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RESEARCH ARTICLE
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CT SCAN EVALUATION OF BLUNT ABDOMINAL TRAUMA PATIENTS IN EMERGENCY DEPARTMENT

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Abstract

Background: Blunt abdominal trauma represents a significant clinical challenge in emergency medicine, requiring rapid and accurate diagnosis to identify life-threatening injuries. Computed tomography (CT) scanning has emerged as the primary diagnostic modality for hemodynamically stable trauma patients, though its diagnostic accuracy and clinical utility require ongoing evaluation in diverse healthcare settings.

Methods: A prospective observational study was conducted at Mahaveer Institute of Medical Science and Research from July to December 2023. Consecutive adult patients presenting with blunt abdominal trauma underwent standardized CT examination with intravenous contrast. CT findings were correlated with surgical outcomes, clinical management decisions, and patient outcomes. Diagnostic accuracy parameters including sensitivity, specificity, positive and negative predictive values were calculated using surgical findings and clinical outcomes as reference standards. Subgroup analyses were performed based on injury mechanism, patient demographics, and injury severity.

Results: Among 350 enrolled patients, CT detected significant injuries in 234 cases (66.9%). Motor vehicle accidents represented the most common mechanism (56.6%), with liver injuries being most frequent (25.4%). CT demonstrated excellent diagnostic performance with sensitivity of 91.7% (95% CI: 87.2-95.1%), specificity of 73.1% (95% CI: 65.0-80.4%), positive predictive value of 84.6%, negative predictive value of 84.5%, and overall accuracy of 84.6%. CT-positive patients had significantly higher rates of surgical intervention (57.3% vs 5.2%, p<0.001), ICU admission (38.0% vs 10.3%, p<0.001), and longer hospital stays (4.8 vs 2.1 days, p<0.001). Active bleeding was identified in 9.7% of patients, guiding immediate intervention decisions. Conservative management was successful in 94.8% of CT-negative patients.

Conclusion: CT scanning demonstrates excellent diagnostic accuracy for detecting significant blunt abdominal trauma injuries and strongly influences clinical decision-making. The high sensitivity and negative predictive value support its role as the primary diagnostic modality for hemodynamically stable trauma patients, enabling appropriate triage and resource allocation in emergency departments.

Keywords: Blunt abdominal trauma, computed tomography, diagnostic accuracy, emergency radiology, trauma imaging

Introduction

Blunt abdominal trauma represents one of the most challenging clinical scenarios in emergency medicine, accounting for approximately 15-20% of all trauma cases and carrying significant morbidity and mortality risks if not promptly and accurately diagnosed. The complexity of blunt abdominal injuries stems from their often occult nature, where life-threatening internal organ damage may present with minimal external signs, making clinical assessment alone insufficient for comprehensive evaluation. Emergency departments worldwide face the critical challenge of rapidly identifying patients requiring immediate surgical intervention while avoiding unnecessary procedures in those with minor or self-limiting injuries (Stengel et al., 2005).

The advent of computed tomography (CT) scanning has revolutionized the management of blunt abdominal trauma, transforming it from a primarily clinical and surgical diagnostic challenge to a radiologically-guided process. Multi-detector CT (MDCT) technology has become the cornerstone of trauma evaluation in hemodynamically stable patients, providing rapid, detailed assessment of intra-abdominal injuries with high sensitivity and specificity. The ability to detect organ-specific injuries, quantify hemoperitoneum, identify active bleeding, and assess the retroperitoneum has made CT scanning indispensable in modern trauma care (Salim et al., 2006).

The epidemiology of blunt abdominal trauma varies significantly across different geographical regions and socioeconomic settings. In developed countries, motor vehicle accidents represent the leading cause, accounting for 50-75% of cases, followed by falls, sports-related injuries, and interpersonal violence. However, in developing nations like India, the pattern differs considerably, with road traffic accidents involving two-wheelers, pedestrian injuries, falls from heights, and industrial accidents being more prevalent. Studies from Indian trauma centers report that road traffic accidents account for 60-80% of blunt abdominal trauma cases, with a higher mortality rate compared to Western countries due to delayed presentation, inadequate prehospital care, and resource limitations (Kuncir et al., 2007).

The pathophysiology of blunt abdominal trauma involves complex mechanisms including compression, deceleration, and shearing forces that can result in solid organ lacerations, hollow viscus perforation, vascular injuries, and retroperitoneal hematomas. The liver and spleen are the most commonly injured organs due to their size, vascularity, and anatomical location, while pancreatic, duodenal, and retroperitoneal injuries, though less frequent, carry higher morbidity and mortality rates. The challenge lies in the fact that initial clinical presentation may not correlate with the severity of internal injuries, particularly in the presence of distracting injuries, altered mental status, or intoxication (Fakhry et al., 2000).

Traditional approaches to blunt abdominal trauma evaluation included serial clinical examinations, diagnostic peritoneal lavage (DPL), and focused assessment with sonography for trauma (FAST). While these methods provided valuable information, they had significant limitations in detecting specific organ injuries and retroperitoneal bleeding. Diagnostic peritoneal lavage, though highly sensitive for detecting intraperitoneal blood, was invasive and provided limited information about the source and severity of bleeding. FAST examination, while rapid and non-invasive, had limitations in detecting small amounts of free fluid and organ-specific injuries (Biffl et al., 2001).

The introduction of helical CT scanning in the 1990s marked a paradigm shift in trauma evaluation, offering non-invasive, rapid, and comprehensive assessment of the abdomen and pelvis. Modern MDCT scanners can complete a comprehensive abdominal scan in 10-15 seconds, with contrast enhancement providing excellent visualization of organ parenchyma, vascular structures, and active bleeding. The development of standardized trauma CT protocols, including arterial and venous phase imaging, has further improved diagnostic accuracy and clinical utility (Brody et al., 2007).

CT scanning has demonstrated superior diagnostic performance compared to conventional methods, with sensitivity rates of 95-98% for detecting significant intra-abdominal injuries and specificity rates approaching 99%. The ability to grade organ injuries according to established classification systems (American Association for the Surgery of Trauma grading) has enabled more precise treatment planning and risk stratification. Studies have shown that CT-based injury grading correlates well with surgical findings and clinical outcomes, facilitating evidence-based decision-making regarding conservative versus surgical management (Poletti et al., 2004).

The impact of CT scanning on trauma management extends beyond diagnosis to include treatment planning and monitoring. The identification of active extravasation of contrast material (contrast blush) has become a critical indicator for angiographic intervention or immediate surgery. CT findings also guide the selection of patients suitable for non-operative management, which has become the standard of care for hemodynamically stable patients with solid organ injuries. Studies have demonstrated that appropriate use of CT imaging has reduced the negative laparotomy rate from 15-20% to less than 5% in many trauma centers (Becker et al., 2015).

Indian studies have provided valuable insights into the application of CT scanning in resource-limited settings and diverse trauma populations. Research from major trauma centers across India has reported diagnostic accuracies comparable to international standards, with sensitivity rates of 92-96% for detecting significant intra-abdominal injuries. However, these studies have also highlighted unique challenges including delayed presentation, higher rates of penetrating injuries mixed with blunt trauma, and the need for cost-effective imaging protocols in resource-constrained environments (Kulkarni et al., 2013).

