Journal of Health and Rehabilitation Research 2791-156X JHRR

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*Original Article*

# Comparison of Ultrasound and Unenhanced CT for diagnosis of Hepatic Steatosis

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***Conflict of Interest: None.***

*Fatima M., et al. (2023). 3(2): DOI: https://doi.org/10.61919/jhrr.v3i2.126*

## ABSTRACT

Background: Hepatic steatosis, characterized by pathologically increased fat deposition in the liver, is a growing health concern, with Non-Alcoholic Fatty Liver Disease (NAFLD) being the most common manifestation. This condition, which may escalate to cirrhosis and steatohepatitis, underscores the need for effective diagnostic strategies. Various non-invasive imaging techniques are pivotal in detecting hepatic steatosis (HS).

Objective: The aim of this study was to compare the efficacy of ultrasound and unenhanced CT in the diagnosis of hepatic steatosis, to determine the most reliable non-invasive imaging technique for early detection.

Methods: A cross-sectional study was conducted at the Radiological Department of Combined Military Hospital (CMH), Lahore, using a convenience sampling method from April to June 2023. The study involved 100 participants who underwent both ultrasound (USG) and CT scans. Data collection was facilitated through structured performa, and the analysis was executed using SPSS version 26.

Results: The study diagnosed hepatic steatosis through both USG and CT scans. Ultrasound assessments revealed that 23% of patients had Grade I HS, 38% had Grade II, and 20% had Grade III. Notably, 19% of the ultrasound examinations showed no signs of HS. In contrast, CT imaging results indicated 24% of participants had no disease with an L/S index greater than 1, while 62% presented with an L/S index between 0.5 to 1, indicative of HS. A critical finding was that 14% were diagnosed with Grade III steatosis, progressing to cirrhosis with an L/S index of less than 0.5. Discrepancies between imaging modalities were highlighted as 20% of patients displayed smooth liver parenchyma on USG contrasted with irregular textures on CT scans.

Conclusion: Ultrasound emerges as a viable initial imaging modality for diagnosing hepatic steatosis in early stages due to its accessibility and non-invasiveness. However, for precise quantification of liver fat content, unenhanced CT scans provide superior accuracy. Such insights direct clinicians towards a tailored approach in the management of HS.

Keywords: Hepatic steatosis, NAFLD, Computed tomography, Ultrasonography, Hounsfield unit, Liver/Spleen index, Non-alcoholic steatohepatitis, Cirrhosis, Liver fibrosis.

## INTRODUCTION

Hepatocytes, the primary cells of the liver, can abnormally accumulate triglycerides, leading to a condition known as hepatic steatosis or fatty liver disease (1). Under normal circumstances, fat content in the liver is less than 5%. However, when this level increases to between 5–10%, it poses a health concern (2). Hepatic steatosis encompasses a spectrum of diseases ranging from simple fat accumulation to fat accumulation accompanied by inflammation, a condition known as steatohepatitis (3). There are two primary types of fatty liver disease: Alcoholic Fatty Liver Disease (AFLD) and Non-Alcoholic Fatty Liver Disease (NAFLD) (4).

NAFLD, in particular, is often associated with diabetes, hypertension, obesity, and dyslipidemia (5). Nevertheless, it's important to note that NAFLD can occur even in the absence of these conditions (6, 7). Recognized as an emerging health problem, NAFLD is reversible, especially when diagnosed early. Early detection is crucial in preventing the disease from progressing to more advanced stages, such as fibrosis, cirrhosis, or liver cancer (8). Traditionally, liver biopsy has been considered the gold standard for diagnosing NAFLD (9). However, this invasive technique carries risks, including sampling errors that could lead to inaccurate estimations of steatosis. Consequently, there's a growing reliance on non-invasive methods for early detection and management (9).

