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Original article

Shear Wave Elastography in NAFLD: A One-Year Cross-Sectional Assessment of Hepatic Fibrosis in a Tertiary Care Setting

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Abstract

Background: *Non-Alcoholic Fatty Liver Disease (NAFLD) is a leading cause of chronic liver disease worldwide, often progressing silently from simple steatosis to fibrosis and cirrhosis. Early and accurate detection of hepatic fibrosis is crucial for risk stratification and management. Shear Wave Elastography (SWE) offers a non-invasive alternative to liver biopsy for assessing liver stiffness, a surrogate marker of fibrosis.*

Objectives: *To assess the grade of hepatic fibrosis in patients with NAFLD using Shear Wave Elastography in a tertiary care hospital.*

Materials and Methods: *A cross-sectional observational study was conducted on 53 patients diagnosed with fatty liver on ultrasonography, selected using systematic random sampling. SWE was performed using the Mindray Resona i9 ultrasound system to assess liver stiffness in kilopascals (kPa). Statistical analysis included ANOVA, Kruskal-Wallis, and Chi-square tests.*

Results: *The majority (67.9%) of patients had Grade I liver stiffness, while 28.3% had Grade II. No statistically significant associations were observed between liver stiffness and BMI, age, sex, or other risk factors. A trend of increasing stiffness with fatty liver severity was observed but was not statistically significant.*

Conclusion: *SWE is a promising non-invasive tool for grading hepatic fibrosis in NAFLD patients, particularly in early detection and monitoring.*

Keywords: *Non-alcoholic Fatty Liver Disease, Elastography, Liver Cirrhosis*

Introduction

Non-Alcoholic Fatty Liver Disease (NAFLD) is emerging as the most common chronic liver condition globally, closely associated with the increasing prevalence of obesity, metabolic syndrome, and type 2 diabetes mellitus [1]. It is characterized by excessive fat accumulation in the liver in the absence of significant alcohol consumption, NAFLD ranges from simple steatosis to non-alcoholic steatohepatitis (NASH), which can progress to fibrosis, cirrhosis, and hepatocellular carcinoma [2-5]. Early identification and grading of hepatic fibrosis are crucial for timely intervention and prognosis.

Traditionally, liver biopsy has been considered the gold standard for assessing fibrosis. However, it is invasive, costly, and associated with potential complications. In recent years, non-invasive imaging modalities such as Shear Wave Elastography (SWE) have gained attention for their accuracy and safety in evaluating liver stiffness, a surrogate marker of fibrosis [6,7]. SWE provides real-time, quantitative measurements of tissue stiffness and has shown promise in differentiating stages of hepatic fibrosis.

The purpose of this study is to assess the grade of hepatic fibrosis in patients with NAFLD using Shear Wave Elastography. Conducted over a one-year period in a tertiary care hospital, this cross-sectional study aims to evaluate the utility of SWE as a reliable, non-invasive tool for fibrosis grading in clinical practice.

Methodology

This hospital-based cross-sectional observational study was conducted over a one-year period, from January 1st to December 31st, 2024, at the Radiology Department of KLE's Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi. The study population consisted of patients referred for ultrasonography and found to

have fatty liver on imaging. A systematic random sampling technique was employed, wherein every alternate patient meeting the inclusion criteria was selected until the required sample size was achieved. Based on a calculated prevalence of 25.2% for NAFLD, an estimated sensitivity of 90%, and an absolute precision of 18%, the minimum required sample size was 43. To account for variability and ensure robustness, a total of 53 patients were ultimately included.

Inclusion criteria comprised adult patients (above 18 years of age) with ultrasonographic evidence of fatty liver, irrespective of gender, and those willing to provide written informed consent. Exclusion criteria included individuals with significant alcohol consumption (>20g/day for women and >30g/day for men), chronic viral hepatitis, other metabolic or genetic liver diseases, advanced liver disease, and the paediatric population. Institutional Ethical Committee clearance was obtained, and all participants were informed about the nature, risks, and benefits of the study before obtaining consent.

Data were collected using a pre-designed, pre-tested questionnaire that captured demographic, anthropometric, clinical, and lifestyle data. Measurements such as height and weight were obtained using standard tools. Fatty liver grading was done using B-mode ultrasonography, and hepatic fibrosis was assessed using 2D Shear Wave Elastography (SWE) on a Mindray Resona i9 ultrasound machine equipped with a SC6-1s curvilinear probe (1–6 MHz). SWE provided real-time quantitative measurements of liver stiffness in kilopascals (kPa), which were categorized into fibrosis grades based on established cutoffs.

Statistical analysis was carried out using appropriate methods. Descriptive statistics included mean, median, and standard deviation. Inferential statistical tests were applied to examine associations between liver stiffness and variables such as age, BMI, and lifestyle factors. ANOVA, Kruskal-Wallis, t-tests, and Chi-square tests were used based on the nature of the data. All findings were recorded and tabulated using Microsoft Excel, and statistical significance was considered at $p < 0.05$.

