Assessment of Blunt Abdominal Trauma A Comparative Analysis of Contrast-Enhanced CT and Ultrasonography in Terms of Sensitivity, Specificity, and Patient Outcomes

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ABSTRACT

Introduction: A prompt and precise diagnosis is necessary for blunt abdominal trauma (BAT), a major source of morbidity and death. With an emphasis on sensitivity, specificity, and patient outcomes, this study evaluates the diagnostic performance of contrast-enhanced computed tomography (CECT) and ultrasonography (US) in evaluating BAT.

Methodology: 84 BAT patients from the Polyclinic Hospital in Islamabad participated in this prospective, comparative research between January and August 2024. Every patient had a first US and then CECT. Using CECT results as the gold standard, the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of US were computed. Analysis was done on clinical outcomes, such as hospital stays, surgical procedures, and death.

Results: US had an 89.7% sensitivity and an 84.6% specificity for detecting free intra-abdominal fluid. Nevertheless, it failed to detect six retroperitoneal hemorrhages and ten minor solid organ damage detected by CECT. CECT has a sensitivity of 97.8%, demonstrating excellent accuracy for detecting solid organ damage. The CECT-guided group had a greater rate of surgical intervention (36.9%) than the US group (32.1%). Despite significantly longer hospital stays for individuals with a CECT diagnosis, the two groups' death rates were similar.

Conclusion: Because of its great sensitivity for detecting free fluid, ultrasonography is a useful first screening method for BAT. However, because of its greater diagnostic accuracy, especially for solid organ and retroperitoneal injuries, CECT is still necessary for a thorough examination.

Keywords: Blunt abdominal trauma, ultrasonography, contrast-enhanced CT, sensitivity, specificity, patient outcomes.

INTRODUCTION

Because of its potential for life-threatening internal injuries and its sometimes modest clinical presentation, blunt abdominal trauma (BAT) continues to pose a serious issue in emergency care.[1] This kind of trauma, which is frequently brought on by car crashes, falls, and physical attacks, is responsible for a significant percentage of ER visits and trauma-related deaths globally.[2, 3] In order to manage BAT, avoid complications, guarantee prompt surgical procedures, and enhance patient outcomes, an early and precise diagnosis is essential. Non-invasively identifying internal injuries, however, can be challenging, particularly when clinical evaluations might not be

clearly correlated with the extent of internal damage.[4-6]

Clinical judgments are heavily influenced by the diagnostic precision of imaging methods. Ultrasonography (US) and contrast-enhanced computed tomography (CECT) are the two main imaging techniques utilized to evaluate BAT.[7] Because of its great sensitivity and specificity, CECT is regarded as the gold standard; nonetheless, it comes with increased expenses, dangers connected to contrast, and radiation exposure.[8] On the other hand, ultrasonography—specifically, the Focused Assessment with Sonography for Trauma (FAST) protocol—offers a quick, non-invasive, and economical substitute; nevertheless, its ability to detect specific injuries may be restricted and its diagnostic precision may be operator-dependent.[8] One of the main causes of morbidity and death among trauma patients is blunt abdominal trauma, which frequently results in damage to solid organs including the kidneys, liver, and spleen. BAT's clinical manifestation can range greatly, from mild discomfort to potentially fatal hemorrhagic shock. As a result, precise diagnostic instruments are necessary to determine the degree of internal harm, develop therapy plans, and enhance patient outcomes.[9]

Because they provide comprehensive cross-sectional pictures that enable the accurate location and characterisation of injuries, contrast-enhanced CT scans have completely changed the way trauma treatment is provided.[10] According to studies, CECT can identify solid organ damage and free fluid in the abdomen with a sensitivity of above 90%.[11] Radiation exposure, possible contrast agent nephrotoxicity, and the requirement for patient stability—which can be difficult in urgent situations—are the drawbacks, though. Contrarily, ultrasonography is readily available, radiation-free, and bedside accessible, which makes it perfect for first trauma evaluation in emergency situations.[12] A popular screening method is the FAST examination, which is intended to swiftly identify free intra-abdominal fluid. Although US is quite good at detecting large hemoperitoneum, it is less sensitive than CECT in detecting retroperitoneal hemorrhage and parenchymal damage. The accuracy of ultrasonography can also be impacted by patient characteristics including body habitus and operator experience.[13]

