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Original Research Article

New Horizon of USG for Screening and Surveillance of Non-Alcoholic Fatty Liver Disease Spectrum

Nitish Upadhyaya[1], Anmol Brar[2], Alok Maheshwari[3]

[1]Assistant Professor, Department of Radiodiagnosis, Rama Medical College Hospital and Research Centre, Hapur, Uttar Pradesh

[2]Junior Resident, Department of Radiodiagnosis, Rama Medical College Hospital and Research Centre, Hapur, Uttar Pradesh

[3]Professor and Head of Department, Department of Radiodiagnosis, Rama Medical College Hospital and Research Centre, Hapur, Uttar Pradesh

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Corresponding Author: Dr. Nitish Upadhyaya

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Abstract:

Background: Non-Alcoholic Fatty Liver Disease (NAFLD) is a significant global health challenge, closely linked to obesity and metabolic syndrome. Despite its prevalence, early detection remains challenging due to the asymptomatic nature of the disease in its initial stages. Advanced ultrasound techniques, including elastography, offer a promising non-invasive alternative for the screening and surveillance of NAFLD, potentially revolutionizing liver disease management.

Methods: This prospective observational study was conducted at Rama Medical College Hospital and Research Centre, Hapur, Uttar Pradesh, from January 2023 to December 2023. It aimed to evaluate the efficacy of advanced ultrasound techniques among 150 outpatients at risk of NAFLD. Participants underwent B-mode imaging and shear wave elastography (SWE) after fasting for at least 8 hours. Data on demographics, BMI, and liver function tests were collected and ultrasound findings were classified into steatosis and fibrosis stages.

Results: Our results demonstrated that 90% of participants had hepatic steatosis, with varying degrees of severity. Half of the participants showed no signs of fibrosis (F0), while 6.7% exhibited cirrhosis (F4). The diagnostic performance of ultrasound, in comparison to liver biopsy, revealed high sensitivity (92.1% for steatosis, 88.9% for fibrosis) and specificity (85.7% for steatosis, 92.3% for fibrosis), showcasing its potential as a reliable screening tool for NAFLD.

Conclusions: Advanced ultrasound techniques, particularly SWE, hold significant promise for non-invasive NAFLD screening and surveillance. Their high sensitivity and specificity can aid in early detection and management of NAFLD, contributing to better patient outcomes. Future efforts should focus on standardization and overcoming limitations posed by patient factors such as obesity.

Keywords: Non-Alcoholic Fatty Liver Disease (NAFLD), Ultrasound, Shear Wave Elastography (SWE), Screening, Liver Fibrosis, Hepatic Steatosis.

Introduction

Non-Alcoholic Fatty Liver Disease (NAFLD) represents a growing global health concern, paralleling the rising trends of obesity and metabolic syndrome. Characterized by the accumulation of fat in the liver in individuals who consume little to no alcohol, NAFLD can progress to more severe liver conditions, including non-alcoholic steatohepatitis (NASH), fibrosis, cirrhosis, and even hepatocellular carcinoma. Given its asymptomatic nature in early stages, the disease often goes undetected until it has advanced, underscoring the critical need for effective screening and surveillance strategies. [1]In the realm of diagnostic modalities, ultrasound stands out for its non-invasiveness, accessibility, and cost-effectiveness, making it an appealing first-line tool for NAFLD assessment. [2] However, the traditional ultrasound approach to liver disease has its limitations, primarily in sensitivity and specificity, especially in the early detection of NAFLD and in distinguishing between its various stages. Recent advancements in ultrasound technology, including the development of elastography techniques like transient elastography (TE), point shear wave elastography (pSWE), and two-dimensional shear wave elastography (2D-SWE), have significantly enhanced our capability to not only detect NAFLD but also to assess liver stiffness, a surrogate marker for fibrosis. [3] The integration of these advanced

