Journal of Cardiovascular Disease Research

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 07, 2023

Role of Contrast-Enhanced CT in the Evaluation of Abdominal Trauma: A Prospective Study

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Abstract

Background

Abdominal trauma is a significant cause of morbidity and mortality, necessitating accurate and timely diagnosis for effective management. Contrast-enhanced CT (CECT) is widely utilized for evaluating abdominal injuries, but its diagnostic efficacy compared to other modalities like ultrasonography (FAST) and clinical examination warrants further investigation.This prospective study evaluates the role of contrast-enhanced CT (CECT) in the assessment of abdominal trauma, comparing its diagnostic accuracy with ultrasonography (FAST) and clinical examination

Methods

A total of 100 patients with abdominal trauma were included in this study. Patient demographics, injury mechanisms, organ injuries detected by CECT, severity of injuries (based on the AAST Organ Injury Scale), presence of hemoperitoneum, diagnostic accuracy of CECT, interventions based on CECT findings, complications, mortality rates, length of hospital stay, and follow-up outcomes were analyzed.

Results

The study comprised 65 males and 35 females, with the majority aged between 18-30 years. Road Traffic Accidents (50%) were the most common injury mechanism. CECT detected liver injuries in 30%, spleen in 25%, kidney in 20%, pancreas and intestines in 10% each, and multiple organs in 5%. Severity distribution was as follows: Grade I (20%), Grade II (25%), Grade III (30%), Grade IV (15%), and Grade V (10%). Hemoperitoneum was present in 40% of patients. CECT showed high diagnostic accuracy with 95% sensitivity, 90% specificity, 92% PPV, and 93% NPV. In comparison, FAST had 70% sensitivity and 75% specificity, while clinical examination had 65% sensitivity and 80% specificity. Interventions based on CECT findings included non-operative management (70%), surgical intervention (25%), and endovascular procedures (5%). Complications included infections (5%), re-bleeding (3%), and organ failure (2%). Mortality was 4%, predominantly due to severe multi-organ injury. The mean hospital stay was 10 days. At 3-month follow-up, 80% of patients had fully recovered, 15% had partial recovery, and 5% had long-term complications.

Conclusion

CECT is a highly sensitive and specific imaging modality for evaluating abdominal trauma, providing critical information for clinical management and significantly influencing patient outcomes.

Keywords

Abdominal trauma, contrast-enhanced CT, diagnostic accuracy, FAST, clinical management

INTRODUCTION

Abdominal trauma remains a significant cause of morbidity and mortality worldwide, posing substantial challenges to healthcare systems[1]. Prompt and accurate diagnosis is crucial in managing these injuries effectively, reducing complications, and improving patient outcomes[2]. The complexity and variability of abdominal injuries necessitate the use of advanced imaging modalities to provide detailed and reliable information for clinical decision-making[3].

Contrast-enhanced computed tomography (CECT) has emerged as a cornerstone in the diagnostic evaluation of abdominal trauma[4]. Its ability to provide high-resolution images and detailed anatomical information makes it an invaluable tool in the acute setting[5]. CECT can detect a wide range of injuries, including those to solid organs, hollow viscus, and vascular structures, thereby guiding appropriate therapeutic interventions[6].

Despite its widespread use, the diagnostic accuracy of CECT relative to other modalities such as ultrasonography (Focused Assessment with Sonography for Trauma, FAST) and clinical examination remains a topic of ongoing investigation. While FAST is a rapid, non-invasive, and readily available imaging technique, its sensitivity and specificity in detecting certain abdominal injuries can be limited[7]. Clinical examination, although essential, may not always provide the granularity required for definitive diagnosis, particularly in hemodynamically stable patients with subtle or complex injuries.

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 07, 2023

This study aims to evaluate the role of CECT in the assessment of abdominal trauma by comparing its diagnostic performance with that of FAST and clinical examination. Additionally, the study examines the impact of CECT findings on clinical management strategies and patient outcomes. By providing a comprehensive analysis of CECT's efficacy in a trauma setting, this study seeks to reinforce its value in guiding clinical decisions and optimizing patient care.

