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Liver Stiffness Measurement as a Diagnostic Tool for Cirrhosis in Chronic Liver Disease: An Accuracy Assessment

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Abstract **Original Research Article**

Background: Chronic liver disease (CLD) is a significant global health burden, often progressing to cirrhosis. Early and accurate diagnosis of cirrhosis is critical for effective management and treatment. Liver stiffness measurement (LSM) is a non-invasive technique that has shown promise in diagnosing cirrhosis in CLD patients. ***Aim of the study:*** The present study aims to assess the accuracy of LSM for diagnosing cirrhosis in a diverse cohort of CLD patients. ***Methods:*** This observational study included 100 CLD patients diagnosed with varying etiologies of liver disease. LSM was performed to assess liver stiffness, and its diagnostic accuracy was evaluated using sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy. Comparisons were made between LSM and other diagnostic tools, including liver biopsy, imaging, and clinical assessments. ***Result:*** LSM demonstrated a sensitivity of 90%, specificity of 85%, and an accuracy of 87.5% for diagnosing cirrhosis, with optimal cutoff values of 10, 12.5, and 15 kPa. Multivariate analysis identified liver stiffness as a significant predictor of liver disease progression. Compared to the APRI and FIB-4 scores, LSM showed superior diagnostic performance across all metrics. ***Conclusion:*** LSM is a reliable and accurate non-invasive tool for diagnosing cirrhosis in CLD patients. It outperforms traditional biomarkers and clinical assessments, offering a promising alternative to liver biopsy. Further studies are warranted to validate its use in diverse populations and clinical settings.

Keywords: Liver stiffness measurement, Cirrhosis, Chronic liver disease, Diagnostic accuracy, Non-invasive diagnostics, APRI, FIB-4, Liver biopsy.

INTRODUCTION

Chronic liver disease (CLD) represents a significant global health challenge, particularly in developed countries where lifestyle factors such as excessive alcohol consumption, obesity, and metabolic syndrome are major contributors [1]. Regardless of the underlying etiology whether toxic, genetic, autoimmune, or infectious all CLDs share a common pathological progression marked by hepatic fibrosis, which can eventually lead to cirrhosis [2]. Cirrhosis, characterized by the replacement of normal liver tissue with scar tissue, is associated with severe complications, including portal hypertension, ascites, variceal bleeding, spontaneous bacterial peritonitis and hepatocellular carcinoma (HCC), all of which contribute to the high mortality rate associated with the disease [1-3]. Early identification of cirrhosis is critical, especially in patients with compensated liver disease, as clinical manifestations like encephalopathy, ascites, or jaundice often arise only in advanced stages [3]. Without timely diagnosis, the disease progresses rapidly, reducing survival rates and patient quality of life. The accurate evaluation of liver fibrosis is essential for guiding therapeutic decisions, predicting prognosis, and managing the risk of liver-related complications in CLD patients [4]. Traditionally, liver biopsy (LB) has been considered the "gold standard" for assessing fibrosis severity. While LB provides high diagnostic accuracy, it has significant limitations. These include invasiveness, the risk of serious complications such as bleeding or pneumothorax, and intra- and inter-observer variability in histopathological interpretation [5,6]. Furthermore, LB is not suitable for repeated assessments due to its invasiveness and potential for sampling error, which limits its utility in the routine monitoring of disease progression or regression [7]. Despite these drawbacks, LB remains the reference method for liver fibrosis staging due to the lack of a universally accepted, non-invasive alternative [8-9]. These limitations have driven

the search for non-invasive, accurate, and reproducible alternatives for fibrosis assessment. In recent years, liver stiffness measurement (LSM) using transient elastography (TE) has emerged as a promising non-invasive technique for evaluating liver fibrosis [10]. TE measures the velocity of a shear wave propagated through the liver, which correlates with the stiffness of the liver tissue and, by extension, the degree of fibrosis [11]. Studies have demonstrated that LSM is a reliable tool for assessing liver fibrosis, with high sensitivity and specificity for detecting significant fibrosis and cirrhosis across various liver diseases, including chronic hepatitis C, HIV-HCV co-infection, and cholestatic liver diseases such as primary biliary cirrhosis and primary sclerosing cholangitis [4,12]. Furthermore, LSM has been shown to predict complications associated with cirrhosis, particularly portal hypertension [13]. Despite the recent introduction of liver stiffness measurement (LSM), its long-term prognostic value in large cohorts of patients with cirrhosis remains underexplored, requiring further prospective studies over the coming years [14]. Therefore, a comprehensive understanding of the diagnostic accuracy of LSM, particularly in patients with varying etiologies of chronic liver disease (CLD), is crucial to enhance its effectiveness and optimize its application in clinical practice. Therefore, the present study aims to assess the accuracy of LSM for diagnosing cirrhosis in a diverse cohort of CLD patients, identify optimal cutoff values for clinical application, and analyze histological features in cases of diagnostic discordance.

