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Comparison Of 2d Shear Wave Elastography With Apri, In Assessment Of Liver Fibrosis In Chronic Liver Diseases

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Abstract

Background: Liver fibrosis is a key endpoint in chronic liver diseases, requiring assessment for early detection and monitoring. SWE induces shear waves to evaluate tissue elasticity, offering real-time imaging and stiffness quantification. The APRI (Aspartate Aminotransferase to platelet ratio index) is a biochemical marker that indicates fibrosis severity based on AST levels and platelet counts, with higher scores suggesting significant fibrosis likelihood.

Results: This study included 85 patients with chronic liver disease. Liver stiffness parameters—mean shear wave velocity and Young's modulus - showed a significant stepwise increase with advancing fibrosis stages ($p < 0.001$). APRI values rose progressively with fibrosis severity and showed a strong positive correlation with elastography parameters, demonstrating excellent diagnostic performance for significant fibrosis (AUC 0.962, sensitivity 96.58%, specificity 91.14%).

Conclusion: The findings confirm that chronic liver disease in this cohort was commonly diagnosed at an advanced stage, emphasizing the need for early detection strategies. 2D shear wave elastography proved to be a reliable non-invasive tool for differentiating fibrosis stages, showing strong statistical significance across disease severity.

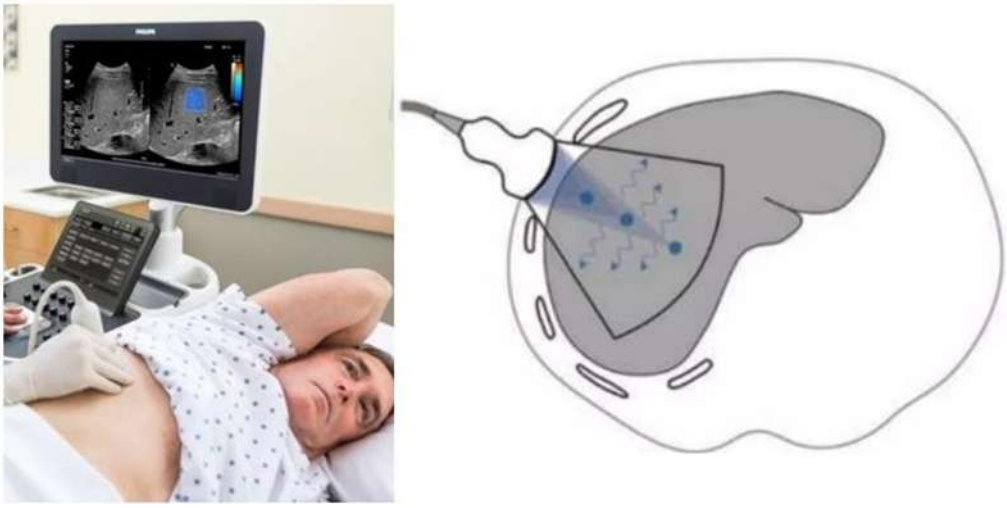
APRI demonstrated excellent correlation with elastography measurements, supporting its utility as a simple, cost-effective biochemical marker for fibrosis assessment. Overall, combining serum-based indices like APRI with elastography can enhance non-invasive evaluation and monitoring of liver fibrosis in chronic liver disease patients.

Keywords: 2D Shear Wave Elastography (2D-SWE), APRI (AST to Platelet Ratio Index), Liver Fibrosis, Chronic Liver Disease, Noninvasive Assessment, Elastography Accuracy, Fibrosis Staging

Introduction

Chronic liver disease (CLD) represents a monumental and escalating global health challenge, constituting a leading cause of morbidity and mortality worldwide.1 The pathological trajectory, often insidious, progresses from initial hepatic injury - triggered by viral agents, toxins, metabolic insults, or autoimmune processes - through varying stages of fibrosis, characterized by the excessive accumulation of extracellular matrix proteins. This fibrogenic process, a common final pathway for disparate etiologies of liver injury, can ultimately culminate in cirrhosis, hepatic decompensation, and hepatocellular carcinoma (HCC).2,3

Figure 1: Physics of 2D Shear Wave Elastography (2D-SWE).



