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COMPARATIVE ACCURACY OF 2-D SHEAR WAVE ELASTOGRAPHY WITH CHILD PUGH SCORING IN LIVER FIBROSIS

Original Research

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ABSTRACT

Background: Liver fibrosis is a progressive response to chronic liver injury, resulting in scar tissue formation and potential evolution into cirrhosis. Early and accurate staging is critical for timely intervention. Two-dimensional shear wave elastography (2D-SWE) provides non-invasive quantification of liver stiffness, while the Child-Pugh score assesses liver function based on bilirubin, albumin, prothrombin time, ascites, and encephalopathy. Comparing these tools enhances clinical decision-making in chronic liver disease management.

Objective: To assess the comparative accuracy of 2D shear wave elastography and the Child-Pugh scoring system in evaluating the severity of liver fibrosis.

Methods: This analytical cross-sectional study was conducted at INMOL Hospital and Aznostics Diagnostic Centre, Lahore. A total of 169 patients with chronic liver disease were selected through convenience sampling. Adults with hepatitis B, hepatitis C, non-alcoholic fatty liver disease, or hepatic steatosis were included, while those with decompensated cirrhosis, prior liver transplantation, or comorbid fluid overload were excluded. Liver stiffness was measured using 2D-SWE, and liver function was classified using the Child-Pugh scoring system. Spearman's correlation test was used to determine the strength and significance of the association between fibrosis staging and liver function status.

Results: Among 169 participants, 43.2% were aged 25–40 years, 38.5% were 41–55 years, and 18.3% were above 55 years. Hepatitis B and C were found in 68.6% and 31.4% of cases, respectively. Frequent weight loss (63.3%), fatigue (65.1%), yellowish appearance (68.6%), and body swelling (31.4%) were reported. Liver size was <12 cm in 11.2%. Fibrosis grades were F0 (24.9%), F1 (20.1%), F2 (30.8%), F3 (15.4%), and F4 (8.9%). Child-Pugh scores were A (75.7%), B (13.0%), and C (11.2%). A strong correlation was observed between fibrosis stage and Child-Pugh score (Spearman's $\rho = 0.759$; $p < 0.0001$).

Conclusion: 2D-SWE demonstrated high diagnostic relevance in assessing liver fibrosis, correlating strongly with Child-Pugh classification. These findings support the utility of SWE as a non-invasive alternative for evaluating liver disease severity and guiding clinical management.

Keywords: Child-Pugh Score, Hepatitis B, Hepatitis C, Liver Cirrhosis, Liver Fibrosis, Shear Wave Elastography, Ultrasonography.

INTRODUCTION

Liver fibrosis is a progressive pathological response to chronic liver injury, characterized by excessive deposition of extracellular matrix proteins leading to the formation of scar tissue. If left untreated, it can progress to cirrhosis, portal hypertension, liver failure, and hepatocellular carcinoma, all of which carry significant morbidity and mortality. The progression of liver fibrosis occurs in stages—ranging from mild perisinusoidal fibrosis (METAVIR F1) to established bridging fibrosis (F3) and ultimately cirrhosis (F4)—with early stages being potentially reversible through timely interventions (1). Chronic liver diseases such as hepatitis B and C, alcoholic liver disease, and increasingly, non-alcoholic fatty liver disease (NAFLD), are primary contributors to fibrosis. In Pakistan, the burden of NAFLD has reached a prevalence of 14.8%, with higher rates observed in adults over 40 years and a slightly greater prevalence in males (2). In pediatric populations, fibrosis may result from conditions such as biliary atresia and autoimmune hepatitis, underscoring the age-specific etiological spectrum of this condition. Clinical assessment of liver fibrosis traditionally relies on histopathological evaluation through liver biopsy, which, despite its diagnostic value, carries risks such as bleeding, sampling error, and procedural discomfort. These limitations have accelerated the shift towards non-invasive diagnostic alternatives (3,4). Among these, imaging modalities like conventional ultrasound and emerging elastography techniques have shown promise. While grayscale ultrasound offers valuable qualitative insights—such as parenchymal echotexture, liver size, and surface irregularities—it lacks the quantitative precision needed to assess fibrosis severity. This gap is bridged by shear wave elastography (SWE), particularly two-dimensional SWE (2D-SWE), which quantifies liver stiffness by measuring the propagation velocity of mechanically generated shear waves, converting this to kilopascal (kPa) values using Young's modulus. These values correlate well with histological fibrosis stages, making 2D-SWE a valuable, reproducible tool for fibrosis staging (5).