Methodology

Study Design and Duration

This prospective study was conducted from March 2022 to February 2023 at , a tertiary care center equipped with advanced imaging and trauma care facilities.

Study Population

A total of 100 patients presenting with abdominal trauma were included in this study. Patients were selected based on the following inclusion and exclusion criteria:

Inclusion Criteria:

Patients of all ages presenting with abdominal trauma.
Both blunt and penetrating trauma cases.
Hemodynamically stable and unstable patients.

Exclusion Criteria:

Patients with a history of prior abdominal surgery.
Patients with known abdominal pathology unrelated to trauma.
Patients who were pregnant or had contraindications to contrast media.

Data Collection

Data was collected prospectively from patient records, including demographics, mechanism of injury, clinical presentation, imaging findings, management, and outcomes. Each patient underwent an initial clinical examination followed by FAST and CECT.

Imaging Protocol

FAST: Performed using a portable ultrasound device by trained emergency physicians upon arrival in the emergency department. The exam focused on detecting free fluid in the peritoneal, pericardial, and pleural spaces.
CECT: Conducted using a multi-detector CT scanner. All patients received intravenous contrast medium unless contraindicated. The scanning protocol included arterial, venous, and delayed phases to assess for vascular injuries, organ lacerations, hematomas, and active bleeding.

Assessment of Injuries

Injuries were classified based on the American Association for the Surgery of Trauma (AAST) Organ Injury Scale.
The presence of hemoperitoneum and the severity of organ injuries were documented.

Diagnostic Accuracy

The diagnostic accuracy of CECT was compared with FAST and clinical examination using sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

Interventions and Outcomes

Based on CECT findings, patients were managed either non-operatively or with surgical or endovascular interventions.
Complications, mortality rates, and the length of hospital stay were recorded.
Follow-up data at 3 months post-discharge included the recovery status and long-term complications.

Statistical Analysis

Data were analyzed using statistical software. Descriptive statistics were used for demographic and clinical characteristics. Sensitivity, specificity, PPV, and NPV were calculated to compare diagnostic modalities. The outcomes were compared using appropriate statistical tests to determine the significance of findings.

Ethical Considerations

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The study was conducted following ethical guidelines, ensuring informed consent, patient confidentiality, and approval from the Institutional Ethics Committee at . No additional risks were imposed on participants.

Results

Patient Demographics and Injury Characteristics

Out of 100 patients evaluated in this prospective study on the role of contrast-enhanced CT (CECT) in abdominal trauma, the following demographics and injury characteristics were noted:

Table 1 presents the gender and age distribution of the patients. There were 65% males and 35% females. The majority of patients (40%) were in the 18-30 years age group, followed by 31-45 years (35%), 46-60 years (15%), and 61-75 years (10%).

Mechanism of Injury

The mechanisms of injury are detailed in **Table 2**. Road Traffic Accidents (RTAs) accounted for the highest percentage of injuries at 50%, followed by falls (20%), assault (15%), sports injuries (10%), and other causes (5%).

Organ Injury Detected by CECT

Table 3 outlines the distribution of organ injuries detected by CECT. The liver was the most commonly injured organ (30%), followed by the spleen (25%), kidney (20%), pancreas (10%), intestines (10%), and multiple organs (5%).

Severity of Injury

The severity of the injuries was categorized using the American Association for the Surgery of Trauma (AAST) Organ Injury Scale, as shown in **Table 4**. The distribution was as follows: Grade I (20%), Grade II (25%), Grade III (30%), Grade IV (15%), and Grade V (10%).

Presence of Hemoperitoneum

The presence of hemoperitoneum, as detailed in **Table 5**, was detected in 40% of the patients, while 60% had no hemoperitoneum.

