that penetrate the abdominal wall can be challenging, and occult injuries may be overlooked, leading to delayed complications that contribute to increased morbidity and mortality.[15-17] Furthermore, the routine utilization of Multi-Detector Computed Tomography (MDCT) has significantly reduced the necessity for additional imaging studies and Diagnostic Peritoneal Lavage. MDCT also plays a crucial role in the post-trauma follow-up of patients with blunt abdominal injuries, aiding in the assessment of injury resolution or progression and the identification of associated complications.[18] The introduction of MDCT represents a significant advancement in the evaluation of abdominal trauma patients, offering shorter scanning times, enhanced resolution due to thinner collimation, and minimized partial volume and motion artefacts. MDCT efficiently captures images during arterial, parenchymal, and excretory phases with optimal post-contrast enhancement. The volumetric data obtained can be utilized to generate high-resolution multiplanar reformations (MPR), maximum intensity projection (MIP), and three-dimensional (3-D) reconstructions, facilitating the visualization of complex injuries and greatly enhancing the diagnostic capability, accuracy, and confidence of radiologists. MDCT plays a crucial role in the management of patients with solid organ injuries, particularly in facilitating non-operative approaches.[19]

Benefits of MDCT in Abdominal Trauma: MDCT provides high-resolution, detailed images of injuries in abdominal trauma cases, surpassing plain radiographs.

In comparison to FAST or ultrasonography, MDCT offers superior visualization of visceral organ injuries, particularly pancreatic and splenic injuries, with fewer artefacts.

MDCT is quicker and less expensive than MRI.

Drawbacks of MDCT: Patients are exposed to high levels of radiation.

It is not feasible for use in hemodynamically unstable patients.

Contraindicated during pregnancy.

MDCT tends to be more time-consuming and costly than ultrasonography.

Advantages of MDCT in Abdominal Trauma: MDCT provides superior resolution and detailed imaging of abdominal injuriescompared to conventional radiographs. It offers better visualization of visceral organ injuries, particularly those involving the pancreas and spleen, with fewer artefacts compared to FAST or Ultrasonography.

MDCT is a more time-efficient and cost-effective option compared to MRI.

Disadvantages of MDCT: Patients are exposed to high levels of radiation during MDCT scans.

MDCT cannot be performed on hemodynamically unstable patients.

It is contraindicated during pregnancy.

MDCT tends to be more time-consuming and costly than ultrasonography.

Laceration: The predominant form of parenchymal organ injury, manifest as irregular, linear, or branching hypodense regions on contrast-enhanced CT scans.

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Hematoma: Intraparenchymal hematoma presents as an elliptical accumulation of hypodense blood on contrast-enhanced CT imaging.

Active Hemorrhage: In trauma cases, active bleeding typically appears early in contrast-enhanced CT scans as focal hyperdense regions, indicating extravasated contrast material due to arterial bleeding.

Hemoperitoneum or Free Intraabdominal Fluid: Injuries to hollow viscera and solid organs often result in hemoperitoneum. Analyzing the attenuation of the hemorrhagic fluid aids in identifying the bleeding source. Fresh blood (with a typical attenuation of 30–45 HU) flows freely within peritoneal recesses, guided by gravity, and may eventually fill the cavity. Adjacent to the haemorrhage source, blood tends to be partly clotted and denser (45–70 HU), termed the sentinel clot sign.[20] This sign proves valuable when the bleeding source is unclear, especially in cases involving multiple organ injuries. Although estimating hemoperitoneum volume by examining fluid in intraabdominal spaces is possible, the amount of bleeding and active extravasation directly influences patient care decisions. A substantial hemoperitoneum doesn't always necessitate surgery.[21] Occasionally, hemoperitoneum may exhibit attenuation values lower than 20 HU.[22]

Pneumoperitoneum and Free Intraabdominal Air: Pneumoperitoneum, or the presence of free intraabdominal air, is a reliable indicator of gastrointestinal or bowel injury in abdominal trauma patients, with a reported specificity of 95%. However, it's not always completely specific and thus not pathognomonic for bowel or gastrointestinal perforation. Isolated free intraperitoneal air doesn't always indicate a perforated bowel; it can result from pneumothorax, chest tube insertion, diaphragmatic injury, or defects in the abdominal wall. However, the presence of free air along with free fluid or focal bowel imaging abnormalities strongly suggests bowel injury.[23,24] Pseudopneumoperitoneum, characterized by air between the abdominal wall and the parietal peritoneum, can lead to a false-positive diagnosis of gastrointestinal or bowel perforation.