In clinical practice, liver stiffness measured by 2D-SWE has shown meaningful correlation with functional scoring systems such as the Child-Pugh classification, which evaluates hepatic reserve based on parameters like bilirubin, albumin, coagulation status, and presence of ascites or encephalopathy (6). This scoring system stratifies patients into grades A to C, reflecting increasing severity of liver dysfunction and guiding prognosis and treatment strategies. Recent studies suggest that higher stiffness values on SWE are associated with worse Child-Pugh scores, indicating that this imaging modality may not only predict histological fibrosis but also correlate with functional hepatic impairment (7,8). Such findings support the integration of elastography with clinical scoring to enhance diagnostic accuracy and inform therapeutic decision-making. Despite the growing body of literature supporting the utility of 2D-SWE, limited local data exists on its correlation with established liver function scores in populations such as those in Pakistan. This creates a research gap in validating non-invasive methods against clinical gold standards in resource-constrained settings. Therefore, the current study aims to assess the correlation between two-dimensional shear wave elastography and Child-Pugh scoring in patients with chronic liver disease. By exploring this relationship, the study seeks to evaluate whether 2D-SWE can reliably serve as a surrogate marker for liver fibrosis and function, offering clinicians a non-invasive, objective, and comprehensive tool for managing cirrhotic patients.

METHODS

This analytical, cross-sectional study was designed to evaluate the diagnostic correlation between two-dimensional shear wave elastography (2D-SWE) and the Child-Pugh scoring system in assessing the severity of liver fibrosis and cirrhosis. The study was conducted across two tertiary-level diagnostic facilities—INMOL Hospital and Aznostics Diagnostic Centre, Lahore—and included 169 adult participants recruited using a convenience sampling method. Eligible participants were adults aged 18 years and older with a confirmed diagnosis of chronic liver disease, including chronic hepatitis B or C, non-alcoholic fatty liver disease (NAFLD), or hepatic steatosis. Patients with evidence of decompensated cirrhosis (e.g., overt ascites, variceal bleeding, hepatic encephalopathy), prior liver transplantation, or those with comorbid conditions like congestive heart failure or chronic renal disease-causing fluid overload were excluded to minimize diagnostic ambiguity and ensure accurate liver stiffness assessment. All participants underwent detailed clinical assessments followed by standardized imaging using 2D-SWE. Liver stiffness was measured using a high-resolution ultrasound system equipped with SWE functionality (exact model: Aixplorer®, SuperSonic Imagine, France), operated by a trained sonologist with a minimum of three years of experience in elastographic techniques (9). Measurements were obtained from the right lobe of the liver via an intercostal approach with patients in the supine position and right arm maximally abducted. A region of interest (ROI) measuring 10–

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15 mm in diameter was selected, avoiding vascular and biliary structures, and positioned 1–5 cm below the liver capsule. For reliability, at least ten valid measurements were recorded per patient, with an interquartile range/median (IQR/M) ratio of less than 0.3 being the cutoff for valid data inclusion (10).

Liver stiffness results, measured in kilopascals (kPa), were then correlated with functional liver status using the Child-Pugh classification, which includes five clinical and biochemical parameters: serum bilirubin, serum albumin, prothrombin time (INR), presence of ascites, and hepatic encephalopathy. Biochemical analyses were conducted using standardized automated methods in certified laboratories. The study protocol received ethical approval from the Institutional Review Board of INMOL Hospital, and informed written consent was obtained from each participant prior to study inclusion. All data were handled with confidentiality and analyzed using SPSS version 25. Descriptive statistics summarized demographic and clinical data, while inferential analysis—including Pearson's and Spearman's correlation tests—was applied to determine the strength and direction of the association between SWE measurements and Child-Pugh scores. Results were graphically illustrated through charts and tables to enhance interpretability.

