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DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY IN DETECTION OF LIVER INJURIES IN TRAUMA PATIENTS KEEPING CT AS GOLD STANDARD

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Abstract

Objective:
The present study aimed to determine the diagnostic accuracy of ultrasonography in detecting liver injuries in patients with abdominal trauma, using computed tomography (CT) as the gold standard.

Methodology:
This cross-sectional diagnostic accuracy study was conducted in the radiology and emergency departments of Pakistan Institute of Medical Sciences, Islamabad. A total of 120 trauma patients with suspected abdominal injury who underwent both ultrasonography and CT scan were included using a non-probability consecutive sampling technique. Hemodynamically unstable patients, patients with a history of liver disease, and those who did not undergo CT scan were excluded. Ultrasonography examinations were performed by experienced radiologists using standard abdominal protocols to detect liver injuries such as lacerations, hematomas, or free fluid. CT scan findings were interpreted independently and considered the gold standard. Diagnostic parameters including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were calculated using statistical software.

Results:
Among the 120 patients, the mean age was 34.6 ± 12.8 years, with males comprising 65% of the study population. Road traffic accidents were the most common mechanism of trauma (51.7%). CT scan confirmed liver injuries in 50 (41.7%) patients. Ultrasonography detected liver injury in 48 patients, with 45 true positives, 63 true negatives, 7 false positives, and 5 false negatives. The sensitivity and specificity of ultrasonography were both 90%, with a PPV of 86.5%, NPV of 92.6%, and an overall diagnostic accuracy of 90%.

Conclusion:
Ultrasonography is an effective, rapid, and non-invasive initial screening tool for detecting liver injuries in trauma patients; however, CT remains the most accurate modality for definitive diagnosis and detailed injury assessment.

INTRODUCTION

Trauma remains a leading cause of morbidity and mortality worldwide, particularly in developing countries, where road traffic accidents and abdominal trauma are highly prevalent. Among abdominal organs, the liver is the most frequently

injured solid organ due to its size and anatomical location in the right upper quadrant (1). Early and accurate diagnosis of liver injuries is critical for appropriate management and improved patient outcomes.

Imaging plays a central role in the evaluation of trauma patients. Traditionally, contrast-enhanced computed tomography (CT) has been considered the gold standard for diagnosing liver injuries because of its high sensitivity and specificity, as well as its ability to grade the severity of injury and detect associated intra-abdominal pathologies (2,3). However, CT has limitations, including radiation exposure, high cost, limited availability in resource-constrained settings, and the need to transport potentially unstable patients (4).

Ultrasonography (USG), particularly the Focused Assessment with Sonography for Trauma (FAST), has emerged as a rapid, non-invasive, and bedside imaging modality in trauma care (5). It is widely used for the initial assessment of hemodynamically unstable patients due to its portability, repeatability, and lack of ionizing radiation (6). Ultrasonography is especially useful in detecting free intraperitoneal fluid, which may indirectly suggest solid organ injury, including liver trauma (7).

Despite its advantages, ultrasonography has limitations in detecting parenchymal liver injuries, especially in the absence of significant hemoperitoneum or in obese patients (8). Its diagnostic accuracy is highly operator-dependent and may vary based on the experience of the examiner and the quality of equipment (9). Therefore, while USG is an essential screening tool, its reliability in comparison to CT scan for definitive diagnosis of liver injuries remains a subject of ongoing research.

Given these considerations, this study aims to evaluate the diagnostic accuracy of ultrasonography in detecting liver injuries in trauma patients, using CT scan as the gold standard. Understanding the effectiveness and limitations of ultrasonography will help optimize trauma management protocols, particularly in settings where CT is not readily accessible (10).