In order to assess blunt abdominal injuries, this study compares the sensitivity, specificity, and overall patient outcomes of CECT and ultrasonography. The study aims to offer evidence-based suggestions for improving diagnostic procedures in trauma treatment by assessing the advantages and disadvantages of each modality, especially in areas with low resources where modern imaging may not always be easily accessible.

METHODOLOGY

Study Design and Setting: The Polyclinic Hospital in Islamabad hosted this cross-sectional, comparative research between January and August of 2024. In order to measure blunt abdominal trauma (BAT), the study sought to determine the sensitivity, specificity, and patient outcomes related to CECT and US.

Sample Size and Calculation: The research comprised 84 individuals who presented with acute abdominal trauma. A statistical technique for investigations of comparative diagnostic accuracy was used to determine the sample size. A margin of error of 10%, a 95% confidence range, and an estimated sensitivity of 90% for CECT and 75% for US were taken into consideration based on earlier research. A sample size of 84 patients was determined using these characteristics, guaranteeing adequate power to identify statistically significant differences between the two diagnostic methods.

Patient Selection: Included were patients with acute abdominal injuries who were between the ages of 18 and 65. Patients with established contraindications to contrast agents, those who were hemodynamically unstable and needed rapid surgical intervention, and those with penetrating abdominal damage were excluded. Consecutive sampling was used to gather data until the required sample size was reached.

Data Collection Procedures: All patients had a comprehensive clinical evaluation upon presentation, which was followed by imaging using contrast-enhanced CT and ultrasonography. First, the FAST methodology was used for ultrasonography to check for free intra-abdominal fluid. Patients then received CECT for a thorough assessment of their organ damage. To ensure minimal delay and preserve diagnostic comparability, the time intervals between the imaging procedures were documented.

Data Analysis: Using CECT results as the reference standard, the sensitivity, specificity, PPV, and NPV of each imaging modality were computed. Fisher's exact and chi-square tests were used to compare the modalities; a p-value of less than 0.05 was deemed statistically significant. The groups were also compared in terms of patient outcomes, such as death, length of hospital stay, and rates of surgical intervention.

Ethical Considerations: The Polyclinic Hospital's institutional ethics committee gave its approval. All participants gave their informed consent, and patient privacy was protected at all times.

RESULTS

The study comprised 84 patients with BAT, whose mean age was 38.6 ± 12.4 years. 27 (32.1%) females and 57 (67.9%) males were present. 46 patients (54.8%) experienced trauma from traffic accidents, which were followed by falls in 24 patients (28.6%) and physical attacks in 14 patients (16.6%). Table 1 provides specifics on the modes of damage and demographic information.

Table 1: Patient Demographics and Mechanisms of Injury

Parameter	Number (%)
Mean Age (years)	38.6 ± 12.4
Gender	
- Male	57 (67.9%)
- Female	27 (32.1%)
Mechanism of Injury	
- Road Traffic Accidents	46 (54.8%)
- Falls	24 (28.6%)
- Physical Assaults	14 (16.6%)

Ultrasonography and CECT imaging results were examined. Of the 84 patients, US found solid organ damage in 39 instances (46.4%) and free intra-abdominal fluid in 52 cases (61.9%). The reference standard, CECT, detected solid organ damage in 49 instances (58.3%) and free intra-abdominal fluid in 58 cases (69.0%). Notably, CECT also identified mild hepatic and splenic damage in 10 more patients that the US missed, as well as retroperitoneal bleeding in 6 instances. Table 2 displays the diagnostic results for both modalities.