RESULTS

The study enrolled 169 participants diagnosed with chronic liver disease. The age distribution showed that 43.2% (n=73) were aged between 25 and 40 years, 38.5% (n=65) were between 41 and 55 years, and 18.3% (n=31) were above 55 years. Among the participants, 68.6% (n=116) were diagnosed with Hepatitis B, whereas 31.4% (n=53) had Hepatitis C. Regarding clinical symptoms, 63.3% (n=107) reported frequent weight loss, while 36.7% (n=62) did not experience this symptom. Fatigue was present in 65.1% (n=110) of cases. A yellowish appearance of the skin and sclera was noted in 68.6% (n=116), and was absent in 31.4% (n=53). Physical examination revealed that 31.4% (n=53) had noticeable body swelling, while the remaining 68.6% (n=116) did not present with this sign. On liver size assessment via imaging, 88.8% (n=150) of participants had a liver size greater than 12 cm, while 11.2% (n=19) had a liver size of less than 12 cm. Evaluation of liver stiffness using two-dimensional shear wave elastography (2D-SWE) showed that 24.9% (n=42) had Fibrosis F0, 20.1% (n=34) had Fibrosis F1, 30.8% (n=52) had Fibrosis F2, 15.4% (n=26) had Fibrosis F3, and 8.9% (n=15) had Fibrosis F4. According to the Child-Pugh classification, the majority of participants, 75.7% (n=128), were classified as Child-Pugh Grade A, while 13.0% (n=22) and 11.2% (n=19) were categorized as Grade B and Grade C, respectively.

Cross-tabulation between 2D-SWE fibrosis stages and Child-Pugh scoring revealed that all participants with Fibrosis F0, F1, and F2 were classified under Child-Pugh Grade A. None of the patients in Grades B or C fell within these earlier fibrosis stages. Among those with Fibrosis F3, 15 participants were classified as Child-Pugh Grade B and 11 as Grade C. Similarly, Fibrosis F4 was observed in 7 patients under Grade B and 8 under Grade C. These results illustrate a clear progression of liver stiffness with worsening Child-Pugh grades. Inferential analysis demonstrated a statistically significant and strong positive correlation between liver stiffness measurements obtained through two-dimensional shear wave elastography (2D-SWE) and functional classification via the Child-Pugh scoring system. Spearman's rank correlation coefficient (ρ) was calculated at 0.759 with a p-value < 0.0001, indicating a robust and meaningful association between increasing fibrosis stage and worsening Child-Pugh grade. This suggests that higher fibrosis scores on 2D-SWE were strongly associated with more severe liver dysfunction as assessed clinically, supporting the diagnostic alignment of the two modalities in evaluating hepatic fibrosis and cirrhosis.

Table 1: Demographics and Clinical Symptoms

Category	Frequency	Percent
Age group 25-40	73	43.2%
Age group 41-55	65	38.5%
Above >55	31	18.3%
Hepatitis B	116	68.6%
Hepatitis C	53	31.4%
Weight Loss (No)	62	36.7%

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Category	Frequency	Percent
Weight Loss (Frequent)	107	63.3%
Fatigue (Present)	110	65.1%
Fatigue (Absent)	59	34.9%
Yellowish Appearance (Present)	116	68.6%
Yellowish Appearance (Absent)	53	31.4%

Table 2: Physical Examination & Liver Size

Category	Frequency	Percent
Body Swelling (Present)	53	31.4%
Body Swelling (Absent)	116	68.6%
Liver Size >12cm	19	11.2%
Liver Size <12cm	150	88.8%

Table 3: Fibrosis Score & Child-Pugh Score

Category	Frequency	Percent
Fibrosis F0	42	24.9%
Fibrosis F1	34	20.1%
Fibrosis F2	52	30.8%
Fibrosis F3	26	15.4%
Fibrosis F4	15	8.9%
Child Pugh Score A	128	75.7%
Child Pugh Score B	22	13.0%
Child Pugh Score C	19	11.2%