METHODOLOGY & MATERIALS

This was a cross-sectional, observational study conducted at the Department of Medicine in Comilla Medical College Hospital, Cumilla, Bangladesh. The aim was to evaluate the diagnostic accuracy of liver stiffness measurement (LSM) and its relationship with liver disease progression in patients diagnosed with chronic liver disease (CLD) during 6 months from July 2024 to December 2024. The study was approved by the institutional ethics committee of Comilla Medical College Hospital, and written informed consent was obtained from all participants. Based on clinical, biochemical, and imaging criteria, the study included 100 adult patients diagnosed with chronic liver disease.

Inclusion criteria:

- Adults aged 18 years and above.
- Confirmed diagnosis of chronic liver disease due to various etiologies such as viral hepatitis (B and C), alcoholic liver disease, and non-alcoholic steatohepatitis (NASH).

Exclusion criteria:

- Pregnancy or lactation.
- Hepatocellular carcinoma.
- Significant comorbid conditions that could interfere with liver disease assessment (e.g., severe renal insufficiency, active malignancy).
- Previous liver transplantation or major abdominal surgery.

Data Collection:

Data were collected using a structured questionnaire and patient medical records, documenting key variables such as demographic information (age, gender, and comorbidities like diabetes mellitus, hypertension, cardiovascular disease, and chronic kidney disease). Clinical history, including the etiology of liver disease (Hepatitis B, Hepatitis C, alcoholic liver disease, and NASH), was recorded. Laboratory parameters such as liver function tests (AST, ALT, ALP, GGT, bilirubin, albumin), complete blood count (platelet count), prothrombin time (INR), creatinine levels, cholesterol, and triglycerides were also documented. Additionally, diagnostic methods including liver biopsy, imaging (ultrasound, CT, MRI), and clinical assessments were considered.

Diagnostic Evaluation:

The diagnostic evaluation for liver disease involved several non-invasive and invasive tests. Liver Stiffness Measurement (LSM) using transient elastography (FibroScan®) was performed to assess liver stiffness, with results measured in kilopascals (kPa) and interpreted based on established cutoff values (10 kPa, 12.5 kPa, 15 kPa) to determine liver fibrosis and cirrhosis. Additionally, the APRI score and FIB-4 index were calculated for each participant to evaluate the stage of liver fibrosis and compare diagnostic accuracy with LSM. The severity of liver disease was further assessed using the Child-Pugh score (ranging from A to C) and the MELD score, which estimates mortality risk based on laboratory parameters. In a subset of 30 patients, liver biopsy was performed to serve as the gold-standard reference for diagnosing and staging liver fibrosis and cirrhosis.

Statistical Analysis:

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 26. Descriptive statistics, including frequencies, percentages, and mean ± standard deviation (SD), were used to summarize the demographic and clinical characteristics of the study population. Continuous variables were compared using the Student's t-test or ANOVA, and categorical variables were analyzed using the chi-square test. The diagnostic performance of LSM, APRI, and FIB-4 index was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy at various cutoff values. Multivariate logistic regression analysis was conducted to identify independent risk factors associated with liver disease progression. The odds ratios (OR) and 95% confidence intervals (CI) were calculated for each factor.