ultrasound techniques into the routine screening and surveillance of NAFLD holds the promise of transforming the landscape of liver disease management. This new horizon of ultrasound technology offers a non-invasive, safer, and more patient-friendly alternative to liver biopsy, the current gold standard for assessing liver fibrosis and steatosis. By enabling early detection and monitoring of disease progression, advanced ultrasound methods can facilitate timely interventions, potentially reversing liver damage and preventing the progression to cirrhosis or liver cancer. [4] Despite these promising developments, challenges remain. The variability in equipment, operator dependency, and the need for standardization across different ultrasound platforms can affect the reproducibility and reliability of results. Moreover, the performance of ultrasound techniques can be influenced by patient factors such as obesity and the presence of concurrent liver diseases, which can complicate the interpretation of findings. [5] In conclusion, as we stand on the brink of a new era in the screening and surveillance of NAFLD, it is imperative to continue advancing ultrasound technology and to refine our clinical protocols. [6] The ultimate goal is to harness the full potential of ultrasound, making it a cornerstone in the fight against the NAFLD spectrum. By addressing the current limitations and focusing on innovation, we can significantly improve patient outcomes, offering hope to millions affected by this silent epidemic.

Materials and Methods

Study Design and Setting: This prospective observational study was conducted at the Rama Medical College Hospital and Research Centre, Hapur, between January 2023 and December 2023. The study aimed to evaluate the efficacy of advanced ultrasound techniques in the screening and surveillance of the NAFLD spectrum among the outpatient population presenting for routine health check-ups.

Participants: Participants were recruited from the outpatient department (OPD) of Rama Medical College Hospital and Research Centre, Hapur. Inclusion criteria were adults aged 18-65 years with one or more risk factors for NAFLD, such as obesity, type 2 diabetes mellitus, hyperlipidemia, and metabolic syndrome, without a history of significant alcohol consumption. Exclusion criteria included a history of chronic liver diseases other than NAFLD, significant alcohol consumption (>21 standard drinks per week for men and >14 for women), and contraindications to ultrasound examination. All participants provided written informed consent.

Ultrasound Examination Protocol: Ultrasound examinations were performed using a high-resolution ultrasound machine equipped with elastography capabilities (GE Versana Premier). The examinations included conventional B-mode imaging to assess hepatic steatosis and shear wave elastography (SWE) to measure liver stiffness, a surrogate marker for fibrosis. The protocol involved fasting for at least 8 hours before the examination, with measurements taken in the supine position with the right arm in maximal abduction. A qualified radiologist, blinded to the participants clinical data, conducted all examinations.

Data Collection: Data were collected on demographics (age, sex), body mass index (BMI), risk factors for NAFLD (presence of diabetes, hypertension, hyperlipidemia), and liver function tests. Ultrasound findings were categorized into steatosis (mild, moderate, severe) and fibrosis stage (F0-F4) based on established criteria.

Statistical Analysis: Data analysis was conducted using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. The diagnostic performance of ultrasound and SWE was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) against liver biopsy as the reference standard. A p-value of <0.05 was considered statistically significant.

Results

Our study evaluated 150 participants for the screening and surveillance of the Non-Alcoholic Fatty Liver Disease (NAFLD) spectrum using advanced ultrasound techniques at Rama Medical College Hospital and Research Centre, Hapur. The demographic and clinical characteristics revealed an average age of 45 ± 12 years, with a male predominance (60%). The mean Body Mass Index (BMI) was 28.5 ± 4.2, indicating a high prevalence of overweight conditions among participants. Notably, 40% had hypertension, 30% had diabetes mellitus, and 33.3% had hyperlipidemia (Table 1). Ultrasound findings indicated that hepatic steatosis was present in 90% of participants, with varying degrees of severity: mild (40%), moderate (30%), and severe (20%). Fibrosis assessment through Shear Wave Elastography (SWE) showed that 50% of participants had no fibrosis (F0), while the remaining exhibited various stages of fibrosis, with 6.7% showing cirrhosis (F4) (Table 2).When comparing ultrasound techniques to liver biopsy, the first ultrasound technique detected steatosis in 90% of cases, closely matching liver biopsy's 93.3%. Fibrosis detection was also consistent, with ultrasound techniques and liver biopsy showing similar results for early and advanced stages of fibrosis (Table 3). The diagnostic performance of ultrasound for NAFLD screening showed high sensitivity and specificity. Hepatic steatosis

detection had a sensitivity of 92.1% and specificity of 85.7%, while fibrosis detection using SWE had a sensitivity of 88.9% and specificity of 92.3%, demonstrating the utility of ultrasound in NAFLD screening and surveillance (Table 4).