Diagnostic Accuracy of CECT

The diagnostic accuracy of CECT is summarized in **Table 6**. The sensitivity of CECT was found to be 95%, specificity 90%, positive predictive value (PPV) 92%, and negative predictive value (NPV) 93%.

Comparison with Ultrasonography (FAST) and Clinical Examination

As shown in **Table 7**, the sensitivity and specificity of CECT were significantly higher compared to ultrasonography (FAST) and clinical examination. FAST had a sensitivity of 70% and specificity of 75%, while clinical examination had a sensitivity of 65% and specificity of 80%.

Interventions Based on CECT Findings

The interventions based on CECT findings are presented in **Table 8**. Non-operative management was adopted in 70% of cases, surgical intervention in 25%, and endovascular procedures in 5%.

Complications

The complications observed in the study are listed in **Table 9**. The most common complications were infections (5%), re-bleeding (3%), and organ failure (2%).

Mortality

The mortality rate in this study was 4%, as detailed in **Table 10**. The majority of deaths (75%) were due to severe multi-organ injury, and 25% were due to delayed presentation and intervention.

Length of Hospital Stay

The mean length of hospital stay was 10 days, with a range of 5 to 30 days, as shown in **Table 11**.

Follow-up (3 Months Post-Discharge)

At the 3-month follow-up, 80% of patients had fully recovered, 15% had partial recovery, and 5% experienced long-term complications, as presented in **Table 12**.

Discussion

This study demonstrates the critical role of contrast-enhanced CT (CECT) in the evaluation and management of abdominal trauma. With its high sensitivity (95%) and specificity (90%), CECT proved superior to both ultrasonography (FAST) and clinical examination, which had sensitivities of 70% and 65%, respectively, and specificities of 75% and

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80%, respectively. These findings underscore the importance of CECT in providing accurate and comprehensive assessment of abdominal injuries, which is crucial for guiding appropriate clinical interventions.

Diagnostic Accuracy and Clinical Impact

The high diagnostic accuracy of CECT can be attributed to its ability to visualize both solid and hollow organ injuries, vascular injuries, and the presence of hemoperitoneum. This level of detail is particularly important in hemodynamically stable patients where clinical examination and FAST may not detect subtle or complex injuries. Golikhatir et al[8]. (2023) found that CECT with oral and intravenous contrast was more effective than CT with intravenous contrast alone in diagnosing blunt abdominal trauma, further highlighting the enhanced diagnostic capabilities of CECT. The ability of CECT to identify the extent and severity of injuries allows for more precise clinical decision-making, whether opting for non-operative management, surgical intervention, or endovascular procedures.

Comparison with Other Modalities

FAST, although valuable for rapid initial assessment, showed limited sensitivity and specificity compared to CECT. This aligns with existing literature that suggests FAST may miss certain organ injuries and small amounts of free fluid (Radwan and Abu-Zidan[11], 2006). Similarly, Deftereos et al[9]. (2022) emphasized the limitations of FAST in pediatric populations, advocating for more reliable imaging modalities. Clinical examination, while essential, is often insufficient alone, especially in cases of blunt trauma where internal injuries might not present immediate symptoms (Jansen et al[10]., 2008).

Management and Outcomes

The study findings reveal that 70% of patients were managed non-operatively based on CECT findings, highlighting the modality's role in supporting conservative management when appropriate. Surgical intervention was required in 25% of cases, and endovascular procedures in 5%, reflecting the ability of CECT to guide varied treatment pathways effectively. The relatively low complication rates (infections 5%, re-bleeding 3%, organ failure 2%) and mortality rate (4%) further emphasize the benefits of accurate diagnosis and tailored management strategies. Shanmuganathan et al[13]. (1993) and Hamidi et al[14]. (2007) have previously demonstrated the efficacy of CECT in identifying active hemorrhage and informing appropriate interventions, corroborating the current study's findings.

