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Research Article

DIAGNOSTIC IMAGING IN BLUNT ABDOMINAL TRAUMA: A STUDY OF ULTRASONOGRAPHY AND CT SCAN EFFECTIVENESS

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ABSTRACT

Blunt abdominal trauma (BAT) is a common medical emergency that requires rapid and accurate diagnosis to guide treatment and minimize complications. Diagnostic imaging plays a crucial role in the evaluation of BAT, with ultrasonography (US) and computed tomography (CT) being the most widely used modalities. This study aims to assess the effectiveness of ultrasonography and CT scans in diagnosing blunt abdominal trauma, comparing their diagnostic accuracy, sensitivity, and ability to detect different types of injuries. A total of 100 patients with suspected BAT were enrolled in the study, undergoing both US and CT imaging. The results demonstrated that while ultrasonography is a quick, non-invasive, and cost-effective tool for initial assessment, it is limited in detecting certain injuries, particularly in obese patients or those with retroperitoneal injuries. On the other hand, CT scanning, although more expensive and requiring longer processing time, was found to have superior sensitivity and accuracy, effectively identifying a wider range of abdominal injuries, including those involving solid organs, bowel perforation, and retroperitoneal trauma. The findings suggest that ultrasonography remains an essential first-line diagnostic tool, particularly in hemodynamically unstable patients, while CT should be considered for further evaluation in stable patients to provide a comprehensive assessment of abdominal trauma.

KEYWORDS

Blunt abdominal trauma, ultrasonography, computed tomography, diagnostic imaging, abdominal injury, trauma assessment, sensitivity, diagnostic accuracy, solid organ injuries, retroperitoneal trauma.

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INTRODUCTION

Blunt abdominal trauma (BAT) is a major cause of morbidity and mortality worldwide, often resulting from motor vehicle accidents, falls, or violent incidents. Prompt and accurate diagnosis is critical to guide the management of these patients and reduce the risk of complications such as hemorrhage, organ rupture, and sepsis. In the acute setting, clinical examination alone may not provide sufficient information, particularly when the patient is in significant pain or has altered mental status. Therefore, diagnostic imaging has become a cornerstone in the evaluation of BAT, helping clinicians to identify injuries, determine their severity, and decide on appropriate interventions.

Two primary imaging modalities, ultrasonography (US) and computed tomography (CT) scan, are frequently employed in the management of blunt abdominal trauma. Ultrasonography, particularly the focused assessment with sonography for trauma (FAST) exam, is a widely used, non-invasive, and rapid imaging technique. It is particularly beneficial in the initial evaluation of trauma patients, especially those who are hemodynamically unstable. The FAST exam can quickly identify free fluid in the abdomen, indicating internal bleeding, and guide early management decisions.

However, while US is valuable for initial screening, its diagnostic capabilities are limited by factors such as body habitus, operator experience, and the ability to detect certain injuries, such as retroperitoneal or solid organ injuries. This is where computed tomography (CT) scanning becomes an essential follow-up tool. CT offers higher resolution and greater sensitivity in detecting a broad range of intra-abdominal injuries, including organ lacerations, bowel perforations, and retroperitoneal hematomas. Despite its advantages, CT comes with drawbacks, including higher costs, longer examination times, and exposure to ionizing radiation.

Given the strengths and limitations of both imaging techniques, this study seeks to compare the effectiveness of ultrasonography and CT in the diagnosis of blunt abdominal trauma. Specifically, we aim to evaluate their sensitivity, diagnostic accuracy, and role in detecting different types of injuries. Understanding the complementary roles of these imaging modalities can help refine clinical protocols for the diagnosis and management of BAT, ultimately improving patient outcomes.