RESULTS

Table 1 highlights the demographic and clinical characteristics of the study cohort, with a mean age of 52.4±11.2 years and a body mass index (BMI) of 27.3±4.5 kg/m². Gender distribution was fairly balanced, with 60% of participants being male. The most common comorbidities were hypertension (45%), diabetes mellitus (30%), and cardiovascular disease (25%). Regarding the etiology of liver disease, Hepatitis B and non-alcoholic steatohepatitis (NASH) were the most prevalent, each affecting 30% of participants. Table 2 reports the biochemical parameters of the patients, with notable liver function test abnormalities. The mean levels for AST and ALT were 75.4±20.3 U/L and 82.1±25.7 U/L, respectively, indicating significant hepatocellular injury. The mean bilirubin level was 2.1±1.0 mg/dL, and serum albumin was low at 3.5±0.8 g/dL, reflecting impaired liver function. Platelet count (140±50 ×10⁹/L) and prothrombin time (INR 1.4±0.2) further suggested liver dysfunction, with an average creatinine level of 1.1 ± 0.4 mg/dL indicating potential kidney involvement. Liver biopsy, imaging, and clinical diagnosis each contributed to the diagnosis in 30% of patients, with imaging being the most frequently used method (40%). The Child-Pugh score, a widely used liver disease severity scoring system, had a mean of 7±2, and the MELD score, which predicts mortality risk, averaged 12±4 (Table 3). Table 4 presents the performance of non-invasive diagnostic tools for liver stiffness measurement. The most commonly used methods were liver stiffness measurement (LSM) (70%), APRI score (50%), and FIB-4 index (60%). The mean LSM value was 16.3±5.2 kPa, with an interquartile range from 12.5 to 18.2 kPa, indicating varying degrees of liver fibrosis. A significant positive correlation was observed between liver stiffness (OR 1.85, $p < 0.001$) and disease progression. Lower platelet count (OR 0.92) and lower serum albumin (OR 0.76) were inversely associated with disease progression, while a higher AST/ALT ratio (OR 2.10) indicated worse liver function (Table 5). Table 6 evaluates the diagnostic accuracy of various LSM cutoff values. At a cutoff of 10 kPa, LSM demonstrated excellent sensitivity (95%) and moderate specificity (75%), yielding an accuracy of 85%. At 12.5 kPa, sensitivity was slightly lower (90%), but specificity increased to 85%, improving the overall accuracy to 87.5%. A higher cutoff of 15 kPa yielded a sensitivity of 85% and specificity of 92%, achieving the highest accuracy of 88.5%. LSM had the highest sensitivity (90%), specificity (85%), and accuracy (87.5%), outperforming the APRI score (72.5%) and FIB-4 index (79%) (Table 7). These findings suggest that LSM is the most reliable diagnostic method for assessing liver fibrosis and cirrhosis in chronic liver disease patients.

Table 1: Demographic and Clinical Characteristics of Study Participants (N=100)

Variables	Frequency (N)	Percentage (%)
	Mean±SD	
Age (in years)	52.4 ± 11.2	
BMI (kg/m²)	27.3 ± 4.5	
Gender		
Male	60	60.00
Female	40	40.00
Comorbidities		
Diabetes mellitus	30	30.00
Hypertension	45	45.00
Chronic kidney disease	20	20.00
Cardiovascular disease	25	25.00
Etiology of liver disease		
Hepatitis B	35	35.00
Hepatitis C	20	20.00
Alcoholic liver disease	15	15.00
Non-alcoholic steatohepatitis (NASH)	30	30.00

Table 2: Laboratory Test Results of Study Participants

Variables	Mean±SD
AST (U/L)	75.4 ± 20.3
ALT (U/L)	82.1 ± 25.7
ALP (U/L)	120.5 ± 30.2
GGT (U/L)	90.2 ± 28.9
Bilirubin (mg/dL)	2.1 ± 1.0
Albumin (g/dL)	3.5 ± 0.8
Platelet count (×10⁹/L)	140 ± 50
Prothrombin time (INR)	1.4 ± 0.2
Creatinine (mg/dL)	1.1 ± 0.4
Cholesterol (mg/dL)	180 ± 35
Triglycerides (mg/dL)	160 ± 40

Table 3: Diagnostic Methods and Scores for Liver Disease Assessment

Variables	Frequency (N)	Percentage (%)
Diagnosis Method		
Liver Biopsy	30	30.00
Imaging	40	40.00
Clinical	30	30.00
Child-Pugh Score (Mean ± SD)	7 ± 2	
MELD Score (Mean ± SD)	12 ± 4	

Table 4: Diagnostic Tools and Liver Stiffness Measurement in the Study Cohort

Variables	Frequency (N)	Percentage (%)
Diagnostic Method		
Liver Stiffness Measurement (LSM)	70	70.00
APRI Score	50	50.00
FIB-4 Index	60	60.00
LSM Value (kPa) (Mean ± SD)	16.3 ± 5.2	
Interquartile Range (IQR)	12.5–18.2 kPa	

Table 5: Multivariate Analysis of Risk Factors for Liver Disease Progression

Variable	Odds Ratio (95% CI)	p-value
Liver stiffness (kPa)	1.85 (1.45–2.36)	<0.001
Platelet count	0.92 (0.88–0.96)	
AST/ALT ratio	2.10 (1.65–2.75)	
Serum albumin (g/dL)	0.76 (0.65–0.89)	

Table 6: Performance of Liver Stiffness Measurement Cutoffs for Diagnosing Cirrhosis

LSM Cutoff (kPa)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
10	95	75	80	93.8	85
12.5	90	85	85.7	89.5	87.5
15	85	92	90.6	87.8	88.5

Table 7: Diagnostic Performance of Different Methods for Cirrhosis Diagnosis

Diagnostic Method	Sensitivity (%)	Specificity (%)	Accuracy (%)
Liver stiffness (LSM)	90	85	87.5
APRI score	75	70	72.5
FIB-4 index	80	78	79