This SWE measure liver stiffness. An ultrasound probe generates a push pulse (ARFI) that creates shear waves travelling through liver tissue. The velocity of these shear waves is then measured, and faster waves indicate stiffer tissue. Using the key equation shown, shear wave velocity is converted into tissue stiffness, where higher velocity corresponds to higher fibrosis (Figure 1)

NITs (Non-invasive techniques) for liver fibrosis have evolved into two principal, complementary categories: serum biomarker panels and imaging-based elastography techniques. Among serum markers, the Aspartate Aminotransferase to Platelet Ratio Index (APRI) stands out due to its compelling simplicity and virtually zero incremental cost.[8] Calculated from two routine laboratory parameters [(AST level / upper limit of normal) / Platelet count (10^9 /L) x 100], APRI requires no specialized equipment, proprietary algorithms, or additional expense.

Table 1: Relationship between APRI values and fibrosis severity[4]

APRI range	Fibrosis stage	Percentage with significant fibrosis	Clinical interpretation
≤ 0.5	S0 - S1	~22%	Mild or absent fibrosis
0.5–1.5	S1 - S2	~52%	Moderate fibrosis
> 1.5	S3 - S4	~75%	Advanced fibrosis / cirrhosis

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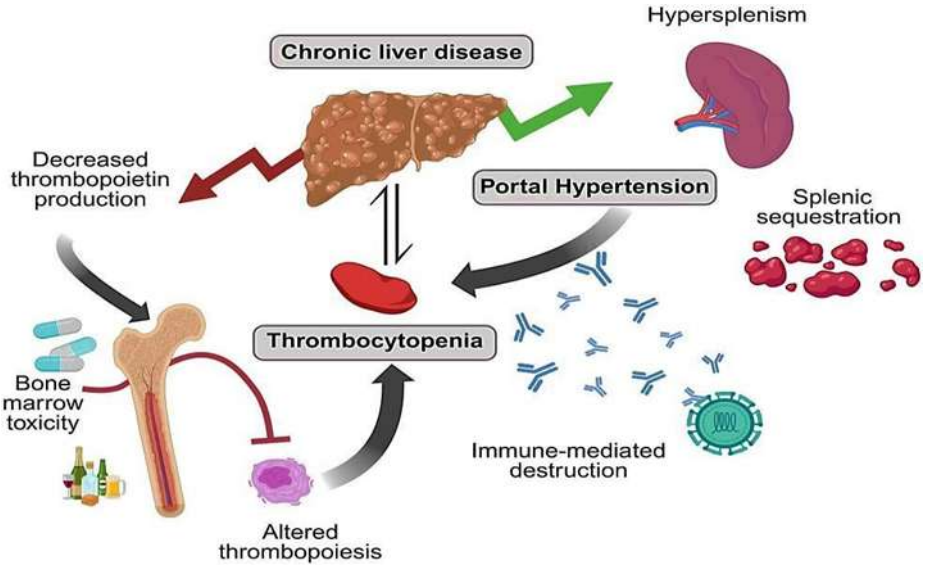
Figure 2: Fibrosis progression leads to increased APRI.



The chronic liver disease leads to thrombocytopenia (low platelet count) through multiple pathways, including decreased thrombopoietin production, bone marrow toxicity, and portal hypertension. These factors result in the sequestration of platelets in an enlarged spleen and their immune-mediated destruction, collectively reducing the total circulating platelet count (Figure 2).

Parallel to the development of serum biomarkers, the field of elastography has revolutionized the non-invasive assessment of liver fibrosis by providing a physical measurement of liver stiffness, which correlates strongly with the degree of fibrotic deposition and architectural distortion. The advent of Shear Wave Elastography (SWE), integrated directly into conventional high-end ultrasound systems, represents a significant technological and conceptual evolution. Two-dimensional SWE (2D-SWE) generates a quantitative, colour-coded elastogram superimposed on a standard B-mode image in real-time. This allows the operator to place a region of interest (ROI) under direct visual control, avoiding large vessels, focal lesions, and acoustic artefacts, thereby theoretically improving the reliability and reproducibility of the measurement.[5,6] Furthermore, 2D-SWE can be performed as part of a comprehensive standard abdominal ultrasound examination, enabling a single-session evaluation of liver parenchyma echotexture, size, surface nodularity, spleen size, and signs of portal hypertension.[7,8]

My study, titled **"Comparison of 2D Shear Wave Elastography with APRI in Assessment of Liver Fibrosis in Chronic Liver Diseases,"** is conceived to provide an evidence-based, contextually relevant answer to this pressing clinical dilemma. By prospectively evaluating and directly comparing the performance characteristics- including sensitivity, specificity, positive and negative predictive values, and the area under the receiver operating characteristic curve (AUROC) - of 2D-SWE and APRI against a histological reference standard (where ethically and clinically indicated) or a composite clinical endpoint, we aim to delineate their respective roles and diagnostic concordance.