Results

General Characteristics of the Study Population

The study included 53 participants, with 29 males (54.7%) and 24 females (45.3%). The age ranged from 28 to 80 years, with a mean age of approximately 49.5 years. The average height was 158.5 ± 8.8 cm and mean weight was 71.2 ± 12.1 kg. The average BMI was 28.4 kg/m², with the majority of participants classified as overweight (48.1%) or Obese Class I (23.1%). Most patients followed a mixed diet (77.4%), 15.1% reported occasional alcohol consumption within the permitted limits, and 37.7% had hypertension. Only 15% were diabetics, and 43.4% reported regular physical exercise. Hepatomegaly was observed in 28.3% of participants. Grade I fatty liver was the most common (67.9%), followed by Grade II (30.2%) and Grade III (1.9%). Mean liver stiffness measured by SWE was 8.02 kPa (range: 4.0 – 12.3 kPa).

Most participants (67.9%) had Grade I liver stiffness, indicating mild fibrosis. A notable 28.3% had Grade II fibrosis, while only 3.8% showed no fibrosis. This suggests that a substantial portion of NAFLD patients already exhibit measurable liver stiffness, highlighting the utility of SWE in early detection (Table 1).

Table 1: Distribution of Liver Stiffness Grades (Shear Wave Elastography)

Liver Stiffness Grade	Frequency (n)	Percentage (%)
Grade 0 (≤6.0 kPa)	2	3.8%
Grade I (6.1–7.9 kPa)	36	67.9%
Grade II (8.0–10.9 kPa)	15	28.3%

Although liver stiffness appeared higher in overweight and obese individuals, the difference across BMI categories was not statistically significant ($p = 0.273$). This suggests that while BMI may influence fibrosis, other metabolic or genetic factors likely contribute to liver stiffness progression in NAFLD patients (Table 2).

Table 2: Association of Liver Stiffness Grade with BMI Category

BMI Category	Grade 0	Grade I	Grade II	Total	p-value
Normal (18.5–24.9)	1	6	3	10	0.273
Overweight (25–29.9)	1	17	8	26	
Obese Class I (30–34.9)	0	8	4	12	
Obese Class II+ (≥35)	0	5	0	5	

Although liver stiffness appeared higher in overweight and obese individuals, the difference across BMI categories was not statistically significant (p = 0.273). This suggests that while BMI may influence fibrosis, other metabolic or genetic factors likely contribute to liver stiffness progression in NAFLD patients (Table 3).

Table 3: Association of Liver Stiffness Grade with Fatty Liver Grade

Fatty Liver Grade	Grade 0 (n=2)	Grade I (n=36)	Grade II (n=15)	Total	p-value
Grade I	1	25	10	36	0.161
Grade II	1	10	5	16	
Grade III	0	1	0	1	

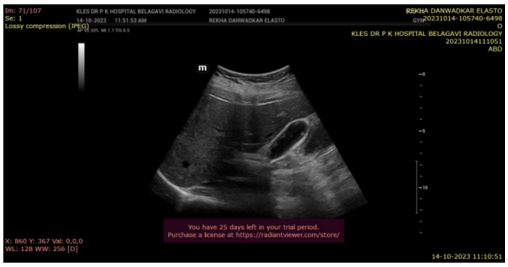
There was no statistically significant association between liver stiffness and common risk factors like hypertension, diabetes, hepatitis, or exercise. This implies that fibrosis progression in NAFLD may be multifactorial and not solely dependent on these conventional clinical parameters (Table 4).

Table 4: Association of Liver Stiffness Grade with Risk Factors

Risk Factor	Grade 0	Grade I	Grade II	P-value
Hypertension (Yes)	0	12	8	0.124
Diabetes (Yes)	0	6	2	0.397
Regular Exercise (Yes)	1	18	4	0.521
History of Hepatitis	0	1	0	0.78
Blood Transfusion	0	3	3	0.85

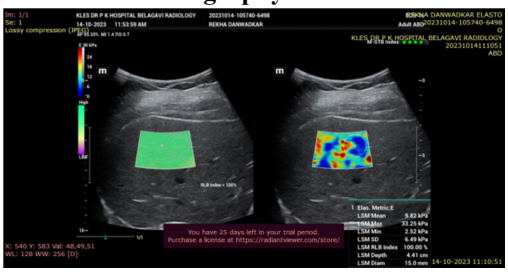
Case I :45 year old female , cook by profession with a BMI of 33.8 kg/m^2 came to OPD for routine check-up and was advised USG abdomen and pelvis

Gray scale ultrasound:



(There is increase in the echogenicity if the liver parenchyma however the periportal echogenicities are preserved suggestive of Grade I fatty infiltration)