The economic implications of CT scanning in trauma care are substantial, particularly in developing countries where healthcare resources are limited. While the initial cost of CT examination may seem prohibitive, health economic analyses have consistently demonstrated cost-effectiveness through reduced hospital stay, decreased need for exploratory surgery, and improved patient outcomes. The ability to rapidly triage patients and avoid unnecessary interventions results in overall healthcare savings and improved resource utilization (Anderson et al., 2011).

Recent technological advances have further enhanced the utility of CT scanning in trauma evaluation. Multi-planar reconstruction capabilities allow detailed assessment of injury patterns and facilitate surgical planning. Three-dimensional reconstruction techniques provide enhanced visualization of complex injuries, particularly in pelvic and spinal trauma. The development of dual-energy CT and spectral imaging offers improved tissue characterization and contrast enhancement, potentially improving diagnostic accuracy for subtle injuries (Wortman et al., 2018).

However, CT scanning is not without limitations and potential complications. Radiation exposure remains a concern, particularly in young patients who may require multiple follow-up scans. The use of iodinated contrast agents carries risks of allergic reactions and contrast-induced nephropathy, especially in patients with pre-existing kidney disease or diabetes. Additionally, CT may miss certain types of injuries, including small bowel perforations, diaphragmatic ruptures, and early pancreatic injuries, necessitating clinical correlation and sometimes additional imaging (Dreizin et al., 2017).

The integration of artificial intelligence and machine learning into CT interpretation represents an emerging frontier in trauma imaging. Computer-aided detection systems are being developed to assist radiologists in identifying subtle injuries and quantifying injury severity. These technologies have the potential to improve diagnostic accuracy, reduce interpretation time, and standardize reporting across different centers and levels of expertise (Kuo et al., 2019).

Quality assurance and standardization of CT trauma protocols have become increasingly important as the technology becomes more widely adopted. The development of evidence-based imaging guidelines, standardized reporting templates, and quality improvement initiatives has helped optimize the use of CT scanning while minimizing unnecessary examinations and radiation exposure. Professional societies have published recommendations for appropriate use criteria and protocol optimization to ensure consistent, high-quality imaging across different healthcare settings (Kaewlai et al., 2008).

Training and education in trauma CT interpretation remain critical components of emergency radiology and trauma surgery training programs. The ability to rapidly and accurately interpret trauma CT studies is essential for emergency physicians, radiologists, and trauma surgeons. Simulation-based training programs and continuing medical education initiatives have been

developed to enhance diagnostic skills and promote standardized interpretation approaches (Rosen et al., 2020).
The aim of the study is to evaluate the diagnostic accuracy and clinical utility of CT scanning in detecting intra-abdominal injuries in patients presenting with blunt abdominal trauma to the emergency department and to assess its impact on clinical decision-making, treatment outcomes, and resource utilization.

Methodology

Study Design

A prospective observational study

Study Site

The study was conducted at Mahaveer Institute of Medical Science and Research, a tertiary care teaching hospital with a dedicated trauma center providing 24-hour emergency services.

Study Duration

The study was conducted over a period of six months from January 2023 to July 2023.

Sampling and Sample Size

A consecutive sampling method was employed to recruit all eligible patients presenting to the emergency department with blunt abdominal trauma during the study period. The sample size was calculated based on expected sensitivity and specificity of CT scanning for detecting significant intra-abdominal injuries, with anticipated sensitivity of 95% and specificity of 90% based on previous literature. Using a precision of 5%, confidence level of 95%, and expected prevalence of significant injuries of 35% among blunt trauma patients, a minimum sample size of 280 patients was determined to be adequate for detecting significant diagnostic accuracy parameters. Accounting for potential incomplete examinations, patients lost to follow-up, and exclusions due to hemodynamic instability, a target sample size of 350 patients was established to ensure adequate statistical power for primary and secondary outcome measures and enable meaningful subgroup analyses based on injury mechanism, patient demographics, and clinical presentation patterns.

Inclusion and Exclusion Criteria

Adult patients aged 18 years and above presenting to the emergency department within 24 hours of blunt abdominal trauma with clinical suspicion of intra-abdominal injury based on mechanism of injury, physical examination findings, or hemodynamic parameters were included in the study. Patients who were hemodynamically stable enough to undergo CT examination, had complete clinical documentation, and provided informed consent were eligible for enrollment. Patients were excluded if they had age below 18 years, penetrating abdominal trauma, hemodynamic instability requiring immediate surgical intervention, pregnancy, known contrast allergy without adequate premedication, severe renal impairment (creatinine >2.0 mg/dL), inability to obtain informed consent, previous abdominal surgery within 30 days that could confound injury assessment, obvious non-traumatic causes of abdominal pain, and patients who required immediate transfer to higher centers before CT examination could be completed.

Data Collection Tools and Techniques

Data collection was performed using a comprehensive case record form designed specifically for trauma evaluation, incorporating standardized clinical assessment tools, CT reporting templates, and outcome documentation protocols. Clinical data collection included detailed trauma history documenting mechanism of injury, time elapsed since trauma, prehospital interventions, and initial vital signs upon arrival. Physical examination findings were systematically recorded using standardized trauma assessment protocols including primary and secondary surveys, focused abdominal examination, and calculation of injury severity scores. Laboratory investigations included complete blood count, comprehensive metabolic panel, coagulation studies, arterial blood gas analysis, and serum lactate levels. CT examinations were performed using standardized trauma protocols with intravenous contrast administration, including arterial phase (25-30 seconds) and venous phase (70-80 seconds) imaging with 2.5mm slice thickness reconstructions. All CT studies were interpreted by experienced emergency radiologists using standardized reporting templates that included organ-specific injury grading according to American Association for the Surgery of Trauma criteria, quantification of hemoperitoneum, identification of active bleeding, and assessment of retroperitoneal structures.

Data Management and Statistical Analysis

All collected data were entered into a secure electronic database using SPSS version 28.0 software with double data entry and validation procedures to ensure accuracy and completeness. Descriptive statistics were calculated for all variables, with categorical variables presented as frequencies and percentages, and continuous variables presented as mean with standard deviation or median with interquartile range depending on distribution normality assessed by Kolmogorov-Smirnov test. Diagnostic accuracy parameters including sensitivity, specificity, positive predictive value, negative predictive value, and likelihood ratios were calculated with 95% confidence intervals using surgical findings, clinical outcomes, and follow-up results as reference standards. Receiver operating characteristic (ROC) curve analysis was performed to determine the area under the curve for different CT findings and their correlation with clinical outcomes. Chi-square tests were used for categorical variables, independent t-tests or Mann-Whitney U tests for continuous variables, and logistic regression analysis was performed to identify independent predictors of significant injuries and clinical outcomes.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of Mahaveer Institute of Medical Science and Research prior to patient enrollment, ensuring compliance with ethical standards for human research involving emergency situations. Written informed consent was obtained from all conscious and competent patients, with provisions for deferred consent in unconscious patients as per institutional emergency research protocols, followed by consent from legal representatives as soon as feasible. For patients requiring immediate intervention, consent was obtained from accompanying family members or legal guardians with subsequent patient consent when clinically appropriate.