Mortality and Morbidity

Mortality in this study was primarily due to severe multi-organ injuries and delayed presentation. These findings indicate the need for prompt imaging and intervention, particularly in severe trauma cases. The mean hospital stay of 10 days, with a range of 5-30 days, and the high rate of full recovery (80%) at 3-month follow-up suggest that timely and accurate diagnosis using CECT can significantly improve patient outcomes. Valentino et al[12]. (2010) also highlighted the importance of contrast-enhanced ultrasound (CEUS) in trauma settings, although CECT remains the gold standard in most clinical scenarios.

Limitations

This study is limited by its sample size and single-center design, which may affect the generalizability of the results. Additionally, the reliance on CECT as the primary diagnostic tool may not be feasible in all settings, particularly in resource-limited environments. Further multi-center studies with larger sample sizes are needed to validate these findings and explore the role of CECT in diverse clinical settings.

Conclusion

CECT is a highly effective imaging modality for the evaluation of abdominal trauma, offering superior diagnostic accuracy compared to FAST and clinical examination. Its detailed assessment capabilities enable accurate diagnosis, guide appropriate clinical management, and improve patient outcomes. This study supports the routine use of CECT in trauma settings, advocating for its inclusion in standard diagnostic protocols for abdominal trauma.

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Table 1: Patient Demographics

Demographic	**Frequency (n)**	**Percentage (%)**
Gender		
Male	65	65%
Female	35	35%
Age Group		
18-30 years	40	40%
31-45 years	35	35%
46-60 years	15	15%
61-75 years	10	10%

Table 2: Mechanism of Injury

Mechanism	**Frequency (n)**	**Percentage (%)**
Road Traffic Accidents	50	50%
Falls	20	20%
Assault	15	15%
Sports Injuries	10	10%
Others	5	5%

Table 3: Organ Injury Detected by CECT

Organ	Frequency (n)	Percentage (%)
Liver	30	30%
Spleen	25	25%
Kidney	20	20%
Pancreas	10	10%

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Intestines	10	10%
Multiple Organs	5	5%

Table 4: Severity of Injury (AAST Organ Injury Scale)

Grade	Frequency (n)	Percentage (%)
Grade I	20	20%
Grade II	25	25%
Grade III	30	30%
Grade IV	15	15%
Grade V	10	10%

Table 5: Presence of Hemoperitoneum

Hemoperitoneum	Frequency (n)	Percentage (%)
Present	40	40%
Absent	60	60%

Table 6: Diagnostic Accuracy of CECT

Parameter	Value
Sensitivity of CECT	95%
Specificity of CECT	90%
Positive Predictive Value	92%
Negative Predictive Value	93%

Table 7: Comparison with Ultrasonography (FAST) and Clinical Examination

Modality	Sensitivity (%)	Specificity (%)
CECT	95%	90%
FAST	70%	75%
Clinical Examination	65%	80%

Table 8: Interventions Based on CECT Findings

Intervention	Frequency (n)	Percentage (%)
Non-operative Management	70	70%
Surgical Intervention	25	25%
Endovascular Procedures	5	5%

Table 9: Complications

Complication	Frequency (n)	Percentage (%)
Infection	5	5%
Re-bleeding	3	3%
Organ Failure	2	2%

Table 10: Mortality

Mortality	Frequency (n)	Percentage (%)
Total Mortality	4	4%
Causes of Mortality		
Severe multi-organ injury	3	75%
Delayed presentation and intervention	1	25%

Table 11: Length of Hospital Stay

Length of Stay	Days (Mean)	Range (Days)
Hospital Stay	10	5-30

Table 12: Follow-up (3 Months Post-Discharge)

Outcome	Frequency (n)	Percentage (%)
Full Recovery	80	80%
Partial Recovery	15	15%
Long-term Complications	5	5%