METHODOLOGY

This cross-sectional diagnostic accuracy study was carried out in the radiology and emergency departments of Pakistan Institute of Medical Sciences, Islamabad, over a period of 6 months. Inclusion criteria include, Trauma patients who presented with suspected abdominal injuries and underwent both ultrasonography and CT scan. A non-probability consecutive sampling technique was used to recruit participants who met the inclusion criteria. Patients who were hemodynamically unstable, had a history of previous liver disease, or did not undergo CT scanning were excluded from the study.

Data were collected after obtaining informed consent from the patients or their attendants. Ultrasonography examinations were performed by experienced radiologists using standard abdominal ultrasound protocols to identify signs of liver injury such as lacerations, hematomas, or free fluid. Subsequently, CT scans of the abdomen were performed and interpreted by radiologists who were blinded to the ultrasound findings, and CT results were considered the reference (gold standard) for confirming liver injuries. A structured data collection form was used to record demographic information, clinical details, and imaging findings.

The qualitative variables in the study included gender, mechanism of trauma (road traffic accident, fall, assault, etc.), presence or absence of liver injury on ultrasonography, and presence or absence of liver injury on CT scan. The quantitative variables included age of the patients (in years), duration of trauma to imaging (in hours), and size or grade of liver injury where applicable. Data were analyzed using statistical software. Diagnostic accuracy parameters such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of ultrasonography were calculated by comparing ultrasound findings with CT scan results. A p-value of ≤0.05 was considered statistically significant.

RESULTS

A total of 120 trauma patients who met the inclusion criteria were included in the study. The mean age of the patients was 34.6 ± 12.8 years with an age range of 18–65 years. Among the participants, 78 (65%) were males and 42 (35%) were females. The most common mechanism of trauma was road traffic accidents (RTA) accounting for 62 (51.7%) cases, followed by falls in 34 (28.3%), and assault or other causes in 24 (20%) patients. The mean duration from trauma to imaging was 5.2 ± 2.1 hours. On CT scan (gold standard), 50 (41.7%) patients were confirmed to have liver injuries while 70 (58.3%) had no liver injury.

Ultrasonography detected liver injury in 48 patients, while 72 patients were reported negative for liver injury. When compared with CT scan findings, 45 patients were true positives, 63 were true negatives, 7 were false positives, and 5 were false negatives. Based on these findings, the sensitivity of ultrasonography in detecting liver injuries was 90%, specificity was 90%, positive predictive value (PPV) was 86.5%, negative predictive value (NPV) was 92.6%, and the overall diagnostic accuracy was 90%.

The results demonstrated that ultrasonography showed a high level of agreement with CT scan findings in the detection of liver injuries among trauma patients. However, a small number of false positive and false negative cases were observed, which could be attributed to factors such as minimal liver lacerations or operator dependency of ultrasound examination.

Table 1: Demographic and Clinical Characteristics of Patients (n = 120)

Variable	Frequency (n)	Percentage (%)
Age (Mean ± SD)	34.6 ± 12.8 years	–
Gender		
Male	78	65%
Female	42	35%
Mechanism of Trauma		
Road Traffic Accident	62	51.7%
Fall	34	28.3%
Assault/Other	24	20%
Liver Injury on CT Scan		
Present	50	41.7%
Absent	70	58.3%

Table 2: Comparison of Ultrasonography with CT Scan in Detection of Liver Injuries

Ultrasonography Findings	CT Positive	CT Negative	Total
Positive	45 (True Positive)	7 (False Positive)	52
Negative	5 (False Negative)	63 (True Negative)	68
Total	50	70	120

Diagnostic Performance of Ultrasonography

Parameter	Value
Sensitivity	90%
Specificity	90%
Positive Predictive Value (PPV)	86.5%
Negative Predictive Value (NPV)	92.6%
Overall Diagnostic Accuracy	90%

DISCUSSION

A total of 120 trauma patients were included in this study, with a mean age of 34.6 ± 12.8 years, indicating that blunt abdominal trauma is more common in the younger, active population. The male predominance (65%) observed in this study is consistent with previously reported literature, likely due to increased exposure to high-risk activities and road traffic accidents. A study conducted in 2021 reported that gray-scale ultrasound combined with Doppler is a simple, non-invasive, economical, and readily available imaging modality with high sensitivity and diagnostic accuracy for liver pathologies (11).