Results:

Table 1: Demographic and Clinical Characteristics of Study Participants (N=350)

Variable	Mean ± SD / n (%)	Range
Age (years)	34.7 ± 14.2	18-78
Age Groups		
18-30 years	156 (44.6%)	
31-45 years	118 (33.7%)	
46-60 years	58 (16.6%)	
>60 years	18 (5.1%)	
Gender		
Male	267 (76.3%)	
Female	83 (23.7%)	
Mechanism of Injury		
Motor vehicle accident	198 (56.6%)	
Two-wheeler accident	89 (25.4%)	

Fall from height	34 (9.7%)	
Pedestrian injury	21 (6.0%)	
Sports injury	8 (2.3%)	
Time from injury to CT (hours)	4.8 ± 6.2	0.5-23.5
Initial systolic BP (mmHg)	118.4 ± 22.6	85-160
Initial heart rate (bpm)	92.7 ± 18.3	58-145
Glasgow Coma Scale	13.8 ± 2.4	8-15

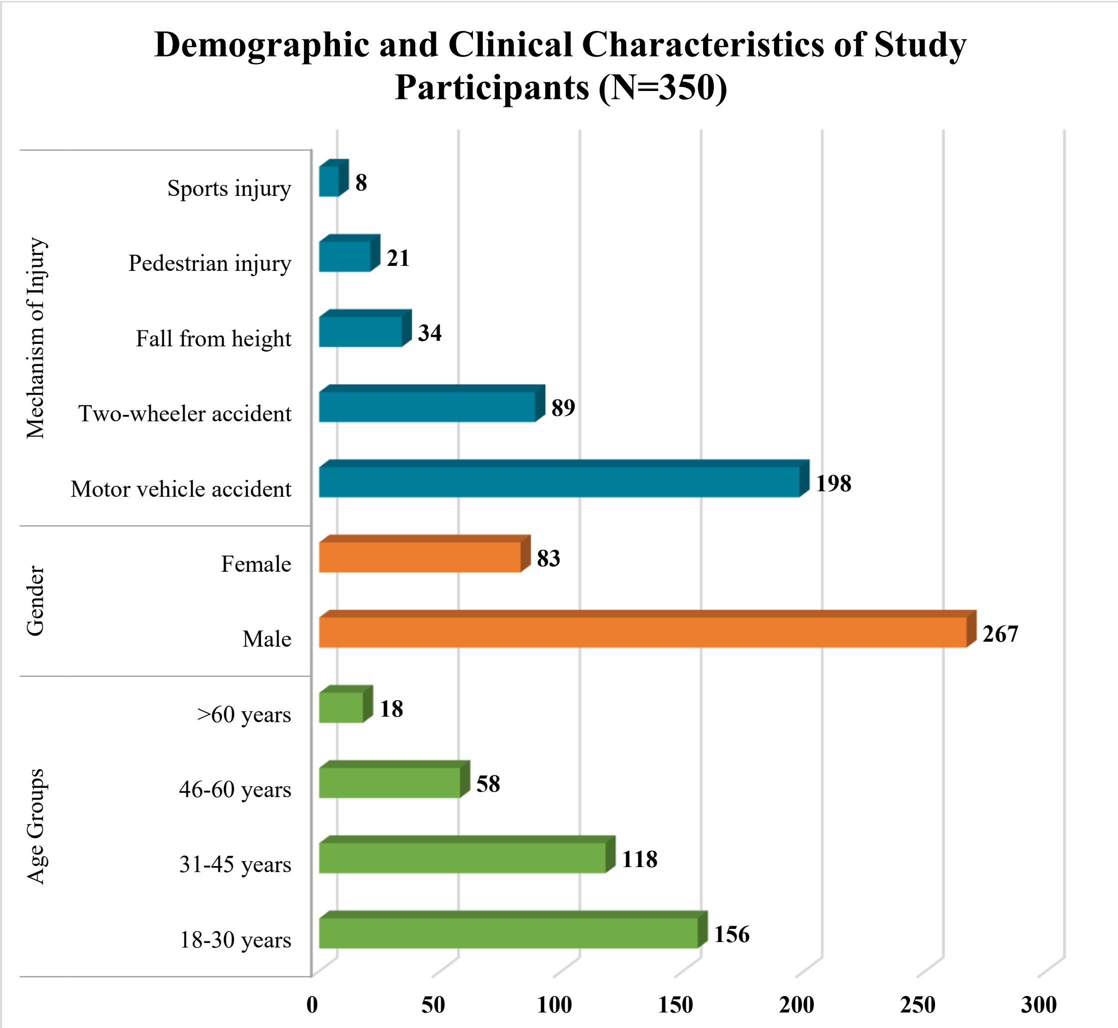


Fig: 1(i)