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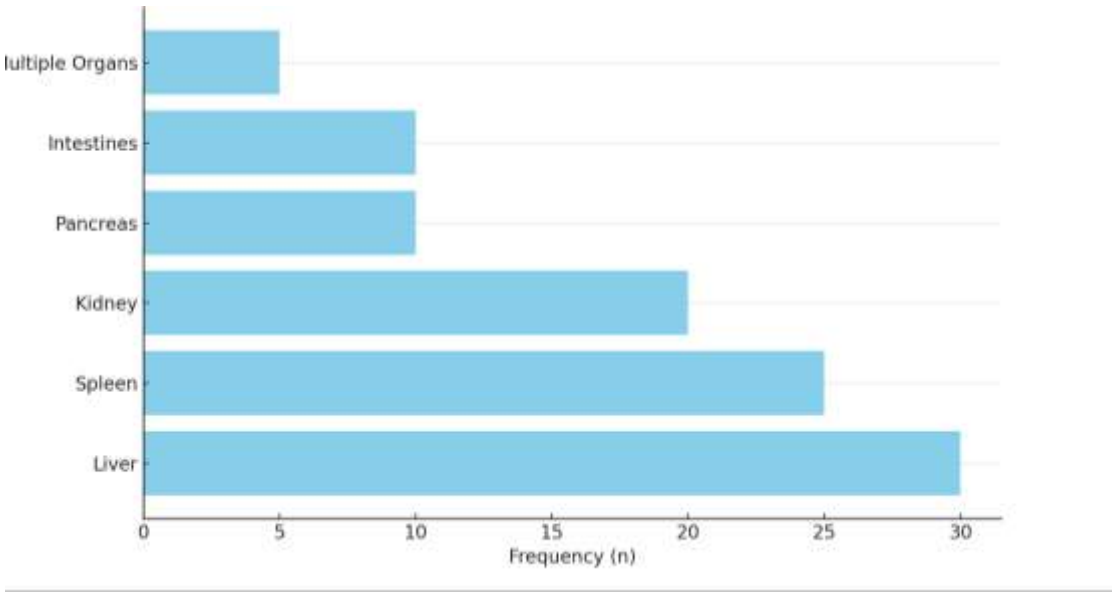