Table 4: Correlation Between 2D Shear Wave Elastography Fibrosis Stages and Child-Pugh Classification

Child Pugh Score Child Score * Shear wave Elastography Fibrosis Score Crosstabulation

		Shear wave Elastography Fibrosis Score		
		Fibrosis F0	Fibrosis F1	Fibrosis F2
Child Pugh Score Child Score	Child Pugh Score A	42	34	52
	Child Pugh Score b	0	0	0
	Child Pugh Score C	0	0	0
Total		42	34	52

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Child Pugh Score Child Score * Shear wave Elastography Fibrosis Score Crosstabulation				
		Shear wave Elastography Fibrosis Score		
		Fibrosis F3	Fibrosis F4	
Child Pugh Score Child Score	Child Pugh Score A	0	0	128
	Child Pugh Score b	15	7	22
	Child Pugh Score C	11	8	19
Total		26	15	169

Table 5: Correlation Analysis Between Fibrosis and Child-Pugh Score

Variables Compared	Correlation Coefficient (Spearman's rho)	P-value	Strength of Correlation	Statistical Significance
2D-SWE Fibrosis Score vs Child-Pugh Score	0.759	0	Strong	Significant

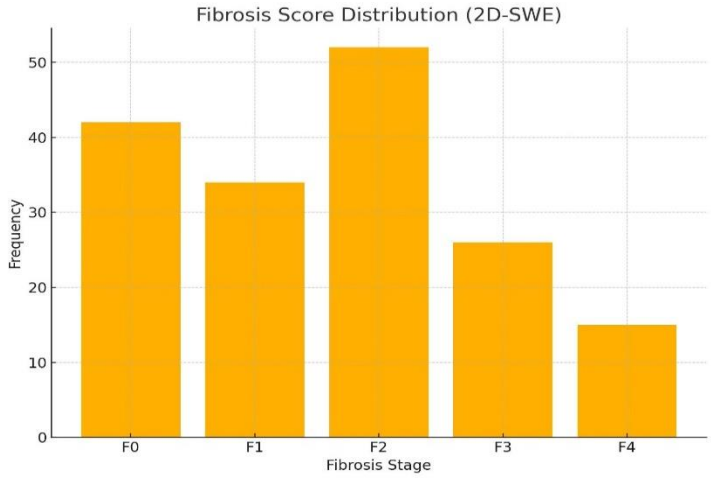

Figure 1 Fibrosis Score Distribution (D-SWE)