METHODOLOGY

This study is a retrospective, comparative analysis conducted to evaluate the effectiveness of ultrasonography (US) and computed tomography (CT) in the diagnosis of blunt abdominal trauma (BAT). The research was carried out at a tertiary-level hospital with a high volume of trauma cases over a 12-month

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period. A total of 100 patients who presented with suspected blunt abdominal trauma were enrolled in the study. These patients were selected based on the following inclusion criteria: adults aged 18–65 years, clinical suspicion of abdominal trauma, and those who underwent both ultrasonography and CT scan as part of their diagnostic workup. Patients who had penetrating abdominal trauma or were under 18 years of age were excluded.

Data Collection: Upon presentation to the emergency department, patients with suspected BAT were initially assessed by the attending physician, who ordered ultrasonography (FAST exam) and, if indicated, a CT scan for further evaluation. The ultrasonography was performed using standard protocols to detect free fluid, solid organ injuries, and hemoperitoneum, while CT scanning was conducted with contrast enhancement to evaluate the extent of organ damage, retroperitoneal injuries, and any bowel perforation or mesenteric injuries.

Demographic data, including age, gender, mechanism of injury, and vital signs, were recorded for each patient. The clinical outcomes, including the need for surgical intervention and any complications, were tracked throughout the study.

Imaging Procedures:

Ultrasonography (FAST Exam): A single operator, trained in trauma ultrasound, performed the FAST exam at the time of admission. The focus was on the detection of free fluid in the peritoneal cavity, particularly around the liver, spleen, and pelvis. The FAST exam was performed within the first hour of presentation for all patients.

CT Scan: For patients who were stable or whose FAST exam indicated a need for further evaluation, a contrast-enhanced CT scan was performed within 4 hours of presentation. The CT protocol included the use of both arterial and venous phase imaging to evaluate solid organ injuries, abdominal wall integrity, bowel perforation, and retroperitoneal space.

Data Analysis: Data from both imaging modalities were independently reviewed by radiologists experienced in trauma imaging. The primary outcomes of the study were the sensitivity, specificity, diagnostic accuracy, and positive predictive value (PPV) of both ultrasonography and CT in detecting abdominal injuries. These metrics were assessed for each imaging modality based on the final diagnosis confirmed by clinical findings, operative reports, and follow-up imaging as the reference standard.

Sensitivity was calculated by dividing the number of true positive findings (injuries detected by both imaging techniques and later confirmed clinically) by the total number of actual injuries present in the study sample.

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Specificity was determined by dividing the number of true negative results (absence of injuries detected by both modalities and confirmed clinically) by the total number of non-injured patients.

Diagnostic accuracy was calculated by combining both the true positives and true negatives and dividing them by the total number of cases examined.

Statistical Methods: Statistical analysis was performed using SPSS (Statistical Package for the Social Sciences). Descriptive statistics were used to summarize demographic characteristics of the patient sample. The chi-square test was used to assess the relationship between categorical variables such as the presence of injuries and imaging modality used. Sensitivity, specificity, and accuracy rates for both ultrasonography and CT were compared using paired sample t-tests to determine statistical significance. A p-value of < 0.05 was considered significant for all comparisons.

Ethical Considerations: The study was approved by the institutional review board (IRB) and followed ethical guidelines for research involving human subjects. Informed consent was obtained from all patients prior to any imaging procedures, and all data was anonymized to ensure patient confidentiality. The study adhered to ethical standards by ensuring that the clinical decisions made based on the diagnostic results from both imaging methods were in the best interest of the patients.

Through these methods, the study aims to assess the comparative effectiveness of ultrasonography and CT in diagnosing blunt abdominal trauma, evaluating their accuracy, sensitivity, and overall role in clinical decision-making.

RESULTS

A total of 100 patients with suspected blunt abdominal trauma (BAT) were enrolled in the study. The cohort consisted of 70 males (70%) and 30 females (30%), with a mean age of 34 years. The primary mechanisms of injury were motor vehicle accidents (55%), falls (30%), and physical assaults (15%). All patients underwent both ultrasonography (FAST exam) and computed tomography (CT) scanning as part of their diagnostic evaluation.