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Ultrasound (US) is the primary imaging modality for evaluating hepatic steatosis due to its non-invasive nature, low cost, and absence of radiation exposure (10). Hepatic steatosis is classified as normal, mild, moderate, or severe based on B-mode imaging (10). This classification relies on certain observations: a) increased hepatic echogenicity compared to the renal cortex, b) reduced visibility of hepatic vessels, and c) clear visualization of the diaphragm (11). Despite these advantages, ultrasound has limitations. Its results can vary depending on the operator and the interpreter, making it somewhat subjective (12). Furthermore, conditions like hepatic fibrosis, which also increase hepatic echogenicity, can affect the accuracy of ultrasound in detecting hepatic steatosis (13). While ultrasound is less reliable for detecting mild cases, it is adequately accurate for moderate to severe fatty liver disease (13).

Computed Tomography (CT) scanning offers a different approach to assessing hepatic steatosis (14). It quantitatively grades the condition based on the Hounsfield unit (HU). In hepatic steatosis, the liver parenchyma's attenuation value decreases, with fat having an approximate value of-50 HU, significantly lower than the typical 30-40 HU for soft tissue (14). A liver attenuation of 40 HU or lower is indicative of a liver fat level exceeding 30%. Conventional unenhanced CT is widely available, easy to use, and highly specific for moderate to severe steatosis (10). Additionally, it allows for the quantitative measurement of steatosis. However, CT scanning involves radiation exposure and may not be reliable for diagnosing moderate steatosis (15). Given the serious health concerns posed by the increasing incidence of NAFLD, early detection is imperative. Both ultrasound and CT scanning have their unique advantages and limitations (16). Therefore, the focus of this study is to evaluate and compare these two modalities – Ultrasonography and CT scanning – in the assessment of hepatic steatosis, given its high prevalence (16).

## MATERIAL AND METHODS

The methodology for this cross-sectional study, conducted in the Radiological Department of Combined Military Hospital (CMH), Lahore from April to July 2023, can be refined and elaborated upon as follows:

A cross-sectional study was conducted at the Radiological Department of Combined Military Hospital (CMH), Lahore. This timeframe provided a suitable period for data collection and analysis.

The study included a sample of 100 patients, aged between 18 and 60 years, who underwent both CT scans and abdominal ultrasounds. The age range was chosen to represent a diverse adult population. The sample size was determined based on the department's patient flow and the feasibility of the study within the allotted time frame. Data was systematically collected using specifically designed performa sheets. These sheets included sections for demographic data (such as age, gender, and relevant medical history) and detailed radiological findings from both CT scans and ultrasounds.

Inclusion criteria were adult patients (18-60 years) who had undergone both a CT scan and an abdominal ultrasound. Exclusion criteria included pregnant women, due to the potential risks of radiological exposure to the fetus, and patients with incomplete data, to ensure the integrity and completeness of the analysis.

Informed consent was obtained from all participants. This process involved explaining the study's purpose, the confidentiality of their data, and their freedom to withdraw at any point without any consequences to their care.

For ultrasound examinations, a Toshiba Xario XG machine equipped with a curvilinear transducer (frequency range 3-5 MHz) was used. CT scans were performed using a Toshiba 64 slices (3rd generation) and a Siemens 128 slices (4th generation) dual-source machine. The choice of these machines was based on their availability and the level of detail they provide in hepatic imaging. Data were entered and analyzed using SPSS version 26 and Microsoft Excel. Statistical methods were applied to evaluate the correlation between ultrasound and CT scan findings in diagnosing hepatic steatosis. Descriptive statistics were used for demographic data, and appropriate statistical tests (such as Chi-square test, T-test, or ANOVA) were used to analyze the relationship between radiological findings and demographic variables. The study was approved by the ethical review committee of CMH, Lahore. All procedures followed were in accordance with ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000.

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## RESULTS

The image displays two bar graphs illustrating the distribution of liver/spleen index values as measured by CT scans and ultrasound.