Table 2: Imaging Findings of Ultrasonography and CECT

Imaging Modality	Free Fluid Detected	No Free Fluid Detected	Solid Organ Injury Detected	No Solid Organ Injury	Retroperitoneal Hemorrhage
Ultrasonography	52 (61.9%)	32 (38.1%)	39 (46.4%)	45 (53.6%)	Not detected
CECT	58 (69.0%)	26 (31.0%)	49 (58.3%)	35 (41.7%)	6 (7.1%)

The results of CECT were compared to the diagnostic accuracy of US. US demonstrated 89.7% sensitivity, 84.6% specificity, 92.3% positive predictive value (PPV), and 79.2% negative predictive value (NPV) for the detection of free intra-abdominal fluid. The specificity for solid organ damage was greater at 91.3%, while the sensitivity was lower at 79.6%. The diagnostic performance of the United States is summarized in figure 1.
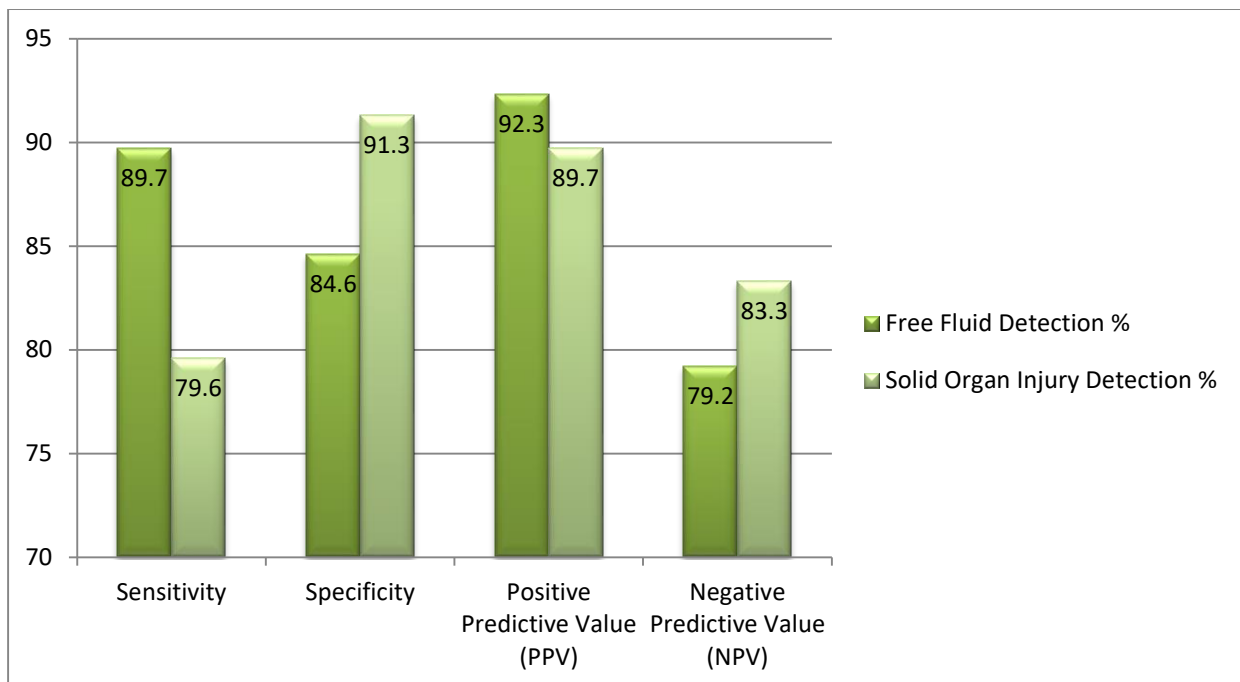
Figure 1: Diagnostic Performance of Ultrasonography

Patients with a primary US diagnosis and those with a primary CECT diagnosis had their clinical outcomes compared. The CECT-guided group had somewhat higher rates of surgical intervention (31 patients, 36.9%) than the US-guided group (27 patients, 32.1%). Hospital stays for patients with CECT were also somewhat longer, averaging 7.1 ± 2.4 days as opposed to 6.4 ± 2.1 days for the US group. With three fatalities (3.6%) in the US-guided group and four deaths (4.8%) in the CECT-guided group, the mortality rates for the two groups were similar. These results are shown in Table 3.