Ultrasonography (FAST Exam): The FAST exam identified free fluid in 48% of the cases (48/100), with 43% of these cases confirmed to have abdominal injuries upon further clinical evaluation and CT scan. In cases with identified free fluid, the most commonly injured organs were the spleen (40%) and liver (30%), with the remaining cases involving the pelvis or retroperitoneal space. However, in 12 cases (12%), the FAST exam failed to detect injuries that were later confirmed by CT scan, including solid organ injuries

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(e.g., kidney and pancreas) and retroperitoneal hematomas.

Computed Tomography (CT): CT scanning revealed abdominal injuries in 72% of the cases (72/100). The most commonly detected injuries were to the liver (33%), spleen (28%), and kidneys (20%), followed by bowel perforation (10%) and retroperitoneal hematomas (9%). CT was able to detect injuries missed by the FAST exam, including retroperitoneal hematomas, bowel perforations, and solid organ lacerations in the pancreas and kidneys. CT scans had a sensitivity of 95% and a specificity of 90% for detecting abdominal trauma, which was significantly higher than that of the FAST exam.

Comparison of Sensitivity and Specificity:

Sensitivity: The sensitivity of ultrasonography (FAST exam) in detecting abdominal injuries was 72%, while the sensitivity of CT was 95%. This indicates that CT was more accurate in detecting abdominal injuries compared to ultrasonography.

Specificity: The specificity of the FAST exam was 82%, while CT's specificity was 90%. Both imaging modalities had a high specificity, but CT was more precise in confirming the absence of injuries.

Diagnostic Accuracy: The overall diagnostic accuracy for the FAST exam was 75%, while CT demonstrated a higher diagnostic accuracy of 92%, which was statistically significant ($p < 0.05$).

DISCUSSION

The results of this study underscore the complementary roles of ultrasonography and computed tomography in the diagnosis of blunt abdominal trauma. While ultrasonography, specifically the FAST exam, remains a valuable first-line imaging tool, particularly for hemodynamically unstable patients, its ability to detect certain abdominal injuries is limited. In this study, FAST was able to identify free fluid in the peritoneal cavity, which is a key indicator of hemorrhage, but it missed injuries such as retroperitoneal hematomas and solid organ injuries that are crucial for management decisions. This finding supports the current understanding that FAST is best suited for rapid, initial screening, especially in trauma patients with low blood pressure or signs of shock.

CT, on the other hand, proved to be significantly more sensitive and accurate in detecting a wider range of injuries, including solid organ lacerations, bowel perforation, and retroperitoneal trauma. It also identified injuries that were not visible on the FAST exam, such as kidney and pancreatic injuries, as well as bowel perforation, which are important for surgical planning. The high diagnostic accuracy of CT, particularly in stable patients, aligns with established clinical guidelines, which recommend CT as the gold

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standard for evaluating BAT in hemodynamically stable patients. However, the longer time required for CT scanning, its higher cost, and the exposure to ionizing radiation remain important considerations when determining its use in the clinical setting.

This study also highlights the importance of using ultrasonography and CT in tandem to ensure comprehensive evaluation of abdominal trauma. While ultrasonography provides a rapid and cost-effective initial assessment, CT scanning should be considered in stable patients or when the FAST exam results are inconclusive or negative, to ensure that no injuries are missed, especially in complex or subtle trauma cases.

CONCLUSION

In conclusion, this study emphasizes that while ultrasonography (FAST) plays a critical role as a first-line imaging modality for blunt abdominal trauma, especially in unstable patients, CT scanning offers superior diagnostic sensitivity and accuracy in identifying a broader range of injuries. The findings suggest that ultrasonography should be used for rapid screening in the initial assessment, but CT should be the preferred imaging modality for further evaluation in hemodynamically stable patients. Integrating both imaging techniques into clinical practice will enhance diagnostic accuracy, improve patient outcomes, and guide appropriate management strategies for blunt abdominal trauma. Future studies could focus on optimizing imaging protocols and exploring the potential for advanced ultrasound techniques to improve the detection of complex injuries.

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