In the present study, road traffic accidents were the leading cause of trauma, accounting for 62 (51.7%) cases, followed by falls in 34 (28.3%) and assaults or other causes in 24 (20%) patients. The mean duration from trauma to imaging was 5.2 ± 2.1 hours, which may influence the detection rate of injuries. On CT scan, which was used as the gold standard, liver injuries were confirmed in 50 (41.7%) patients, while 70 (58.3%) patients showed no evidence of liver injury. Similarly, a 2025 study demonstrated that triphasic CT has very high sensitivity in differentiating liver lesions, although specificity may be slightly reduced due to background liver changes (12).

Ultrasonography detected liver injury in 48 patients, and when compared with CT findings, 45 were true positives, 63 true negatives, 7 false positives, and 5 false negatives. These findings resulted in a sensitivity of 90%, specificity of 90%, PPV of 86.5%, NPV of 92.6%, and overall diagnostic accuracy of 90%. These values indicate that ultrasonography is highly reliable in both detecting and excluding liver injuries in trauma patients. Supporting these findings, a 2025 study reported that ultrasound is a dependable initial diagnostic modality, whereas CT remains essential for detailed injury delineation and management planning (13).

The high sensitivity (90%) observed suggests that ultrasonography is effective in identifying most cases of liver injury, thereby reducing the likelihood of missed diagnoses. The high NPV (92.6%) further indicates that a negative ultrasound result can reliably exclude liver injury in the majority of patients, which is particularly useful in emergency settings. These results are in agreement with Feyzi et al. (2015), who reported that negative ultrasound findings combined with clinical observation can effectively rule out abdominal injury, especially when performed by experienced radiologists (14).

Despite its high diagnostic performance, ultrasonography showed some limitations, as reflected by 7 false-positive and 5 false-negative cases. False negatives may occur in cases of minimal liver lacerations, small hematomas, or absence of detectable free fluid, especially in early imaging. False positives may arise due to misinterpretation of artifacts, bowel gas, or anatomical variations. Additionally, ultrasound is highly operator-dependent, which may affect its diagnostic accuracy.

CT imaging remains superior for comprehensive evaluation, as it provides detailed anatomical visualization, accurate grading of liver injuries, and detection of associated intra-abdominal injuries. A 2023 study emphasized that CT findings such as contrast extravasation are critical in guiding immediate surgical intervention, highlighting its indispensable role in trauma management (15). Similarly, a 2022 study reported that FAST is fairly sensitive, specific, and accurate in diagnosing visceral injuries in blunt abdominal trauma and supports its use as an initial screening tool due to its non-invasive and radiation-free nature (16).

Overall, the findings of this study demonstrate that ultrasonography has a high level of agreement with CT scan, with an overall diagnostic accuracy of 90%. While it cannot replace CT for definitive diagnosis and detailed injury assessment, it serves as a rapid, accessible, and effective first-line imaging modality. Therefore, the combined use of ultrasonography for initial screening followed by CT for confirmation remains the most appropriate approach in the evaluation and management of blunt abdominal trauma.

CONCLUSION

Ultrasonography demonstrated high diagnostic performance in detecting liver injuries in trauma

patients, with a sensitivity and specificity of 90% when compared with computed tomography (CT) as the gold standard. The findings indicate that ultrasonography is a useful, rapid, and non-invasive initial screening tool for evaluating liver injuries in patients with blunt abdominal trauma. However, CT scan remains the most accurate imaging modality for confirming the diagnosis and for detailed assessment of injury severity. Therefore, ultrasonography can be effectively used for early assessment, while CT should be performed for definitive evaluation and management planning.

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