Table 3: Clinical Outcomes of Patients Diagnosed with US and CECT

Outcome	US-Guided Diagnosis	CECT-Guided Diagnosis	p-value
Surgical Interventions	27 (32.1%)	31 (36.9%)	0.12
Length of Hospital Stay	6.4 ± 2.1 days	7.1 ± 2.4 days	0.08
Mortality Rate	3 (3.6%)	4 (4.8%)	0.62

CECT identified subtle injuries, including small splenic lacerations and minor hepatic contusions, in 10 patients that were missed by US. Retroperitoneal injuries were detected in 6 patients on CECT but were not visualized using US. The chi-square test showed a significant difference in the ability to detect retroperitoneal injuries between US and CECT ($p < 0.05$). Correlation analysis revealed a stronger association between CECT findings and subsequent surgical interventions ($r = 0.82$) compared to US findings ($r = 0.71$). This result emphasizes the superior reliability of CECT in guiding clinical decision-making.

DISCUSSION

The results of this study emphasize the importance of imaging modalities in the evaluation of BAT, with a focus on the advantages and disadvantages of CECT and US. Our findings show that US is not very good at detecting solid organ and retroperitoneal injuries, but it is quite good at detecting free intra-abdominal fluid (89.7%) and specificity (84.6%). These findings are in line with other studies that have repeatedly demonstrated that US is a very good screening tool but less trustworthy for assessing injuries in-depth,

particularly in situations of severe trauma.[14, 15]

The gold standard, CECT, detected six retroperitoneal hemorrhages and ten more solid organ damage that the US had overlooked. This result is in line with other researches showing that CECT's higher sensitivity and specificity enable a more thorough assessment, especially when it comes to identifying minor or concealed injuries.[16, 17] The fact that only CECT can identify retroperitoneal bleeding highlights its diagnostic benefit since, because of anatomical limitations, US frequently isn't able to image this area well.

Our study's clinical results showed that, in comparison to the US, CECT-guided diagnoses resulted in a somewhat greater rate of surgical procedures and lengthier hospital stays. This pattern is in line with other research showing that patients with CECT had more conclusive surgical procedures because more injuries were seen, which may not have been obvious with US alone[18, 19]. Comparable mortality rates across the two groups, however, imply that US is still a useful first diagnostic tool, especially in situations when quick decisions are crucial, even though CECT offers more thorough information.

The idea that comprehensive imaging might inform better clinical judgments was further supported by our research, which revealed a good connection ($r = 0.82$) between CECT results and later surgical procedures. On the other hand, the weaker correlation for US ($r = 0.71$) raises the possibility that some injuries are overlooked or underreported, which might postpone treatment.[20]

Limitations and Future Suggestions: There are many restrictions on this study. The results may not be as broadly applicable as they may be because of the limited sample size and the fact that the data came from a single location. Furthermore, selection bias may be introduced by the retrospective design. Larger, multicenter cohorts and a prospective design in future research would support the validity of these results and improve their relevance. Furthermore, in areas with limited resources, using more recent imaging technologies, like portable CECT or contrast-enhanced ultrasonography, might further boost patient outcomes and diagnostic accuracy.

CONCLUSION

This study shows that although ultrasonography is a useful first screening method for blunt abdominal trauma, contrast-enhanced CT is more effective in detecting subtle and retroperitoneal lesions. Because of its exceptional sensitivity and specificity, which enable more precise clinical judgments, CECT is still the gold standard. Ultrasonography can successfully detect serious injuries in environments with limited resources, but CECT is necessary for thorough evaluation and patient outcome optimization.

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