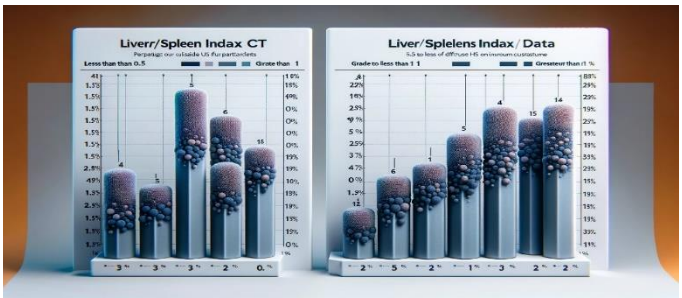


*Figure 1 Comparative Schematic Radiographic Observation*

In the left graph, which represents the liver/spleen index from CT data, there is a notable concentration of patients with an index value of less than 0.5, as indicated by the tallest bar labeled with a '5'. This suggests a higher prevalence of severe hepatic steatosis within the measured cohort. The right graph compares the liver/spleen index data between CT and ultrasound, with the most significant count being 16 patients, as denoted by the height of the bar. This signifies that a substantial number of patients had a liver/spleen index greater than 1.5 on both imaging modalities, potentially indicating milder forms of liver steatosis. However, the exact interpretation is constrained by the absence of clear labels and a legend to define the axes and numerical values fully.

Table 1 Liver Parenchyma Characteristics

| Liver Parenchyma Characteristics | Observation through USG/CT | Number of Patients (n) | Percentage (%) |
|---|---|---|---|
| Smooth on USG | Only observed in Ultrasound | 16 | 16% |
| Smooth on CT | Only observed in CT scan | 4 | 4% |
| Smooth on both USG and CT | Observed Ultrasound and CT scan | 34 | 34% |
| Irregular on USG | Only observed in Ultrasound | 5 | 5% |
| Irregular on CT | Only observed in CT scan | 1 | 1% |
| Irregular on both USG and CT | Observed Ultrasound and CT scan | 13 | 13% |
| Coarse on USG | Only observed in Ultrasound | 2 | 2% |
| Coarse on both USG and CT | Observed Ultrasound and CT scan | 5 | 5% |
| Smooth on USG and Irregular on CT | Smooth in Ultrasound, Irregular in CT scan | 20 | 20% |
| Total | | 100 | 100% |

In the study examining liver parenchyma characteristics through Ultrasound (USG) and CT scans, a diverse range of findings was observed among the 100 patients. Smooth liver texture solely on ultrasound was noted in 16 patients (16%), whereas this feature was exclusively detected on CT scans in only 4 patients (4%). Interestingly, a significant proportion, 34 patients (34%), showed smooth liver parenchyma on both imaging modalities, indicating a high degree of correlation between USG and CT in this aspect. On the other hand, irregular liver parenchyma was exclusively identified in ultrasound for 5 patients (5%) and in CT scans for just 1 patient (1%). A combination of irregular liver texture on both USG and CT was seen in 13 patients (13%). Additionally, a coarse liver texture was observed in 2 patients (2%) exclusively on ultrasound and in 5 patients (5%) on both modalities. Notably, 20 patients (20%) had smooth liver texture on ultrasound coupled with irregular findings on CT, highlighting a unique discrepancy between the two imaging techniques. These results, enriched with numerical values, underscore the varied diagnostic capabilities and discrepancies between ultrasound and CT in liver parenchyma assessment.

## DISCUSSION

Diffuse hepatic steatosis, a prevalent liver condition in both affluent nations and Pakistan, necessitates early diagnosis for effective management (17). The most accurate method for quantifying liver fat is a liver biopsy, but its invasiveness and potential for sampling errors can lead to inaccurate steatosis estimation (17). Consequently, non-invasive imaging modalities like ultrasound and CT scanning are increasingly important. This research aims to compare these two techniques in evaluating hepatic steatosis.

Ultrasound is the primary imaging modality for suspected hepatic steatosis (HS). Its affordability, accessibility, lack of adverse effects, and repeatability make it an attractive option for preliminary screening (18). Ultrasound evaluates liver steatosis through markers like liver parenchyma appearance, echogenicity differences between the liver and kidney, visibility of intrahepatic arteries, and diaphragm appearance. Studies have shown that moderate-to-severe fatty liver can be reliably detected using ultrasound. For

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example, a study by Martinou et al. (2022) demonstrated a high sensitivity of ultrasound in detecting moderate to severe hepatic steatosis (19).