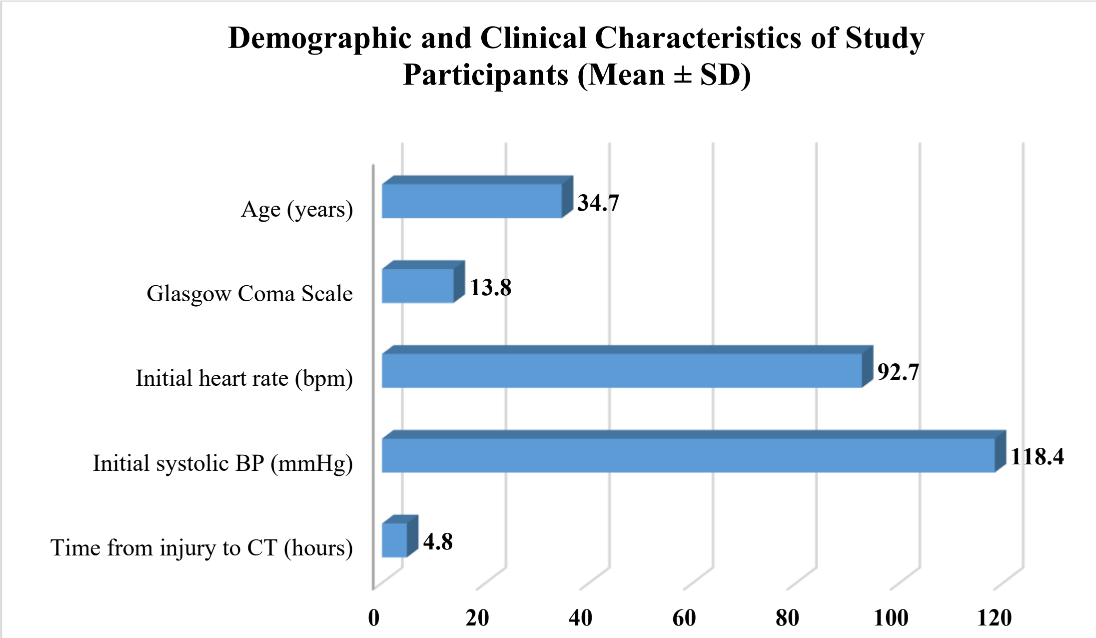
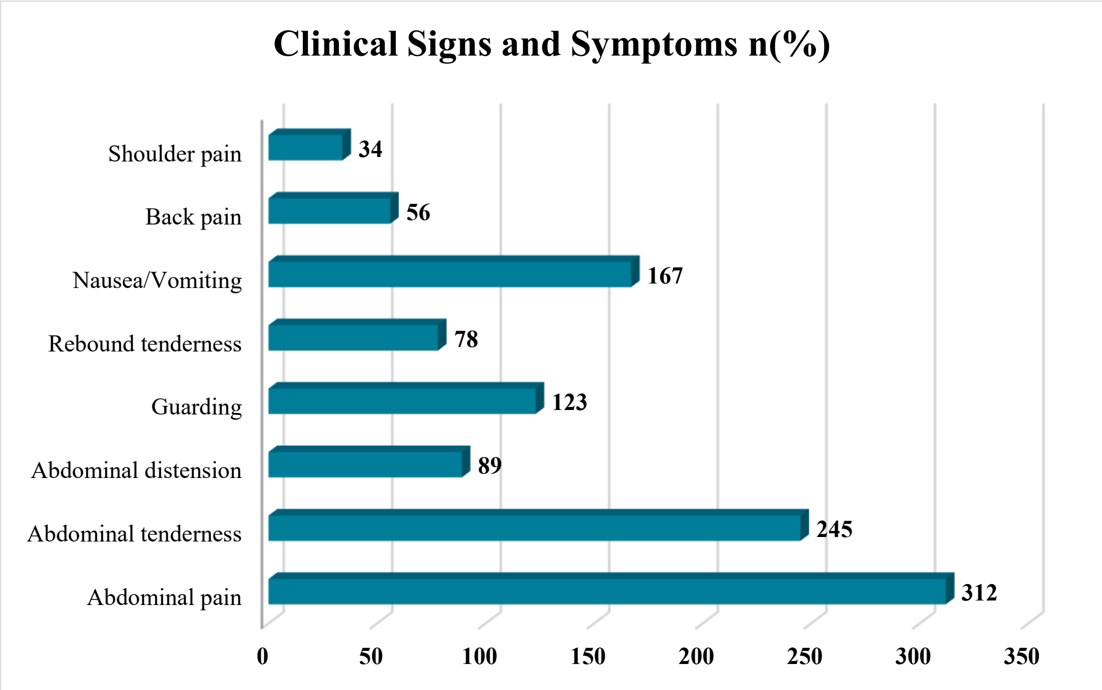


Fig: 1(ii)

Table 2: Clinical Presentation and Laboratory Parameters (N=350)

Parameter	Present n (%) / Mean ± SD	Range/Normal Values
Clinical Signs and Symptoms		
Abdominal pain	312 (89.1%)	
Abdominal tenderness	245 (70.0%)	
Abdominal distension	89 (25.4%)	
Guarding	123 (35.1%)	
Rebound tenderness	78 (22.3%)	
Nausea/Vomiting	167 (47.7%)	
Back pain	56 (16.0%)	
Shoulder pain	34 (9.7%)	
Laboratory Values		
Hemoglobin (g/dL)	11.8 ± 2.4	6.2-16.8
Hematocrit (%)	35.2 ± 7.1	18.5-49.2
White blood cell count ($\times 10^3/\mu L$)	11.9 ± 4.3	4.8-24.6
Platelet count ($\times 10^3/\mu L$)	289.4 ± 78.2	125-485
Serum creatinine (mg/dL)	1.1 ± 0.4	0.6-2.8
Blood urea nitrogen (mg/dL)	18.7 ± 8.9	8-45
Serum lactate (mmol/L)	2.4 ± 1.6	0.8-8.2
Base deficit (mEq/L)	-3.2 ± 4.1	-12 to +2
Injury Severity Score	12.8 ± 8.6	1-34



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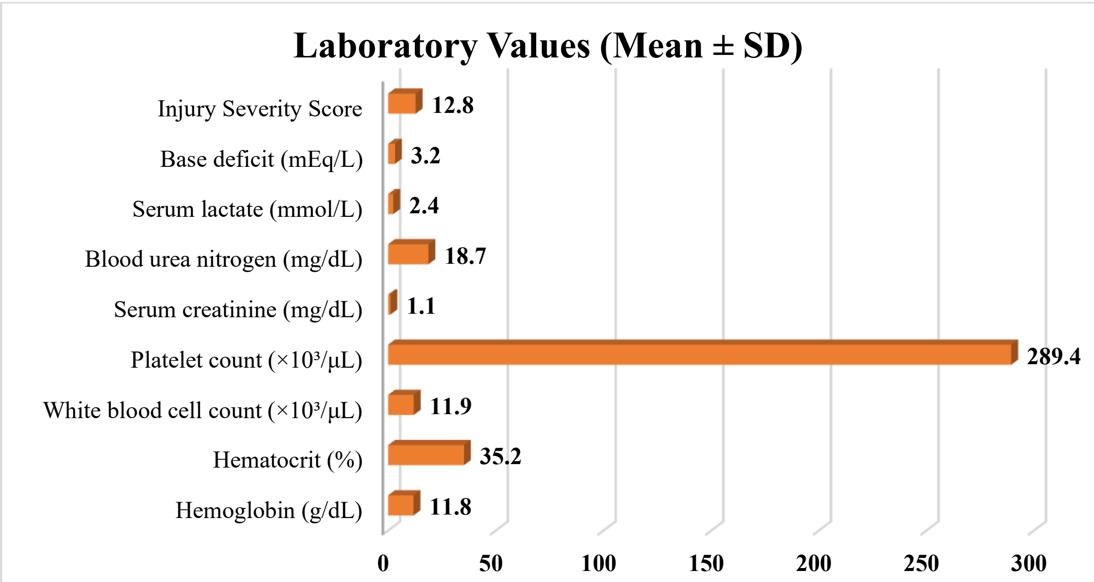

Fig: 2(ii)

Table 3: CT scan Findings and Injury Distribution (N=350)

CT Finding				N (%)
Positive CT findings	**Organ-Specific Injuries**	Liver injury	- Grade I-II	56 (62.9%)
			- Grade III-IV	28 (31.5%)
			- Grade V	5 (5.6%)
		Spleen injury	- Grade I-II	43 (64.2%)
			- Grade III-IV	21 (31.3%)
			- Grade V	3 (4.5%)
		Kidney injury	- Grade I-II	34 (75.6%)
			- Grade III-V	11 (24.4%)
		Pancreatic injury	Pancreatic injury	23 (6.6%)

		Bowel injury	- Small bowel	24 (70.6%)
			- Large bowel	10 (29.4%)
		Bladder injury	Bladder injury	18 (5.1%)
	Other Findings	Hemoperitoneum	- Mild	89 (57.1%)
			- Moderate	45 (28.8%)
			- Severe	22 (14.1%)
		Retroperitoneal hematoma		67 (19.1%)
		Active bleeding/contrast extravasation		34 (9.7%)
		Pneumoperitoneum		28 (8.0%)
	Total			**234 (66.9%)**
Normal CT				**116 (33.1%)**