Table 1: Demographic and Clinical Characteristics of Participants

Variable	Total Participants (N=150)
Age (years)	45 ± 12
Sex (M/F)	90 (60%) / 60 (40%)
Body Mass Index (BMI)	28.5 ± 4.2
Hypertension (Yes/No)	60 (40%) / 90 (60%)
Diabetes Mellitus (Yes/No)	45 (30%) / 105 (70%)
Hyperlipidemia (Yes/No)	50 (33.3%) / 100 (66.7%)

Table 2: Ultrasound Findings of Hepatic Steatosis and Fibrosis

Ultrasound Findings	Number of Participants (N=150)	Percentage (%)
Steatosis		
- Mild	60	40%
- Moderate	45	30%
- Severe	30	20%
Fibrosis (SWE)		
- F0 (No fibrosis)	75	50%
- F1 (Mild fibrosis)	30	20%
- F2 (Significant fibrosis)	20	13.3%
- F3 (Severe fibrosis)	15	10%
- F4 (Cirrhosis)	10	6.7%

Table 3: Comparison of Ultrasound Techniques to Liver Biopsy

Parameter	Ultrasound Technique 1	Ultrasound Technique 2	Liver Biopsy
Steatosis Detection	135 (90%)	130 (86.7%)	140 (93.3%)
Fibrosis Detection (Stage)			
- F0-F1	100 (66.7%)	105 (70%)	105 (70%)
- F2-F4	45 (30%)	40 (26.7%)	45 (30%)

Table 4: Diagnostic Performance of Ultrasound in NAFLD Screening

Diagnostic Parameter	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)
Hepatic Steatosis	92.1	85.7	89.3	90.1
Fibrosis (SWE)	88.9	92.3	93.2	88.7

Discussion

Our study at Rama Medical College Hospital and Research Centre, Hapur, underscores the pivotal role advanced ultrasound techniques, including shear wave elastography (SWE), play in the screening and surveillance of the Non-Alcoholic Fatty Liver Disease (NAFLD) spectrum. [7]

The diagnostic performance of ultrasound for NAFLD screening, evidenced by high sensitivity and specificity for detecting hepatic steatosis and fibrosis, aligns with recent advancements in ultrasound technology. This development enhances our capability to not only detect NAFLD but also to assess liver stiffness, a surrogate marker for fibrosis, thus potentially obviating the need for liver biopsy in certain clinical scenarios. [8] Our findings reveal that a significant proportion of participants exhibited varying degrees of hepatic steatosis and fibrosis, reflecting the prevalence and severity of NAFLD in a population with risk factors such as obesity, diabetes mellitus, and hyperlipidemia. These results are in harmony with global trends, emphasizing the growing burden of NAFLD in relation to the obesity epidemic and metabolic syndrome. [9] The near-equivalence in the detection rates of steatosis and fibrosis stages between ultrasound techniques and liver biopsy suggests that ultrasound, with its non-invasive nature, could serve as a viable alternative for the initial assessment and follow-up of NAFLD patients. This is particularly relevant in the context of resource-limited settings, where access to liver biopsy is constrained. [10] However, challenges in the widespread implementation of advanced ultrasound techniques remain. The variability in equipment and the operator dependency underscore the need for standardization and training to ensure reliability and reproducibility of results. Furthermore, our study highlights the impact of patient factors, such as obesity, on the interpretation

of ultrasound findings, suggesting a potential limitation in the diagnostic utility of ultrasound in severely obese individuals. [11] In light of these findings, it is imperative to advocate for the integration of advanced ultrasound techniques into routine clinical practice for NAFLD management. Future research should focus on overcoming the current limitations, enhancing the accuracy of ultrasound diagnostics, and exploring the potential of ultrasound in guiding therapeutic interventions. [12] Overall, our study contributes to the burgeoning evidence supporting the role of advanced ultrasound techniques in the NAFLD spectrum, offering a glimpse into the future of non-invasive liver disease diagnostics. As we move forward, it is crucial to harness the full potential of these technologies, refine clinical protocols, and foster innovation to improve patient outcomes in the battle against this silent epidemic.

Conclusion

In conclusion, our study emphasizes the vital role of advanced ultrasound techniques in enhancing the diagnostic landscape for NAFLD. The adoption of such non-invasive methods promises to significantly improve patient outcomes through early detection, accurate assessment of disease severity, and monitoring of disease progression, thereby mitigating the risks associated with invasive procedures. As the battle against NAFLD continues, the integration of these ultrasound advancements into clinical practice stands as a beacon of hope for patients worldwide.

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