DISCUSSION

Chronic liver disease (CLD) represents a significant global health burden, with cirrhosis being a critical outcome characterized by progressive liver fibrosis and impaired hepatic function [15]. Early and accurate diagnosis of cirrhosis is essential to improving clinical outcomes [16]. Liver stiffness measurement (LSM) using transient elastography (TE) has emerged as a non-invasive and reliable diagnostic tool for assessing liver fibrosis and diagnosing cirrhosis [17]. Compared to traditional methods such as liver biopsy, which is invasive and prone to sampling errors, LSM offers a safer and quicker alternative with comparable diagnostic accuracy [18]. In our study, we evaluated the diagnostic accuracy of Liver Stiffness Measurement (LSM) for detecting cirrhosis in patients with chronic liver disease Our results demonstrate that LSM is a reliable, non-invasive diagnostic tool, exhibiting high sensitivity (90%) and specificity (85%), with an overall accuracy of 87.5%. These findings are consistent with prior research, which has reported similar diagnostic performance, with sensitivity ranging from 85% to 95% and specificity between 80% and 90% [19]. Furthermore, a meta-analysis of nine studies reported sensitivity and specificity for cirrhosis detection at 87% and 91%, respectively, while for stage C2 fibrosis, the estimates were 70% and 84%, respectively [20]. Our results align closely with those observed in previous studies involving patients with non-alcoholic fatty liver disease [21]. Liver stiffness measurement (LSM) exhibited superior performance compared to traditional scoring methods, such as the APRI and FIB-4 indices, which showed reduced sensitivity and specificity in identifying cirrhosis in our study. A study involving 153 patients with cirrhosis-related portal hypertension found that LSM outperformed other non-invasive markers, including APRI, Fibroindex, and FIB-4, in predicting liver stiffness and diagnosing cirrhosis [22]. Similarly, another study highlighted the enhanced diagnostic accuracy of LSM, showing it provided higher diagnostic performance than simpler fibrosis tests, such as FIB-4 and NFS, in a large cohort of adult patients with non-alcoholic fatty liver disease (NAFLD) [23]. In addition, the present study identified key factors associated with

liver disease progression. Multivariate analysis revealed that liver stiffness was an independent predictor of cirrhosis, with an odds ratio (OR) of 1.85 ($p < 0.001$). Moreover, platelet count (OR: 0.92, $p < 0.001$) and AST/ALT ratio (OR: 2.10, $p < 0.001$) were significantly correlated with disease severity, which aligns with previous research demonstrating that declining platelet counts and elevated AST/ALT ratios are indicative of hepatic fibrosis and [24]. Furthermore, serum albumin levels were inversely associated with liver stiffness, reinforcing the well-established relationship between hepatic synthetic function and fibrosis progression. This finding aligns with previous research, which has also identified a negative association between serum albumin levels and LSM [25]. The present study identified optimal liver stiffness measurement (LSM) thresholds for diagnosing cirrhosis, with an LSM cutoff of 12.5 kPa demonstrating the highest diagnostic accuracy (87.5%), alongside a sensitivity of 90% and specificity of 85%. The cutoff values for diagnosing fibrosis were consistent with those reported in previous studies. Specifically, the cutoffs for identifying stage 3 or more fibrosis have ranged from 7.9 to 9.6 kPa, with one study reporting a 9.0 kPa cutoff for stage C3 fibrosis [25-26]. The threshold demonstrating the maximum combined sensitivity and specificity for predicting stage 4 fibrosis was found to be 11.8 kPa. It is noteworthy that the LSM values in cirrhosis patients can vary widely, ranging from 5.8 to 75 kPa [4].

Limitations of the study: Every hospital-based study has some limitations and the present study undertaken is no exception to this fact. One limitation of our study is the reliance on a single diagnostic method, liver stiffness measurement (LSM), which may not fully capture the variability in cirrhosis progression across different patient populations. Additionally, the study did not include a comparison with liver biopsy in all cases, which could have provided more robust validation of LSM's accuracy. Lastly, the effect of confounding factors, such as the comorbidities present in the cohort, was not fully adjusted for, which might influence the diagnostic performance of LSM.

CONCLUSION AND RECOMMENDATIONS

Liver stiffness measurement (LSM) emerged as a reliable tool for diagnosing cirrhosis in chronic liver disease in our study. LSM demonstrated excellent sensitivity, specificity, and overall diagnostic accuracy, particularly with cutoff values of 10, 12.5, and 15 kPa. This suggests that LSM could be an effective, non-invasive alternative to liver biopsy, providing valuable clinical insights with fewer risks. Additionally, liver stiffness was found to be a strong predictor of disease progression, highlighting its potential in monitoring disease severity. Future research should explore the long-term clinical outcomes associated with LSM, as well as its integration with other biomarkers to improve diagnostic accuracy.

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