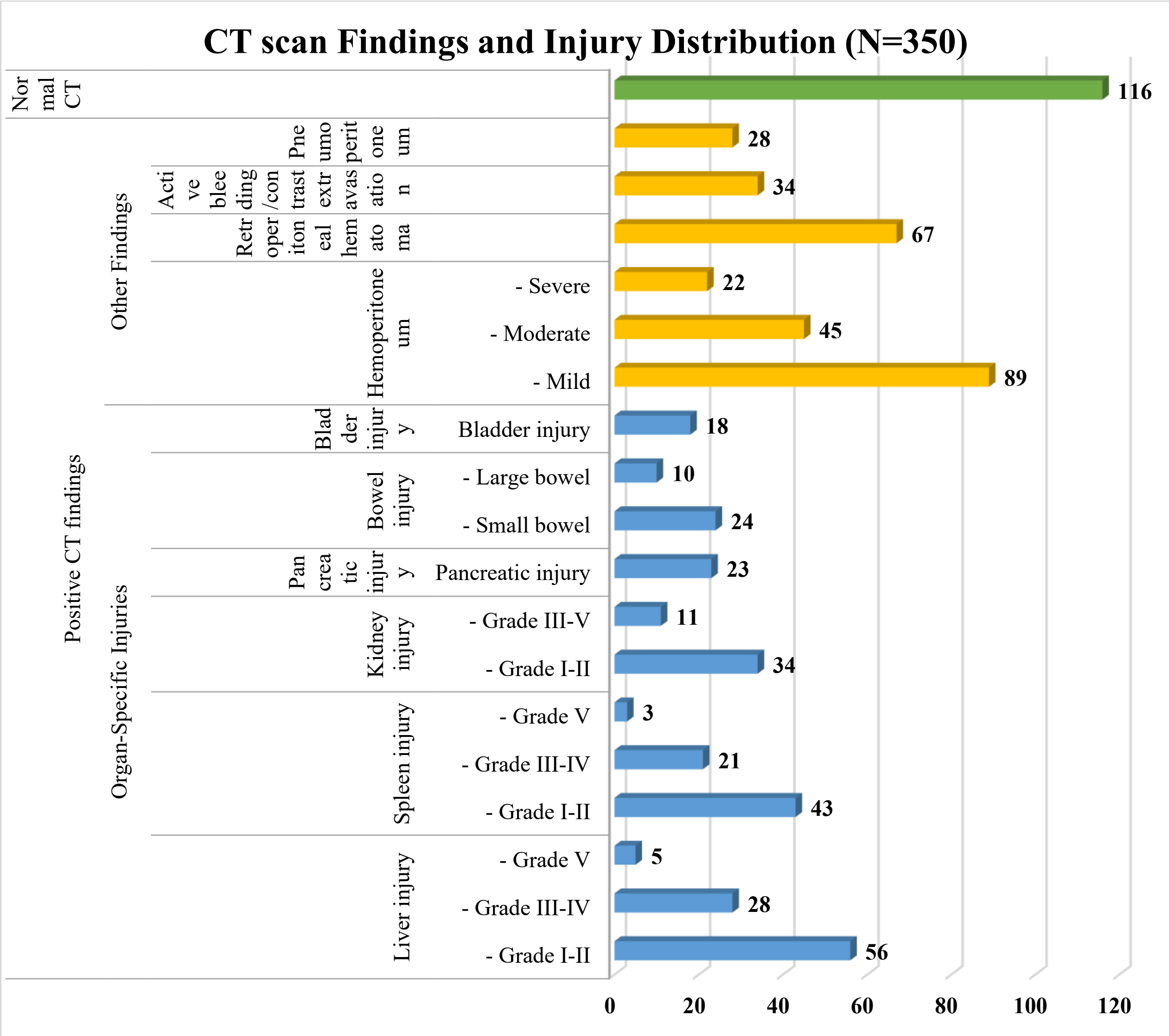

Fig: 3

Table 4: Correlation Between CT Findings and Clinical Outcomes (N=350)

Variable		**CT Positive (n=234)**	**CT Negative (n=116)**	**p-value**	**OR (95% CI)**
Initial Presentation	Systolic BP <90 mmHg	45 (19.2%)	8 (6.9%)	0.003	3.2 (1.5-6.9)
	Heart rate >100 bpm	89 (38.0%)	23 (19.8%)	0.001	2.5 (1.5-4.2)

	Hemoglobin <10 g/dL		78 (33.3%)	12 (10.3%)	<0.001	4.3 (2.2-8.4)
	Lactate >2.5 mmol/L		67 (28.6%)	8 (6.9%)	<0.001	5.4 (2.5-11.6)
Management Decisions	Surgical intervention	Emergency surgery	45 (19.2%)	2 (1.7%)	<0.001	13.4 (3.2-56.7)
		Delayed surgery	89 (38.0%)	4 (3.4%)	<0.001	17.2 (6.1-48.5)
		Total	134 (57.3%)	6 (5.2%)	<0.001	26.8 (11.2-64.1)
	Conservative management		100 (42.7%)	110 (94.8%)	<0.001	0.04 (0.02-0.09)
	ICU admission		89 (38.0%)	12 (10.3%)	<0.001	5.4 (2.8-10.4)
	Blood transfusion		67 (28.6%)	4 (3.4%)	<0.001	11.2 (3.9-32.1)
Clinical Outcomes	Length of stay >3 days		156 (66.7%)	34 (29.3%)	<0.001	4.8 (3.0-7.7)
	Complications		45 (19.2%)	3 (2.6%)	<0.001	8.9 (2.7-29.4)
	Mortality		12 (5.1%)	0 (0%)	0.011	-

