Ultrasound Shear Wave Elastographic Evaluation of Liver in Non-Alcoholic Fatty Liver Disease: A Hospital-Based Cross-Sectional Study

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Abstract: *Background: Non-Alcoholic Fatty Liver Disease (NAFLD) is a major cause of chronic liver disease, particularly in South Asia, with significant progression risks to fibrosis, cirrhosis, and hepatocellular carcinoma. Shear Wave Elastography (SWE) is a non-invasive alternative to liver biopsy for assessing liver stiffness and detecting fibrosis. Objective: To evaluate the utility of SWE in identifying liver fibrosis in NAFLD patients and to analyse associated risk factors in the Saurashtra population. Methods: A cross-sectional study was conducted on 100 NAFLD patients from September 2022 to September 2023. Patients underwent B-mode ultrasound and SWE using Samsung RS80A with Prestige. Liver stiffness was categorized into normal (<5.7 kPa), dysfunction (<8 kPa), and fibrosis (>8 kPa). Risk factors such as age, BMI, diabetes, and hypertension were examined. Results: Liver dysfunction or fibrosis was observed in 34% of patients, with 9% showing significant fibrosis (>8 kPa). Risk Factors: 1) Obesity (BMI > 25): 58% of fibrosis cases (OR = 7.9). 2) Diabetes: 57% of fibrosis cases (OR = 3.3). 3) Age >60 years: 41% of fibrosis cases (OR = 1.8). 4) Higher grades of fatty liver correlated with increased fibrosis, though the association was not statistically significant (p = 0.13). Conclusion: SWE is a reliable, non-invasive diagnostic tool for detecting liver fibrosis in NAFLD patients. It highlights the importance of addressing modifiable risk factors such as obesity and diabetes to prevent progression to irreversible liver damage. Multi-center and longitudinal studies are recommended for further validation.*

Keywords: Non-Alcoholic Fatty Liver Disease, Shear Wave Elastography, Liver Fibrosis, Obesity, Diabetes, Ultrasound Imaging, Saurashtra Population

1. Introduction

Non-Alcoholic Fatty Liver Disease (NAFLD) is a prevalent public health concern, particularly in South Asia, with a reported prevalence of 49.2% in India. NAFLD encompasses a wide clinical spectrum, from benign hepatic steatosis to non-alcoholic steatohepatitis (NASH), fibrosis, cirrhosis, and, in severe cases, hepatocellular carcinoma. Risk factors like obesity, diabetes, and metabolic syndrome are strongly associated with disease progression.

Liver biopsy remains the gold standard for diagnosing and staging NAFLD. However, its invasive nature limits its utility as a screening tool. Consequently, non-invasive techniques, such as Shear Wave Elastography (SWE), have gained prominence. SWE assesses liver stiffness, correlating it with fibrosis severity, and offers a cost-effective and patient-friendly alternative for early detection. This study evaluates SWE's efficacy in detecting fibrosis among NAFLD patients in the Saurashtra region of Gujarat, with an emphasis on associated risk factors and clinical correlations.

2. Materials and Methods

a) **Study Design:** Cross-sectional hospital-based study on 100 patients conducted over one year (Sept 2022 - Sept 2023).

b) **Inclusion Criteria:** Patients with fatty infiltration on ultrasound or abnormal liver function tests.

c) **Exclusion Criteria:** Alcoholic patients, metabolic liver disease, chronic viral hepatitis, and acute liver injury.

d) **Technique:** Samsung RS80A with Prestige for shear wave elastography.
   - Region of interest (ROI) placed 1.5–2 cm under the liver capsule, avoiding the left lobe and vasculature.
   - Liver stiffness measured in kPa with a median of 10 readings.

Table 1: Stiffness Grading:

Condition	Stiffness (kPa)
Normal	<5.7
Dysfunction (F1)	<8
Fibrosis (F2 or F3)	>8
Cirrhosis (F4)	>17

Data Collection and Analysis
- Demographics, clinical history, and SWE results were recorded in **Microsoft Excel**.
- Associations and odds ratios for risk factors were calculated using **Chi-square tests**. A **p-value < 0.05** indicated significance.

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3. Results

1) Demographics

a) Gender Distribution:
- **Male**: 40%
- **Female**: 60%

b) Age Group Distribution:
- Highest prevalence of liver dysfunction and fibrosis observed in the **61–70 years** age group (20%).

Table 2

Characteristic	Number of Patients (n=100)	Percentage
Gender (Male)	40	40%
Gender (Female)	60	60%
Age Group (Years)		
20–30	15	15%
31–40	20	20%
41–50	25	25%
51–60	20	20%
61–70	20	20%

2) Risk Factors
Most Common Risk Factors:
- Overweight/Obesity (BMI > 25): **55%**
- Diabetes: **42%**
- Smoking History: **37%**
- Hypertension: **33%**

Table 3

Risk Factor	Number of Patients	Percentage
BMI > 25 (Overweight/Obese)	55	55%
Diabetes	42	42%
Hypertension	33	33%
Smoking History	37	37%