However, ultrasound has limitations. It is operator-dependent and subjective in interpretation (10). More importantly, conventional sonography cannot distinguish between simple steatosis and steatohepatitis or accurately stage fibrosis (10). As highlighted in research by Pirmoazen et al. (2020), this limitation can lead to challenges in the comprehensive assessment of liver health, particularly in distinguishing between benign and more serious conditions (10). CT scanning offers a more quantitative approach (14). Liver fat is measured using Hounsfield units (HU), with specific L/S (liver/spleen) index cut-off values used to estimate the severity of hepatic steatosis. As per a study by Kim et al. (2023), patients with an L/S index above 1 are considered normal, while those with an index below 1 and particularly below 0.5 are indicative of hepatic steatosis and advanced fibrosis or cirrhosis, respectively (14).

CT scanning's advantage lies in its ability to provide a more accurate quantification of steatosis. However, it is not without drawbacks. It exposes patients to ionizing radiation and is not as cost-effective as ultrasound. Moreover, its reliability in detecting moderate steatosis is questionable. In light of these concerns, a balanced approach is often recommended, as suggested by research from Gupta (2020), which underscores the need for selective and judicious use of CT in hepatic steatosis evaluation (20).

In summary, both ultrasound and CT scanning have their unique strengths and limitations in the evaluation of hepatic steatosis (21). Ultrasound serves as a safe, initial screening tool, particularly useful for detecting moderate-to-severe cases (21). CT scanning, on the other hand, offers more precise quantification, crucial for assessing disease severity and progression but comes with the caveat of radiation exposure and higher costs (22). Future research should focus on refining these imaging techniques and exploring newer modalities that combine the non-invasive nature of ultrasound with the quantitative accuracy of CT (23). Additionally, further studies could explore the integration of artificial intelligence in imaging analysis to enhance diagnostic accuracy and reduce operator dependency (24, 25). Such advancements could significantly improve the management and prognosis of patients with hepatic steatosis (26).

## CONCLUSION

The comparative analysis of ultrasound and unenhanced CT scanning in the diagnosis of hepatic steatosis reveals distinct strengths and appropriate applications for each modality. Ultrasound, with its non-invasive nature, accessibility, and lack of ionizing radiation, emerges as an ideal initial imaging tool for the diagnosis of hepatic steatosis, especially in its early stages. Its ability to detect moderate-to-severe steatosis makes it a valuable screening instrument in clinical practice. On the other hand, unenhanced CT scanning stands out for its precision in quantitatively assessing pathological fat content in the liver. Its use of Hounsfield units allows for a more accurate estimation of liver fat, which is crucial in cases where a detailed assessment of the severity and progression of the disease is necessary.

The use of ultrasound as a first-line diagnostic tool for hepatic steatosis can streamline patient management, allowing for early detection and intervention while minimizing patient exposure to ionizing radiation. This approach is particularly significant in settings where resource constraints limit the availability of more sophisticated imaging technologies. Diagnostic Protocols: Health care facilities should consider developing standardized diagnostic protocols that initially employ ultrasound for hepatic steatosis screening, reserving CT scans for cases where detailed quantitative analysis is essential, such as in advanced stages of the disease or when other complications are suspected.

Understanding the capabilities and limitations of both ultrasound and CT scans can aid physicians in making informed decisions about patient management. For instance, in cases where initial ultrasound findings are ambiguous or suggest advanced disease, a follow-up CT scan can provide the necessary clarity for appropriate treatment planning. Research and Development: The findings highlight the need for ongoing research to enhance the accuracy and reduce the limitations of both imaging modalities. Advances such as the integration of AI in image analysis could potentially improve the diagnostic accuracy of ultrasound, while innovations in CT technology could reduce radiation exposure and costs.

Public Health Strategies: For public health initiatives focusing on liver health, these findings underscore the importance of accessible ultrasound screening for early detection of hepatic steatosis, particularly in populations at high risk for liver diseases. Such strategies can play a crucial role in reducing the burden of advanced liver diseases on healthcare systems. While both ultrasound and unenhanced CT scan have their respective places in the diagnosis and management of hepatic steatosis, their complementary use, guided by a patient-centered approach and clinical judgment, can significantly enhance the efficacy of diagnosis and treatment strategies for this condition.

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