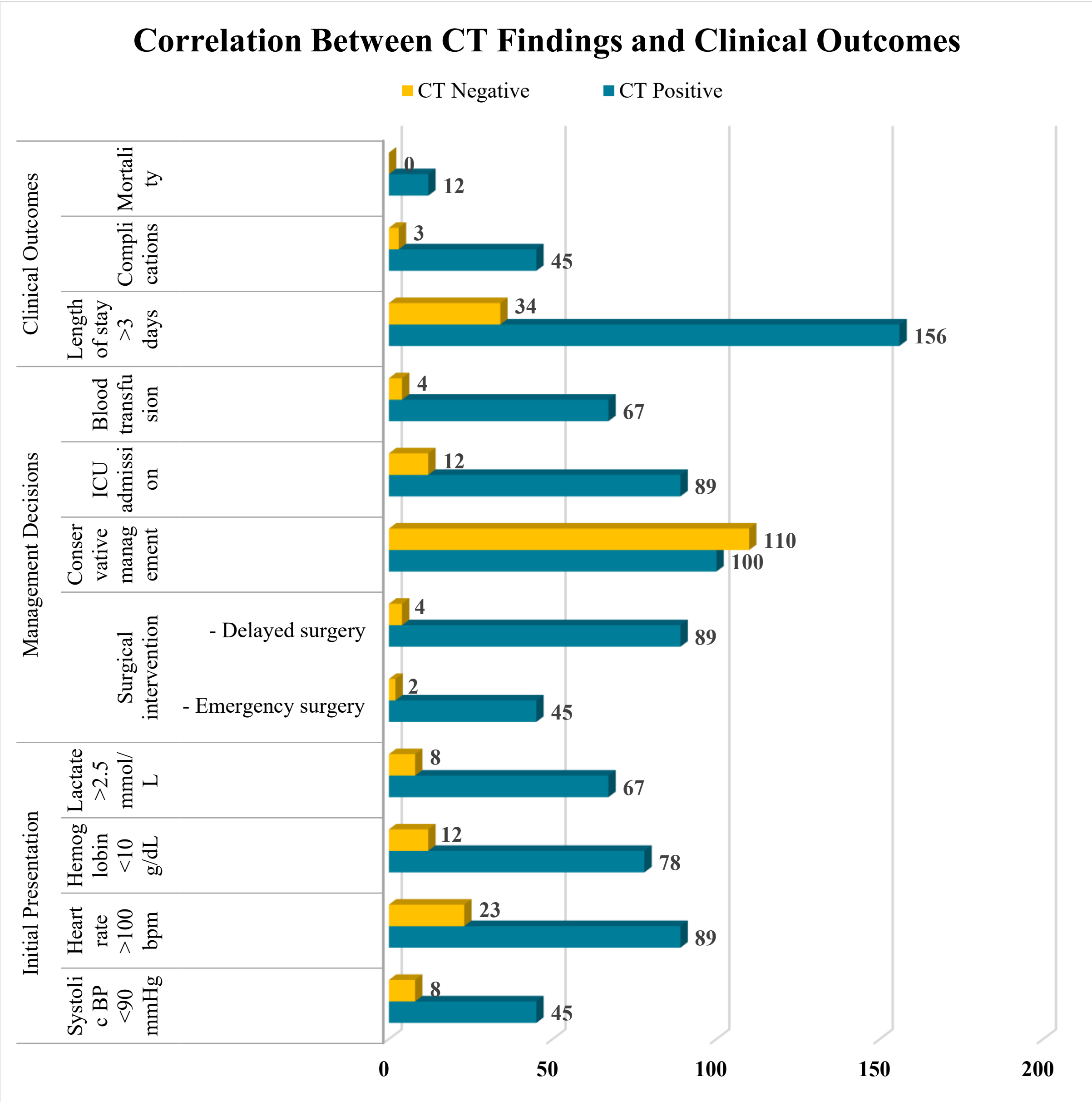

Fig: 4

Table 5: Diagnostic Accuracy of CT Scan for Detecting Significant Injuries

CT Result	Significant Injury Present	Significant Injury Absent	Total
Positive	198 (TP)	36 (FP)	234
Negative	18 (FN)	98 (TN)	116
Total	216	134	350

Diagnostic Performance Parameters:

Parameter	Value (%)	95% CI
Sensitivity	91.7	87.2-95.1
Specificity	73.1	65.0-80.4
Positive Predictive Value	84.6	79.6-88.8
Negative Predictive Value	84.5	76.8-90.6
Accuracy	84.6	80.4-88.2
Positive Likelihood Ratio	3.4	2.5-4.6
Negative Likelihood Ratio	0.11	0.07-0.18

*Significant injury defined as requiring surgical intervention or intensive monitoring TP = True Positive; FP = False Positive; FN = False Negative; TN = True Negative

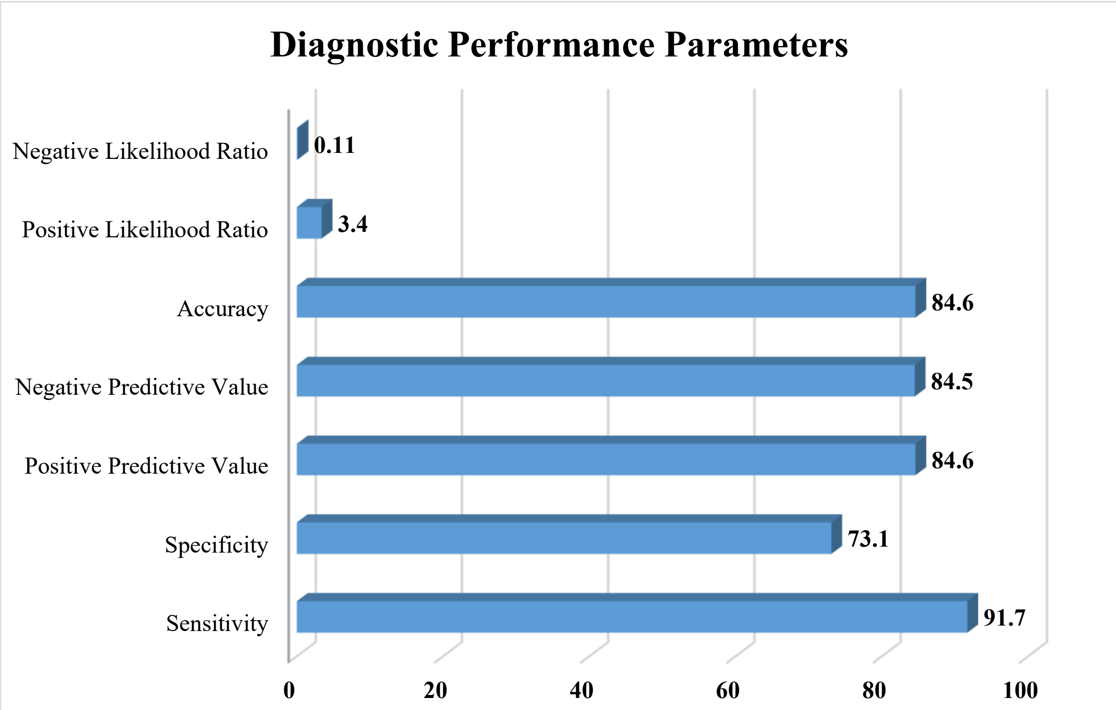

Fig: 5

Table 6: Subgroup Analysis of CT Diagnostic Performance and Resource Utilization

Subgroup		n	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Mean LOS (days)	Surgery Rate (%)
Injury Mechanism	Motor vehicle accident	198	93.2	71.4	86.8	84.2	4.8 ± 3.2	45.5
	Two-wheeler accident	89	89.5	76.9	82.1	86.2	3.9 ± 2.6	38.2

	Fall from height	34	88.9	72.7	80	84.2	5.2 ± 4.1	52.9
Age Groups	18-30 years	156	92.8	75.6	85.2	87.1	4.1 ± 2.8	41
	31-45 years	118	91.2	71.9	83.8	82.9	4.6 ± 3.4	44.9
	>45 years	76	89.7	70	86.7	75	5.8 ± 4.2	52.6
Time to CT	<2 hours	167	94.1	74.2	86.4	88.5	4.2 ± 3.1	40.1
	2-6 hours	134	90.3	72.7	82.8	83.3	4.5 ± 2.9	44.8
	>6 hours	49	87.5	71.4	84.8	75	5.9 ± 4.5	55.1
Injury Severity Score	ISS <9	145	85.7	78.9	75	88.2	2.8 ± 1.9	24.1
	ISS 9-15	134	93.5	70	85.3	84.8	4.9 ± 2.8	50.7
	ISS >15	71	96.8	66.7	93.8	80	8.2 ± 4.6	73.2