3) Association Between Fatty Liver Grades and Fibrosis
Fibrosis Distribution Across Fatty Liver Grades:
a) **Grade 1**:
- No Fibrosis: **58 cases**
- Dysfunction (5.7–8 kPa): **17 cases**
- Fibrosis (>8 kPa): **6 cases**
b) **Grade 2:**
- No Fibrosis: **6 cases**
- Dysfunction: **7 cases**
- Fibrosis: **2 cases**
c) **Grade 3:**
- No Fibrosis: **2 cases**
- Dysfunction: **1 case**
- Fibrosis: **1 case**

Table 4

Fatty Liver Grade	No Fibrosis	Dysfunction (5.7–8 kPa)	Fibrosis (>8 kPa)
Grade 1	58	17	6
Grade 2	6	7	2
Grade 3	2	1	1

4) Risk Factors in Patients with Dysfunction and Fibrosis
Among patients with liver dysfunction or fibrosis (**n=34**):
- BMI > 25: **58%**
- Diabetes: **57%**
- Age > 60 years: **41%**

Table 5

Current Study	Diabetics had higher fibrosis prevalence (OR 3.3).
BMI > 25	58%
Diabetes	57%
Age > 60 Years	41%

5) Odds Ratios for Risk Factors
Risk Factor Contribution:
- BMI > 25: **7.9**
- Diabetes: **3.3**
- Age > 60 years: **1.8**

Table 6

Current Study	Diabetics had higher fibrosis prevalence (OR 3.3).
BMI > 25	58%
Diabetes	57%
Age > 60 Years	41%

4. Discussion

This study sheds light on the epidemiology of liver dysfunction and fibrosis in NAFLD patients using shear wave elastography (SWE). Key findings are detailed below:

1) Age-Related Trends
- Fibrosis and dysfunction were most prevalent in patients aged 61–70 years.
- Older age groups are more susceptible due to cumulative metabolic insults.
- Comparison with literature

Table 7

Study	Age Group Most Affected
Frith J et al.	≥ 60 years
Current Study	61–70 years

2) Gender Trends
- Equal prevalence among males and females in older age groups, likely due to the loss of oestrogen's protective effect post-menopause.
- Comparison with literature:

Table 8

Study	Key Observation
• Lonardo A et al.	• Post-menopausal women show increased fibrosis risk.
• Current Study	• Similar prevalence in men and post-menopausal women.

3) Diabetes and Fibrosis
- Diabetes was a significant risk factor, with 57% of fibrosis cases observed in diabetic patients.
- Hyperglycaemia's role in hepatocyte injury and diabetic hepatopathy contributes to fibrosis progression.
- Comparison with literature:

Table 9

Study	Key Observation
Porepa L et al.	Higher liver disease risk in diabetics.
Current Study	Diabetics had higher fibrosis prevalence (OR 3.3).
BMI > 25	58%
Diabetes	57%
Age > 60 Years	41%

4) Obesity and Fibrosis
- Obesity emerged as a dominant risk factor, with 58% of fibrosis cases occurring in overweight/obese individuals.
- Obesity-associated inflammation and insulin resistance are major contributors.
- Comparison with literature:

Table 10

Study	Key Observation
Vernon G et al.	NAFLD severity correlates with metabolic conditions.
Current Study	Obesity increases fibrosis risk (OR 7.9).

5) Fatty Liver Grades and Fibrosis
- While fibrosis increased with higher fatty liver grades, the association was not statistically significant (p = .13).
- This highlights the multifactorial nature of fibrosis development, influenced by co-existing metabolic conditions.
- Comparison with literature:

Table 11

Study	Key Observation
Seeberg et al.	Fibrosis correlates with steatosis and metabolic factors.
Current Study	No significant correlation between fatty grades and fibrosis.

6) Clinical Implications
- Role of SWE:
  SWE offers a non-invasive, reproducible method to detect liver stiffness early, enabling timely interventions.
- Risk Factor Modification:
  Addressing obesity, diabetes, and hypertension through lifestyle or medical interventions can significantly reduce fibrosis progression.

5. Limitations

1) Single-center study limits generalizability.
2) Lack of histological confirmation restricts validation.
3) Overlapping risk factors (e.g., diabetes and obesity) complicate isolation of independent effects.

6. Conclusion

This study highlights the effectiveness of **Shear Wave Elastography (SWE)** as a non-invasive and reliable tool for detecting liver fibrosis in **Non-Alcoholic Fatty Liver Disease (NAFLD)**. Key findings include:
1) **Prevalence**: Liver dysfunction or fibrosis was present in 34% of patients, with 9% showing advanced fibrosis (>8 kPa).

2) **Risk Factors**:
- **Obesity (BMI > 25)** was the most significant predictor (OR = 7.9).
- **Diabetes (OR = 3.3)** and **age >60 years (OR = 1.8)** also strongly correlated with fibrosis.
3) **Fatty Liver Grades**: Higher grades of fatty liver showed a slight predilection for fibrosis, though not statistically significant (p = 0.13).

Clinical Implications: SWE offers a practical alternative to liver biopsy, enabling early diagnosis and monitoring of fibrosis. Interventions targeting modifiable risk factors, such as obesity and diabetes, are critical for preventing progression to irreversible liver damage.

7. Limitations

The single-centre design, lack of histological confirmation, and overlapping risk factors necessitate further multi-centre and longitudinal studies to validate these findings. SWE holds significant potential for the early detection and management of NAFLD, reducing the burden of advanced liver disease through timely intervention.

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