Foreign Body:A foreign body (FB) refers to any object or material originating from outside a person's body. In trauma scenarios, foreign bodies may be present in gunshot wounds (such as bullet fragments or pellets), blast injuries, and occasionally, after roadside accidents. Detecting a foreign body can be challenging, depending on factors like the wound's nature and location, the timing and mechanism of injury. Soft tissue foreign bodies often result from penetrating injuries or abrasive trauma, leading to patient discomfort, deformity, delayed wound healing, localized and systemic infections, and potential further trauma during removal attempts. CT imaging is an invaluable tool for identifying the location, quantity, and composition of foreign bodies by assessing their Hounsfield units (HU). Metallic foreign bodies typically exhibit attenuation values exceeding 2500 HU.

Subcutaneous Emphysema or Surgical Emphysema: Subcutaneous emphysema refers to the presence of air in the subcutaneous layer beneath the skin's dermis. The skin comprises the epidermis and dermis, with the subcutaneous tissue situated below the dermis. Air leakage into various body spaces and cavities can lead to pneumomediastinum, pneumothorax, pneumoperitoneum, and pneumoretroperitoneum. Air travels from these regions along pressure gradients between intra-alveolar and perivascular interstitium, disseminating to the head, neck, chest, and abdomen through interconnected fascial and anatomical planes. Subcutaneous emphysema can arise from traumatic, surgical, spontaneous, or infectious causes. CT scans reveal dark or black pockets in the subcutaneous layer with negative Hounsfield units (approximately -1000 HU), indicating the presence of gas or air. MDCT is highly sensitive in pinpointing the location and source of injury responsible for surgical or subcutaneous emphysema, which may not be apparent on plain radiographs.

Fractures in Abdominal Trauma: Bone fractures occurring in abdominal trauma or polytrauma patients are frequently the result of high-energy external forces, such as those experienced in roadside accidents or falls from significant heights. These fractures commonly involve the pelvic bones and extra-pelvic bones, including vertebrae, lower ribs, and the proximal femur, in cases of abdominopelvic trauma. In instances of polytrauma, fractures can occur anywhere from head to toe. Pelvic bone fractures associated with injuries to solid abdominal organs in abdominopelvic trauma often indicate a poor prognosis.

Associated Thoracic Findings in Abdominal Trauma: Roadside accidents are the leading cause of trauma, often resulting in high-energy forces that can lead to injuries in multiple body areas, known as polytrauma. Thoracoabdominal injuries are particularly prevalent in such accidents, although falls from height, gunshot wounds, and blast injuries can also cause associated thoracic or thoracoabdominal injuries. Common thoracic injuries include fractures of the ribs and spine, lung injuries (such as lacerations and contusions), pneumothorax, and pleural effusion/hemothorax. While abdominal CT scans typically only visualize a small portion of the thorax, any thoracic findings observed during the evaluation of abdominal trauma warrant further investigation with a dedicated thoracic CT scan to assess the extent of the injury more accurately.

Aims and Objectives

Aim: To analyze the spectrum of Multidetector Computed Tomography findings in cases of abdominal trauma referred to the department of

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Objective: Diagnosis with findings of the type or spectrum of injury with the organs involved.

MATERIALSANDMETHODS

The prospective study was conducted in M. G. M Medical College, Kishanganj on patients reporting from 1stSeptember 2022 to 30thApril 2024 after obtaining Institutional Thesis committee and Ethics Committee approval and written informed consent from the patient/guardian.

Source of Data: The main source of data for the study was the patients referred to the department of Radiodiagnosis and Imaging, M. G. M Medical College, Kishanganj from the emergency room and department of surgery.

Equipment: Equipment was used a 16 slice CT scanner, GE make. CT windows was used to abdomen, lung and bone for all suspected abdominal trauma patients. Iohexol (omnipaque) was used as a contrast material wherever required.

Duration of Study and Sample Size: A Total 50 patients were enrolled for the study

Inclusion criteria

Clinical suspicion of abdominal trauma in Hemodynamically stable patients.