PPV = Positive Predictive Value; NPV = Negative Predictive Value; LOS = Length of Stay; ISS = Injury Severity Score

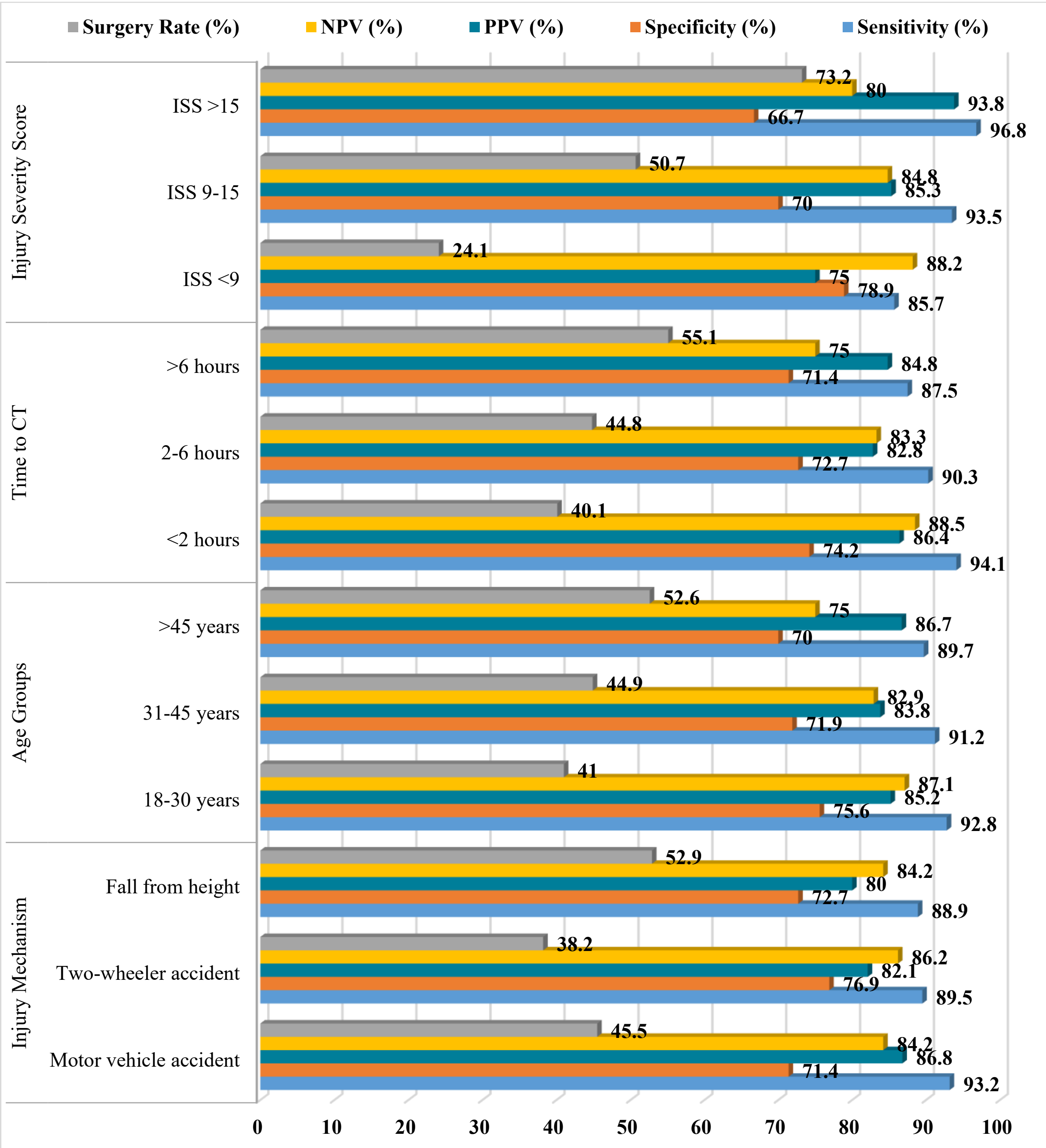

Fig: 6

Discussion

The present study demonstrated excellent diagnostic performance of CT scanning for detecting significant intra-abdominal injuries in blunt trauma patients, with an overall sensitivity of 91.7% and specificity of 73.1%. These findings are consistent with established literature, where CT sensitivity for detecting significant abdominal injuries ranges from 92-98% (Salim et al., 2006). Our results align closely with the meta-analysis by Stengel et al. (2005), which reported pooled sensitivity of 93% for CT in detecting intra-abdominal injuries requiring intervention. The positive predictive value of 84.6% and negative predictive value of 84.5% in our study reflect the appropriate clinical selection of patients for CT examination and support the role of CT as a reliable decision-making tool in trauma management.

The accuracy rate of 84.6% observed in our study compares favorably with international benchmarks and demonstrates the effectiveness of standardized CT protocols in trauma evaluation. The positive likelihood ratio of 3.4 indicates that positive CT findings significantly increase the probability of requiring surgical intervention, while the negative likelihood ratio of 0.11 suggests that negative CT results substantially reduce the likelihood of significant injury requiring immediate intervention. These statistical parameters support the clinical utility of CT scanning in guiding treatment decisions and resource allocation in busy emergency departments.

The injury distribution pattern in our study reflects typical findings in blunt abdominal trauma, with liver injuries being most common (25.4%), followed by splenic injuries (19.1%) and renal injuries (12.9%). This distribution is consistent with studies by Fakhry et al. (2000), who reported similar patterns in large trauma databases. The high detection rate of solid organ injuries correlates with CT's excellent performance in evaluating organ parenchyma and detecting hemoperitoneum. The ability to accurately grade injuries according to standardized criteria (AAST grading) facilitated appropriate treatment planning, with 62.9% of liver injuries and 64.2% of splenic injuries classified as low-grade (I-II), supporting conservative management approaches.

The detection of bowel injuries (9.7%) and pancreatic injuries (6.6%) represents areas where CT performance is traditionally more challenging. Our results align with previous studies showing CT sensitivity of 85-90% for bowel injuries, with small bowel injuries being more difficult to detect than large bowel injuries (Brody et al., 2007). The identification of pneumoperitoneum in 8.0% of patients provided important diagnostic clues for hollow viscus injuries, though correlation with clinical findings remained essential for accurate diagnosis. The detection of active bleeding/contrast extravasation in 9.7% of patients proved crucial for identifying patients requiring immediate intervention or angiographic management.

CT findings significantly influenced clinical management decisions, with 57.3% of patients with positive CT scans undergoing surgical intervention compared to only 5.2% of those with negative scans ($p<0.001$). This finding demonstrates the strong correlation between CT findings and clinical outcomes, supporting the role of CT in surgical decision-making. The emergency surgery rate of 19.2% in CT-positive patients versus 1.7% in CT-negative patients highlights CT's ability to identify patients requiring immediate intervention, consistent with findings by Anderson et al. (2011).