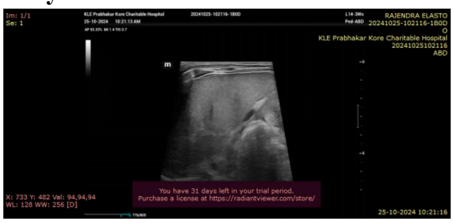
Shear wave elastography :



(Circle is placed in the ROI box in homogenous colour area and 5-6 values were recorded and mean kPa values considered)

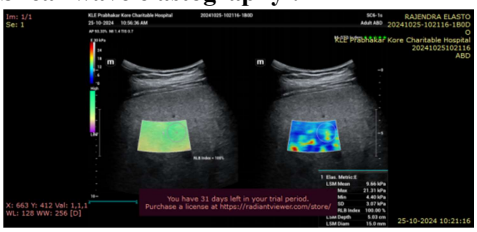
Case 2: 48 year old male , pharmacist by occupation came to OPD for complaint of acidity and upper gastrointestinal discomfort. The patient was advised USG abdomen and pelvis.

Gray scale ultrasound:



(There is increase in the echogenicity if the liver parenchyma with loss of periportal echogenicities are preserved suggestive of Grade I fatty infiltration)

Shear wave elastography :



(Circle is placed in the ROI box in homogenous colour area and 5-6 values were recorded and mean kPa values considered)

Discussion

This study demonstrated that Shear Wave Elastography (SWE) effectively detects early-stage hepatic fibrosis in NAFLD patients. Among 53 participants, 67.9% exhibited Grade I liver stiffness, while 28.3% had Grade II fibrosis. The mean liver stiffness was 8.02 kPa, suggesting that a significant proportion of patients already exhibit measurable fibrosis, even in the absence of severe clinical symptoms or comorbidities. Interestingly, there was no statistically significant association between liver stiffness and common metabolic risk factors such as BMI, diabetes, hypertension, or exercise, implying that other intrinsic factors may contribute to fibrosis progression in NAFLD.

NAFLD is characterized by hepatic fat accumulation not caused by alcohol, progressing from simple steatosis to non-alcoholic steatohepatitis (NASH) and ultimately fibrosis. Fibrosis occurs due to chronic low-grade inflammation, lipotoxicity, and insulin resistance, leading to extracellular matrix deposition and increased liver stiffness. Our findings of higher fibrosis rates in overweight and obese patients, despite not reaching statistical significance, are biologically plausible given the established role of adipose tissue in promoting systemic inflammation and hepatic fibrogenesis.

In a comparable hospital-based cross-sectional study of 154 patients, SWE effectively differentiated between low and high fibrosis stages using a stiffness threshold of 6.1 kPa, with a reported sensitivity of 83% and specificity of 92.7% (Vinyasa & Patil, 2022) [8]. Our mean SWE value of 8.02 kPa suggests a fibrosis level consistent with their moderate fibrosis group, reinforcing the utility of SWE for identifying at-risk patients even in asymptomatic or early stages.

Similarly, a study by Kelkar et al. found that 60% of NAFLD patients had significant fibrosis (≥F2) using SWE, which strongly correlated with FIB-4 and APRI scores (Kelkar et al., 2024) [9]. While our study did not observe statistically significant associations between fibrosis and diabetes, hypertension, or exercise, their findings highlight the need for a multi-parameter diagnostic approach combining SWE with biochemical markers.

Another study by Kasireddy et al. reported that patients with more components of metabolic syndrome and higher grades of fatty liver had significantly increased risk of advanced fibrosis, with SWE identifying F3-F4 fibrosis at higher odds (OR up to 13.7) (Kasireddy et al., 2021) [10]. While our study found that liver stiffness was higher in overweight and obese individuals, the lack of statistical significance ($p = 0.273$) suggests potential confounding factors such as insulin resistance or genetic predisposition not captured in our dataset.

Moreover, advanced fibrosis was reliably identified in a European multicenter study using the ElastPQ SWE method, with a threshold of ≥10.4 kPa indicating cirrhosis (F4), showing strong diagnostic accuracy (AUROC 0.949) (Bauer et al., 2022) [11]. Our highest recorded stiffness value (12.3 kPa) likely corresponds with early cirrhosis, confirming the threshold's clinical relevance. Animal model studies have further supported SWE's accuracy, demonstrating excellent correlation between liver stiffness and histologic fibrosis (AUC > 0.92) (Kang et al., 2015), reinforcing its value in both research and clinical settings [12].

Conclusion

The observed liver stiffness distribution in our cohort is consistent with prior studies, reinforcing SWE as a sensitive, non-invasive method for fibrosis assessment in NAFLD. However, our findings also highlight the multifactorial nature of fibrosis, suggesting that integrating SWE with clinical and biochemical indices may enhance diagnostic accuracy and risk stratification.

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