Exclusion Criteria

All hemodyanmically unstable patients.

RESULTS

The present study included 50 patients having acute and chronic abdominal trauma, who were admitted to MGM Medical College & Hospital Kishanganj, Bihar.

Gender Distribution: In the present study of abdominal trauma, the majority of patients were males. Out of a total of 50 patients, 43 were males and only 07 were females. The male to female ratio was 6.14 :1.

Age Distributions: Out of 50 patients evaluated in our study, the maximum number of patients were in the age group of 21-30 years and 11-20 years, comprising 34% and 18% of the cases.

Type of trauma: Out of 50 patients evaluated for abdominal trauma, the most common injury type is blunt trauma, comprising 78% of the case and penetrating type trauma comprising only 22% of the cases. Roadside accident involving vehicles was seen to be the most common cause of injury (66%) followed by assault (12%) and gunshot (12%). Stab injury comprises only 10% of the total cases.

Pneumoperitonium/ Free intra-abdominal air: Out of 50 cases in our studies, 11 patients show pneumoperitoneum as a finding in abdominal trauma.

Solid Organ & Gastrointestinal/Bowel Injuries: Out of 50 cases, solid abdominal organ injury was seen in 38 (76%) patients and gastrointestinal injury was seen in 6 (12%). The no. of cases with no organ injury was 10(20 %).

MDCT findings in abdominal organ injury: Out of 50 cases, the multi-organ injury was seen in 18 (36%) cases, single organ injury was noted in 22 (44%) cases and there are 10 (20%) cases, with no organ injury.

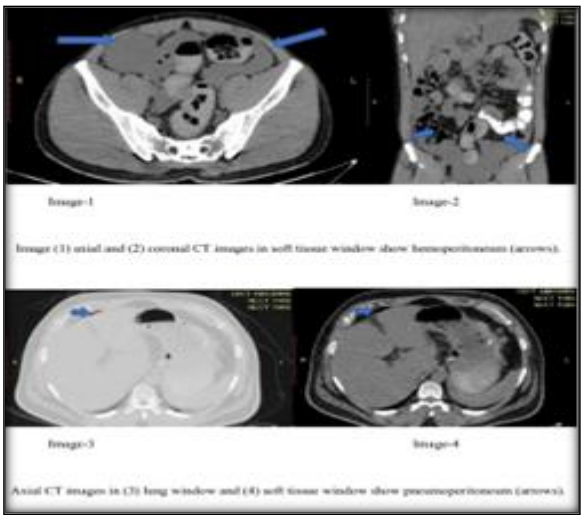
Injured Abdominal Organ: Out of 50 cases, the most common injured organ was the liver followed by spleen and renal with several cases 18(36%), 15(30%), and 14 (28%) respectively. The bowel or gastrointestinal injury was seen in 6 (12%) cases, adrenal gland injury was seen in 4(8%) and penile injury was seen in only 1(2%) cases. The pelvic fracture was seen in 3(6%) cases out of all injuries.

Foreign Bodies: Out of 50 cases in our study, the foreign body (metallic) was seen in 6 (12%) patients. All of these metallic foreign bodies are seen in gunshot injuries.

Associated Thoracic Findings: Out of 50 cases in our study, associated thoracic findings includes, pleural effusion was seen in 27 (54%) cases, pneumothorax in 6 (12%) of cases, lung contusion in 4 (8%) cases, and lung laceration in only 2 (4%) cases.

Associated Fractures: Out of 50 cases in our study, the associated pelvic fracture was seen in 3 (6%) of cases and non-pelvic (including ribs, spine, and femur) was noted in 18 (36%) cases. By applying the statistical Z test extra pelvic fracture is more significant in a roadside accident than other causes of injury ($p<0.05$).