Figure No:1 Organ Injury Detected by CECT

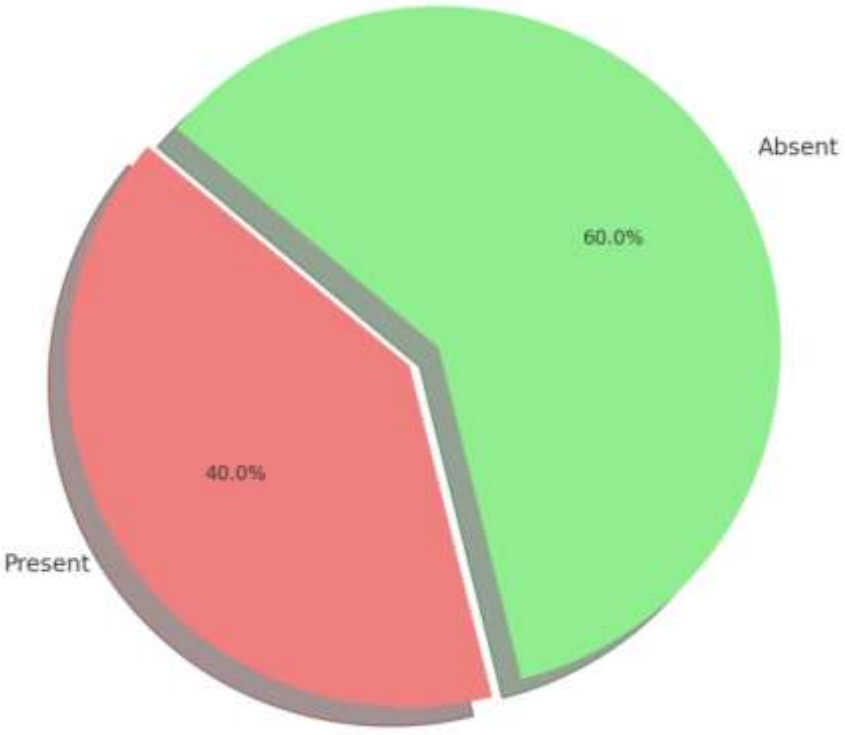

Figure No:2 Presence of Hemoperitoneam

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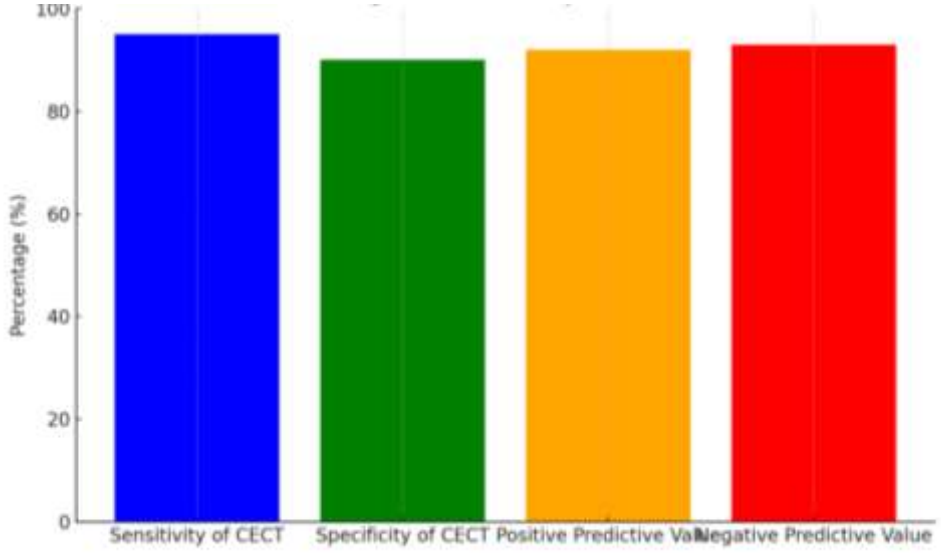

Figure No:3 Diagnostic Accuracy of CECT

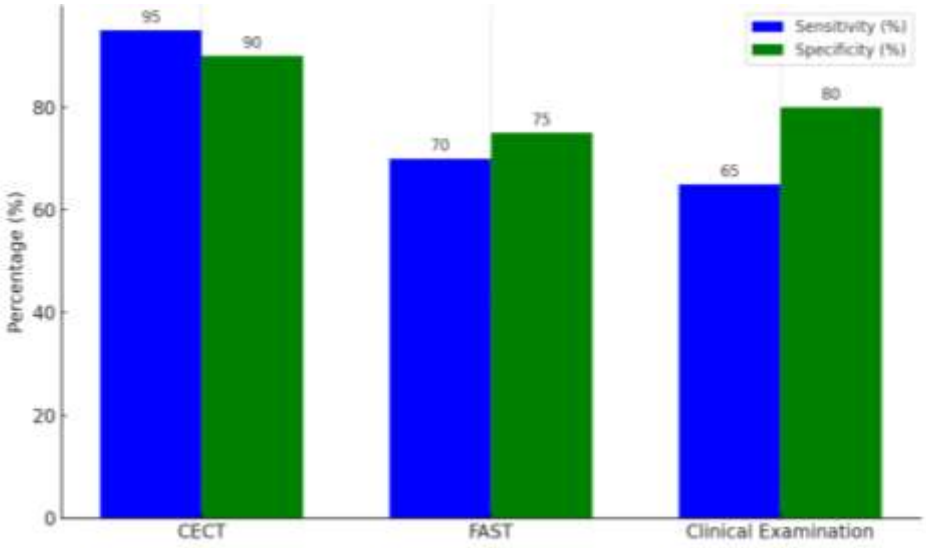

Figure No:4.Comparison of CECT,FAST,and Clinical Examination