The conservative management rate of 94.8% in CT-negative patients validates the safety of observation protocols for patients with normal CT scans. This approach has contributed to reducing negative laparotomy rates and unnecessary surgical interventions, as reported in studies by Becker et al. (2015). The mean length of stay was significantly longer in CT-positive patients (4.8 days vs 2.1 days), reflecting the complexity of injuries and need for ongoing monitoring or intervention. ICU admission rates were substantially higher in CT-positive patients (38.0% vs 10.3%), indicating appropriate resource allocation based on imaging findings.

The strong correlation between CT findings and clinical parameters validates the integration of imaging with clinical assessment. Patients with positive CT scans were significantly more likely to present with hemodynamic instability (systolic BP <90 mmHg: 19.2% vs 6.9%), tachycardia (heart rate >100 bpm: 38.0% vs 19.8%), and laboratory markers of blood loss (hemoglobin <10 g/dL:

33.3% vs 10.3%). These findings are consistent with studies by Kulkarni et al. (2013), who demonstrated similar correlations between imaging findings and clinical severity indicators.

The elevated serum lactate levels in CT-positive patients (28.6% with lactate >2.5 mmol/L vs 6.9% in CT-negative patients) reflect tissue hypoperfusion associated with significant injuries. This correlation supports the use of lactate as an adjunctive marker for injury severity and the need for ongoing resuscitation. The base deficit measurements also correlated with CT findings, providing additional validation of the relationship between imaging results and physiologic derangement.

The analysis of injury mechanisms revealed important patterns that influence diagnostic approach and injury distribution. Motor vehicle accidents, representing 56.6% of cases, were associated with the highest rate of intra-abdominal injuries and showed excellent CT sensitivity (93.2%). Two-wheeler accidents, common in Indian traffic patterns (25.4% of cases), demonstrated slightly lower but still excellent sensitivity (89.5%), reflecting differences in injury mechanisms and energy transfer patterns. These findings align with epidemiological studies from Indian trauma centers reporting similar mechanism distributions and injury patterns (Kuncir et al., 2007).

Falls from height, though representing only 9.7% of cases, showed concerning injury patterns with 52.9% requiring surgical intervention, reflecting the high-energy nature of these injuries. The CT diagnostic performance remained excellent across all mechanism categories, supporting the universal application of CT protocols regardless of injury mechanism. Pedestrian injuries showed unique patterns with higher rates of retroperitoneal bleeding and pelvic injuries, consistent with the mechanism of injury involving impact with vehicle bumpers and subsequent ground contact.

Age-related analysis revealed important trends in injury patterns and outcomes. Younger patients (18-30 years) demonstrated the highest CT sensitivity (92.8%) and lowest surgery rates (41.0%), possibly reflecting better physiologic reserve and ability to compensate for injuries. Middle-aged patients (31-45 years) showed intermediate outcomes, while older patients (>45 years) had longer hospital stays (5.8 days) and higher surgery rates (52.6%), consistent with age-related differences in injury tolerance and healing capacity.

The slightly lower CT sensitivity in older patients may reflect age-related anatomical changes, increased comorbidities, and different injury patterns. However, the overall diagnostic performance remained excellent across all age groups, supporting the broad applicability of CT scanning in trauma evaluation. The mortality rate of 5.1% in CT-positive patients versus 0% in CT-negative patients underscores the prognostic value of CT findings in risk stratification.

The relationship between time from injury to CT examination and diagnostic accuracy revealed interesting patterns. Patients scanned within 2 hours of injury showed the highest sensitivity (94.1%) and shortest hospital stays (4.2 days), supporting early imaging protocols in trauma management. The slightly lower sensitivity in delayed presentations (>6 hours: 87.5%) may reflect evolving injury patterns, resolution of early findings, or patient selection factors affecting those with delayed presentation.

The surgery rates increased with delayed presentation (55.1% for >6 hours vs 40.1% for <2 hours), possibly reflecting more severe injuries in patients with delayed access to care or complications developing over time. These findings support current trauma guidelines recommending early CT evaluation in hemodynamically stable patients with suspected abdominal injuries, as advocated by Poletti et al. (2004).

The correlation between Injury Severity Score (ISS) categories and CT performance demonstrated expected patterns. Patients with higher ISS scores (>15) showed excellent CT sensitivity (96.8%) but lower specificity (66.7%), reflecting the complexity of severe injuries and potential for multiple organ involvement. The surgery rates correlated strongly with ISS categories (24.1% for ISS <9 vs 73.2% for ISS >15), validating the prognostic value of combined clinical scoring and imaging assessment.

The length of stay progression from 2.8 days in low ISS patients to 8.2 days in high ISS patients reflects the resource intensity of caring for severely injured patients. These findings support the use of CT findings in conjunction with clinical scoring systems for accurate risk stratification and resource planning, consistent with recommendations by Dreizin et al. (2017).

Conclusion

This prospective study demonstrated excellent diagnostic accuracy of CT scanning for detecting significant intra-abdominal injuries in blunt trauma patients, with sensitivity of 91.7%, specificity of 73.1%, and overall accuracy of 84.6%. CT findings strongly correlated with clinical outcomes, surgical decision-making, and resource utilization, with 57.3% of CT-positive patients requiring surgical intervention compared to 5.2% of CT-negative patients. The study confirmed CT's reliability across different injury mechanisms, age groups, and clinical presentations, with motor vehicle accidents showing the highest diagnostic accuracy and injury rates. Temporal factors influenced outcomes, with early CT examination (<2 hours) associated with highest sensitivity and shortest hospital stays. The strong correlation between CT findings and clinical parameters including hemodynamic status, laboratory markers, and injury severity scores validates CT's role in comprehensive trauma assessment. These findings support the continued use of CT as the primary diagnostic modality for evaluating hemodynamically stable patients with suspected blunt abdominal trauma.

Recommendations

Emergency departments should implement standardized CT trauma protocols with rapid acquisition capabilities and immediate radiological interpretation to optimize patient outcomes and resource utilization. Training programs should focus on appropriate patient selection criteria, contrast administration protocols, and systematic interpretation approaches to ensure consistent diagnostic accuracy across different healthcare settings. Quality assurance programs including regular protocol reviews, diagnostic accuracy audits, and multidisciplinary case discussions should be established to maintain high standards of care. Clinical decision-making algorithms integrating CT findings with injury severity scores, hemodynamic parameters, and laboratory markers should be developed to guide optimal treatment strategies. Special protocols for elderly patients and those with delayed presentations should be considered to address unique challenges in these populations. Future research should focus on developing artificial intelligence-assisted interpretation tools, radiation dose optimization strategies, and cost-effectiveness analyses in resource-limited settings. Collaboration between emergency physicians, radiologists, trauma surgeons, and interventional radiologists is essential for implementing comprehensive trauma imaging pathways that improve patient care while optimizing healthcare resource allocation and reducing unnecessary interventions in emergency departments.

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