MDCT Images:



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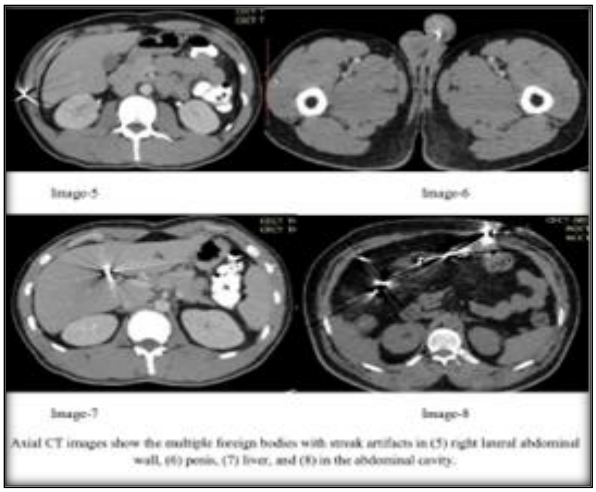
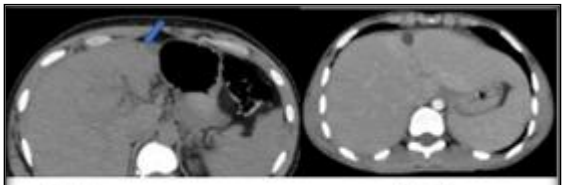
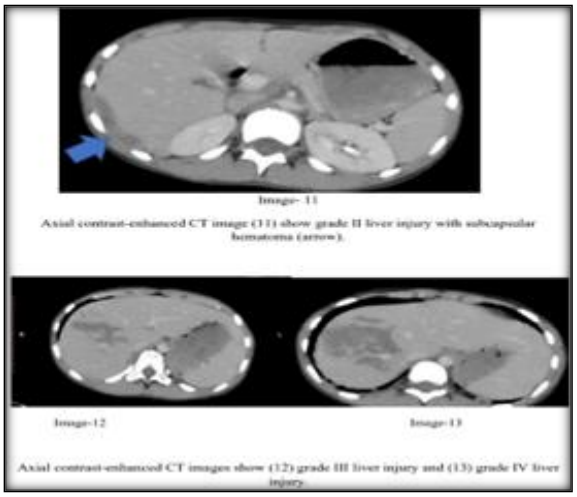


Axial CT images show the multiple foreign bodies with streak artifacts in (5) right lateral abdominal wall, (6) penis, (7) liver, and (8) in the abdominal cavity.

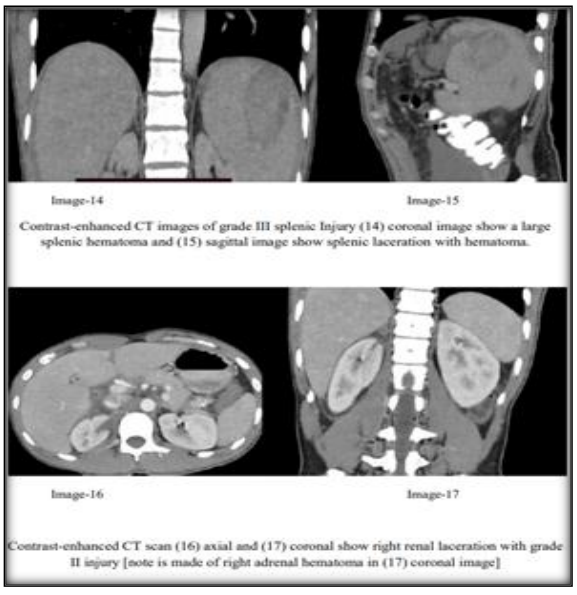


Axial CT images of grade I liver injury. (9) non-contrast show a linear hypodense laceration in liver (arrow) and (10) contrast-enhanced show round hypodense hematoma in liver



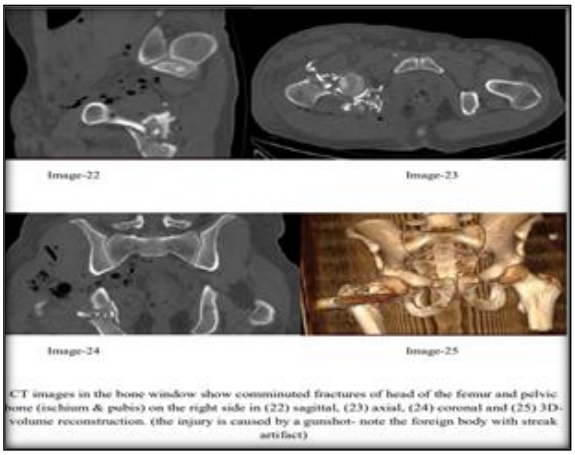
Axial contrast-enhanced CT image (11) show grade II liver injury with subcapsular hematoma (arrow).