Aims of the study:

- To compare the diagnostic accuracy of 2D shear wave elastography versus APRI for staging liver fibrosis in adults with chronic liver diseases.

Objectives of the study:

- To determine liver shear wave elasticity in liver fibrosis in patients with chronic liver disease.
- To correlate with APRI values.

Materials And Methods:

Source of Data: The main source of data for the study are patients from Bapuji Hospital and Chigateri

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District Hospital attached to J.J.M. Medical College, Davangere.

Study design: Analytical study

Study period: 18 months (March 2024 to August 2025)

Place of study: Bapuji Hospital.

Sample size: Intended to study a minimum of 85 cases

Inclusion Criteria:

All the patients who were diagnosed with a chronic liver disease

Suspected to have chronic liver disease with risk factors such as significant alcohol intake (>80g/day for more than 5 years) or abnormal liver function tests.

Exclusion Criteria:

Patients with focal liver lesions.

Pregnant patients.

Patients with gross ascites.

Methodology:

Informed consent will be obtained (After clearance from ethical committee). Details of the study protocol will be explained to the subjects.

Technique:

All the patients underwent routine investigations and then APRI score was calculated for all patients.

Liver stiffness measurement was done by 2D-shear wave elastography using ultrasound machine LOGIQ E10 with C1-6-D curvilinear probe. For each patient, the right lobe of liver was visualized through the optimal intercostal space with the right arm in maximally abducted position while the patient was lying in supine position. Patient was instructed to hold their breath for 3 - 5 seconds for imaging. The ROI (region of interest) was fixed at 1 - 2 centimeters beneath the right liver capsule (Glisson's capsule), away from intrahepatic vessels, bile duct, and gallbladder. The ultrasound beam is focused at a given location which creates plane shear waves, which propagate over a region of interest (ROI) of tissue.

The particular segment of liver was shot 10 - 12 times and the result was considered reliable only when 10 successful shots were obtained. The machine automatically calculated the mean elastic modulus (in kPa) within the region of interest.

The elastogram in 2D-SWE is displayed continuously in real time and is color coded. The measurements were considered valid when the elastogram was stable for atleast 3 seconds before image acquisition and ROI was homogeneously color coded.

Representative case:

The liver elastography report for patient from Bapuji Hospital details a non- invasive assessment of liver stiffness, conducted using Shear Wave Elastography (SWE) on December 27, 2025. Twelve measurements were taken, providing a robust dataset. Key findings include a median stiffness of 10.63 kPa and median shear wave velocity of 1.83 m/s, with an interquartile range for stiffness of 1.16 kPa. The IQR/Median ratios are 10.9% for stiffness and 11.0% for velocity, indicating reliable results. A median stiffness of 10.63 kPa typically suggests severe fibrosis (staged as F3).

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Discussion:

The CLD is a progressive condition characterized by continuous hepatocellular injury, inflammation, and fibrosis, which may ultimately progress to cirrhosis and its related complications. Accurate staging of liver fibrosis is essential for prognostication, therapeutic decision-making, and follow-up. Although liver biopsy is considered the gold standard, its invasive nature, sampling variability, and associated complications have necessitated the development of reliable non-invasive alternatives. The present study evaluated the role of 2D-SWE in assessing liver fibrosis and correlated elastography findings with clinical and laboratory parameters, with comparisons drawn from previously published studies.