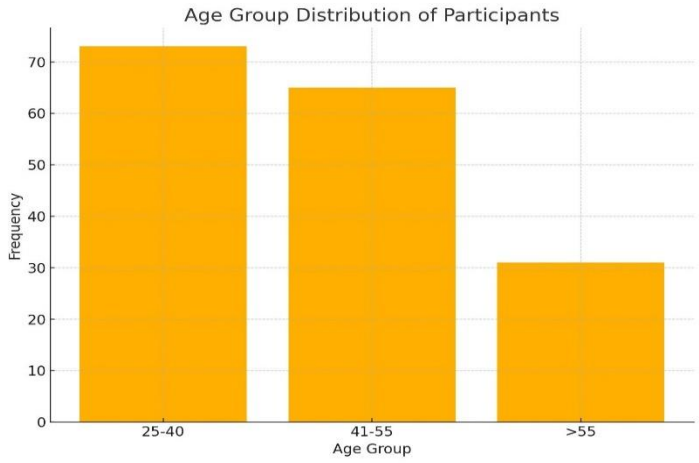

Figure 2 Age Group Distribution of Participants

DISCUSSION

The present study provided compelling evidence on the utility of two-dimensional shear wave elastography (2D-SWE) in assessing liver fibrosis, with a particular focus on its correlation with the Child-Pugh scoring system in patients with chronic liver disease. The observed high prevalence of Hepatitis B (68.6%) and Hepatitis C (31.4%) among the participants contrasts markedly with national prevalence rates reported in Pakistan, which stand at 2.5% and 4.8% respectively (11). This discrepancy is attributable to the targeted recruitment of individuals already diagnosed with liver pathology, thus reflecting a higher-risk population rather than a representation of the general public. The elevated prevalence of clinical symptoms such as weight loss and jaundice, observed in 63.3% and 68.6% of participants respectively, aligns with earlier clinical reports recognizing these signs as indicators of progressive hepatic dysfunction (12). Fatigue, reported in 65.1% of cases, further supports the symptomatic spectrum commonly associated with advancing fibrosis (13). Liver size assessment revealed hepatomegaly in the majority of participants, with 88.8% exhibiting liver sizes greater than 12 cm. This finding is congruent with prior research noting enlarged liver size in early and moderate stages of fibrosis, with a tendency for liver size to decrease in advanced cirrhosis due to parenchymal atrophy and architectural distortion (14,15). The staging of fibrosis via 2D-SWE in this study demonstrated a balanced distribution across early to advanced fibrosis stages, reinforcing existing literature that supports elastography as a reliable and reproducible modality for quantifying liver stiffness. This modality's ability to non-invasively stratify fibrosis stages adds substantial clinical value, especially in scenarios where histopathological confirmation via biopsy is either contraindicated or inaccessible (16,17).

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The Child-Pugh classification revealed that most patients retained compensated liver function, with 75.7% falling under Score A. This distribution mirrors patterns seen in previous reports where early-stage fibrosis and compensated cirrhosis dominate clinical presentations at diagnosis (18). Importantly, inferential analysis confirmed a strong and statistically significant positive correlation between SWE-derived fibrosis scores and Child-Pugh classes, underscoring the concurrent rise in liver stiffness with deteriorating hepatic functional reserve. This finding substantiates the combined use of SWE and Child-Pugh grading in comprehensive liver disease evaluation and management (19,20). A key strength of the study lies in its application of both structural and functional liver assessments, bridging radiological and clinical evaluation techniques. The use of standardized SWE protocols and correlation with clinically validated scoring further enhances the robustness of the findings. However, certain limitations must be acknowledged. The use of convenience sampling limits generalizability, as the study population may not represent the broader spectrum of chronic liver disease patients. Additionally, exclusion of decompensated cirrhotics, though methodologically justified to avoid confounding, limits the ability to fully capture the spectrum of hepatic decompensation. The cross-sectional nature of the study also restricts causal inferences and temporal analysis of disease progression.

Future studies should consider longitudinal designs to track fibrosis progression over time and incorporate larger, more diverse cohorts to improve external validity. Inclusion of serum biomarkers such as APRI or FIB-4 could also offer complementary diagnostic insight when combined with SWE. Furthermore, comparative analysis between 2D-SWE and other non-invasive elastographic modalities such as transient elastography or magnetic resonance elastography would help delineate the relative efficacy and operational feasibility of each approach. In conclusion, this study reinforces the diagnostic reliability of 2D-SWE in liver fibrosis evaluation and demonstrates its strong correlation with Child-Pugh functional classification (21). These findings advocate for broader clinical adoption of elastographic tools, particularly in settings where biopsy is impractical, enhancing early detection, monitoring, and individualized management of chronic liver disease.

CONCLUSION

This study concludes that two-dimensional shear wave elastography is a valuable, non-invasive tool for accurately assessing liver fibrosis, showing strong correlation with functional liver impairment as measured by the Child-Pugh classification. The findings underscore the clinical importance of integrating elastographic evaluation into routine practice for patients with chronic liver disease, particularly those at risk of progression to cirrhosis. By highlighting common complications and functional deterioration even in early stages, the study reinforces the need for early detection, continuous monitoring, and timely intervention to improve patient outcomes and reduce the burden of advanced liver disease.

Author Contribution

Author	**Contribution**
Tayyaba Aslam	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Hafiz Shehzad Muzammil	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Rana Bilal Idrees	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Fatima Mahrukh	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Jahanzaib*	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sana Ali	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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