Axial contrast-enhanced CT images show (12) grade III liver injury and (13) grade IV liver injury.



Contrast-enhanced CT images of grade III splenic Injury (14) coronal image show a large splenic hematoma and (15) sagittal image show splenic laceration with hematoma.

Contrast-enhanced CT scan (16) axial and (17) coronal show right renal laceration with grade II injury [note is made of right adrenal hematoma in (17) coronal image]



CT images in the bone window show comminuted fractures of head of the femur and pelvic bone (ischium & pubis) on the right side in (22) sagittal, (23) axial, (24) coronal and (25) 3D-volume reconstruction. (the injury is caused by a gunshot- note the foreign body with streak artifact)

DISCUSSION

Out of 50 patients with acute and chronic abdominal trauma, 43 (86%) were male and 7 (14%) were female, resulting in a male-to-female ratio of 6.14:1. The majority of patients were aged 21-30 years (34%), with the peak incidence in this age group. The least affected were children aged 0-10 years, with only 2 cases (4%). The mean age of patients was 33.4 years. Blunt trauma was the most common cause, accounting for 39 cases (78%), while penetrating trauma accounted for 11 cases (22%). Roadside accidents were the leading cause of blunt trauma (33 cases, 66%), followed by assaults (6 cases, 12%). Gunshot injuries were the most common cause of penetrating trauma (6 cases, 12%), followed by stab injuries (5 cases, 10%). Free intra abdominal fluid or hemoperitoneum was the most common finding, present in 45 out of 50 patients (90%). It was observed in 31 out of 33 roadside accidents, all 6 assault cases, 4 out of 6 gunshot cases, and 4 out of 6 stab injury cases. Pneumoperitoneum was more common in penetrating injuries, with 11 cases in total—6 from penetrating trauma and 5 from blunt trauma. Solid organ injuries were most prevalent, occurring in 38 cases (76%), while bowel/gastrointestinal injuries were seen in 6 cases (12%). Pelvic fractures were noted in 3 cases (6%). The liver was the most frequently injured organ (18 cases, 36%), followed by the spleen (15 cases, 30%) and kidneys (14 cases, 28%). Liver injuries were mostly lacerations (94.7%), with grade III injuries being the most common. Splenic injuries were also predominantly lacerations, with grade III injuries being the most frequent. Renal injuries were more common on the right side, with lacerations being the most frequent injury type. Adrenal injuries were observed in 4 cases (8%), all of which were contusions. There was one case (2%) of penile laceration caused by a gunshot, classified as a grade I AAST injury. Gastrointestinal injuries occurred in 6 cases (12%), mainly involving the small bowel. Diaphragmatic injury was seen in one case (2%), abdominal wall/rectus sheath injuries in 13 cases (26%), and subcutaneous emphysema in 6 cases (12%). Metallic foreign bodies, all related to gunshot

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injuries, were found in 6 patients (12%). Associated thoracic findings included pleural effusion in 27 cases (54%), pneumothorax in 6 cases (12%), lung contusion in 4 cases (8%), and lung laceration in 2 cases (4%). Extra pelvic fractures, notably more common in roadside accidents, were observed in 18 cases (36%).

CONCLUSION

In conclusion, our study highlights the demographic and clinical patterns of abdominal trauma among a cohort of 50 patients. Males were significantly more affected than females, and young adults aged 21-30 years were the most vulnerable group. Blunt trauma, predominantly from roadside accidents, emerged as the leading cause of abdominal injuries, with free intra-abdominal fluid or hemo-peritoneum being the most common associated finding. Solid organ injuries, particularly to the liver, spleen, and kidneys, were prevalent, while bowel injuries and pelvic fractures were less frequent. Penetrating injuries, mainly from gunshots and stabbings, were associated with a higher incidence of pneumo-peritoneum. The presence of metallic foreign bodies in gunshot injuries underscores the need for careful radiological assessment. These findings emphasize the importance of targeted preventive measures, especially for young adults and in traffic-related incidents, and highlight the need for prompt and accurate diagnostic protocols in managing abdominal trauma.

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