Direct comparative studies: 2D-SWE versus APRI

Direct head-to-head comparisons are essential to inform clinical choices. A rigorous study by Gerber et al. (2015) in 207 patients with mixed-etiology CLD found 2D- SWE (AUROC 0.94 for ≥F2) significantly outperformed APRI (AUROC 0.78).[9] The study concluded that 2D-SWE was superior for individual fibrosis stage prediction. Similarly, Zeng et al. (2019) in a large cohort of 216 treatment-naïve HBV patients demonstrated AUROCs of 0.93 vs. 0.73 for significant fibrosis and 0.96 vs. 0.85 for cirrhosis, for 2D-SWE and APRI respectively.[10] For ruling out cirrhosis, APRI can show a high negative predictive value (NPV >90%) when using a very low cutoff (<0.5), but its positive predictive value (PPV) is often poor (<50%), leading to many false positives.[11] In stark contrast, 2D-SWE provides higher PPVs (often >80% for cirrhosis at optimal cutoffs), meaning a high stiffness value is a more reliable indicator of advanced disease, crucial for triggering definitive management.[12,13]

SWE measures liver stiffness. An ultrasound probe generates a push pulse (ARFI) that creates shear waves traveling through liver tissue. The velocity of these shear waves is then measured, and faster waves

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indicate stiffer tissue. Using the key equation shown, shear wave velocity is converted into tissue stiffness, where higher velocity corresponds to higher fibrosis.

The APRI Calculation Formula: A clear breakdown of the mathematical model for the APRI score using by below formula:

The APRI score calculation is based on a mathematical model where high AST levels indicate hepatocyte injury, raising the numerator, while low platelet counts suggest portal hypertension/splenomegaly, which increases the denominator. This formula helps in determining the AST-to-Platelet Ratio Index (APRI).

$$APRI = \frac{\left(\frac{AST}{ULN}\right) \times 100}{Platelet\ Count\left(\frac{10^9}{L}\right)}$$

Figure 3: Formula of APRI (AST Platelet ratio index)

2D-SWE provides excellent performance (AUROCs >0.90 for advanced stages), high reproducibility, and the unique advantage of real-time B-mode guidance for anatomical correlation. APRI retains important value as an inexpensive, universally available, and perfectly reproducible triage tool. Its optimal use is to rule out advanced disease in low-prevalence settings or as the first step in a sequential algorithm, thereby efficiently reducing the number of patients requiring more costly elastography.[2,13,14]

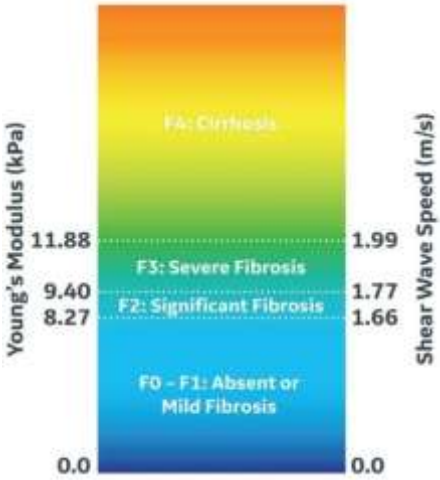

Figure 4: Shear wave elastography in LOGIQ E 10 machine. Cut-off of Youngs modulus and shear wave velocity for various grades of fibrosis.

In the present study, the mean age of patients was 48.02 ± 12.36 years, with the majority falling within the 35 – 64 -year age group. This observation closely aligns with findings by Bellamkonda et al., who reported a mean age of 46.9 years, and Izranov et al., who observed that chronic liver disease predominantly affects middle- aged adults. Similarly, Castera et al. reported that liver fibrosis is most commonly detected during middle age, likely due to the prolonged asymptomatic progression of chronic liver disease.[15,16,17] These findings confirm that clinically significant fibrosis is frequently identified in middle-aged individuals.

Liver enzyme analysis revealed elevated mean AST (73.14 U/L) and ALT (69.76 U/L) levels, indicating ongoing hepatocellular injury. In agreement with Yu et al., AST showed a stronger correlation with fibrosis severity, while ALT demonstrated limited reliability in advanced fibrosis, as also reported by Giannini et al,.[18,19] These findings emphasize that AST is a more

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reliable indicator of fibrosis progression compared to ALT in advanced disease stages.

The mean platelet count in the present study was 2.20 lakhs/cu.mm, with reduced levels observed in advanced fibrosis stages. Similar observations were reported by Izranov et al., who noted thrombocytopenia predominantly in F3 - F4 stages, and by Peck-Radosavljevic, who emphasized platelet decline as a surrogate marker of portal hypertension and hypersplenism.[16,20] These findings support the association between thrombocytopenia and advanced liver fibrosis.

Severe fibrosis (F3) was the most prevalent stage in the present study, accounting for 31.76% of cases. Comparable distributions were reported by Bellamkonda et al. and Izranov et al., where most patients belonged to F2 - F4 stages.15,16 This predominance of advanced fibrosis reflects delayed clinical presentation, which is commonly observed in hospital-based studies of chronic liver disease.

Elastography findings demonstrated a progressive increase in shear wave velocity from 0.80 m/s in F0 to 2.35 m/s in F4. These results are in strong agreement with studies by Bellamkonda et al. and Sporea et al., both of whom reported a stage-wise rise in shear wave velocity with increasing fibrosis severity.[15,21,22] This confirms the reliability of shear wave velocity as a marker of fibrosis progression.

Similarly, Young's modulus values increased from 1.93 kPa in F0 to 13.5 kPa in F4 in the present study. Comparable stiffness values have been reported by Bellamkonda et al. and Ferraioli et al., who recommended similar kPa ranges for fibrosis staging.[15,23] This close correspondence with published data further validates Young's modulus as a quantitative indicator of fibrosis severity.

When compared with serum-based markers, the present study demonstrated that shear wave elastography provides superior stage-wise discrimination of fibrosis. While Fabris et al. reported that serum markers are most useful for identifying cirrhosis and Yu et al and Sterling RK et al. noted overlap of APRI values in intermediate fibrosis stages, the present findings show that 2D-SWE offers better differentiation across all fibrosis stages, particularly in intermediate disease. [24,20,25]

Conclusion:

This study comprehensively evaluated the role of 2D-SWE and biochemical markers, particularly the APRI, in assessing liver fibrosis among patients with chronic liver disease.

Both mean shear wave velocity and Young's modulus showed a stepwise and statistically significant increase from absent fibrosis to cirrhosis, confirming the strong relationship between liver stiffness and fibrosis stage.

APRI values also increased progressively with worsening fibrosis and demonstrated a strong positive correlation with elastography parameters. The correlation coefficients between APRI and mean shear wave velocity, as well as Young's modulus, were high and statistically significant, supporting the validity of APRI as a surrogate marker of liver stiffness.

In conclusion, this study demonstrates that 2D shear wave elastography is a reliable, non-invasive modality for accurately staging liver fibrosis in chronic liver disease. When combined with simple biochemical indices such as APRI, it provides a robust, accessible, and cost-effective approach for fibrosis assessment, potentially reducing the need for invasive liver biopsy and improving early diagnosis, monitoring, and management of patients with chronic liver disease.

Elastography parameters across fibrosis stages:

Elastography parameters showed a clear and progressive increase with advancing fibrosis stage. Mean shear wave velocity increased steadily from absent fibrosis to cirrhosis, and a similar stepwise rise was observed in Young's modulus values. Statistical analysis using the Kruskal–Wallis test demonstrated highly significant differences across all fibrosis stages ($p < 0.001$), confirming that 2D shear wave elastography effectively differentiates between varying degrees of liver fibrosis.

Comparison of laboratory parameters across fibrosis stages:

Comparison of laboratory parameters across fibrosis stages showed statistically significant differences for total bilirubin, AST, ALT, and platelet counts, all of which worsened with increasing fibrosis severity. AST showed the strongest association with fibrosis progression, followed by ALT and bilirubin. Hemoglobin levels, however, did not show a significant difference across fibrosis stages, indicating limited utility as a marker of fibrosis severity.

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APRI values across fibrosis stages:

APRI values demonstrated a consistent and stepwise increase from absent fibrosis to cirrhosis. Patients with mild or no fibrosis had low APRI values, while those with advanced fibrosis and cirrhosis showed substantially higher scores. The differences across fibrosis stages were statistically significant, indicating that APRI reliably reflects the severity of liver fibrosis.

Correlation between APRI and elastography parameters:

Correlation analysis showed a strong positive relationship between APRI and elastography parameters. APRI correlated highly with both mean shear wave velocity and Young's modulus, and these elastography measures were also strongly correlated with each other. All correlations were statistically significant, demonstrating excellent agreement between biochemical and imaging-based non-invasive markers of fibrosis.

ROC analysis of APRI for detecting significant fibrosis ≥ F2:

ROC curve analysis showed that APRI had excellent diagnostic performance for detecting significant fibrosis. The area under the curve was 0.962, indicating very high accuracy. At an optimal cut-off value of 0.67, APRI demonstrated high sensitivity and specificity, confirming its reliability as a non-invasive screening tool for significant liver fibrosis

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