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A study to assess hepatic steatosis and fibrosis in chronic hepatitis B patients with the help of non-invasive tests

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ABSTRACT

Background: Chronic hepatitis B (CHB) is a persistent global health issue, frequently leading to hepatic fibrosis and steatosis. Although liver biopsy remains the diagnostic benchmark, its invasiveness necessitates safer alternatives. Non-invasive methods such as FibroScan, aspartate transaminase to platelet ratio index (APRI), and Fibrosis-4 (FIB-4) scores have shown promise in assessing liver pathology. **Aims and Objectives:** To evaluate the diagnostic performance of APRI, FIB-4, and FibroScan in detecting hepatic fibrosis and steatosis in CHB patients and their correlation with biochemical and virological parameters. **Materials and Methods:** This cross-sectional study was conducted at Maharani Laxmi Bai Medical College, Jhansi, from January 2023 to June 2024. A total of 112 patients with CHB were enrolled. Liver stiffness and steatosis were assessed using FibroScan and controlled attenuation parameters. APRI and FIB-4 scores were calculated, and laboratory values, including aspartate aminotransferase (AST), alanine aminotransferase (ALT), and hepatitis B virus (HBV) DNA, were analyzed. **Results:** Advanced FIB-4 was observed in 42 patients (37.50%) and severe steatosis (S3) in 41 patients (36.60%). Elevated AST levels (>2×upper limit of normal) were found in 54 patients (48.21%) and ALT in 57 patients (50.89%). High HBV DNA levels (>20,000 IU/mL) were present in 59 patients (52.67%). APRI score >1.5 showed a sensitivity of 85.71% and specificity of 79.55% (area under the curve [AUC]: 0.837), whereas FIB-4 score >3.25 had a sensitivity of 64.29% and specificity of 85.37% (AUC: 0.815). Both scores showed limited utility in detecting steatosis. **Conclusion:** FibroScan, APRI, and FIB-4 are effective non-invasive tools for assessing hepatic fibrosis in CHB patients. They offer viable alternatives to biopsy, especially in settings with limited resources.

Key words: Chronic hepatitis B; Hepatic fibrosis; Hepatic steatosis; APRI; Fibrosis-4; FibroScan; Controlled attenuation parameter; Non-invasive tests; Hepatitis B virus DNA; Liver stiffness measurement

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INTRODUCTION

Chronic hepatitis B (CHB) infection continues to be a major global health challenge, affecting nearly 296 million individuals worldwide. It contributes significantly to the burden of liver-related morbidity and mortality, particularly due to complications such as hepatic steatosis and fibrosis, which may progress silently to cirrhosis or hepatocellular carcinoma.[1] While liver biopsy has traditionally been the gold standard for assessing these complications, its invasive nature, potential for sampling errors, and procedural risks have highlighted the need for non-invasive and reproducible diagnostic methods.[2] In this context, newer technologies such as transient elastography (FibroScan) and biochemical

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indices such as aspartate transaminase to platelet ratio index (APRI) and Fibrosis-4 (FIB-4) have gained prominence due to their simplicity, safety, and diagnostic utility.[3]

Hepatic steatosis, previously considered benign, is now understood to significantly influence the progression of liver disease, especially when coexisting with CHB. It is associated with metabolic derangements and worsens the hepatic environment, hastening fibrosis. Hepatic fibrosis, on the other hand, is a complex pathological response to chronic liver injury characterized by excess extracellular matrix deposition, often driven by activated hepatic stellate cells. As fibrosis advances, liver function becomes increasingly impaired, and clinical complications ensue.[4,5]

Non-invasive diagnostic tools, particularly FibroScan and serum-based markers, provide an opportunity to detect these changes early and monitor disease progression effectively. This approach is especially valuable in resource-constrained settings, offering accessible and repeatable options for routine care. Although several studies have explored these modalities, there is a lack of region-specific data, especially among Indian patients with CHB.

Aims and objectives

Aims

- To evaluate the diagnostic utility of non-invasive tools – APRI, FIB-4 score, and FibroScan – in detecting hepatic fibrosis and steatosis in patients with CHB and to assess their correlation with clinical and biochemical parameters.

Objectives

- To assess the prevalence and grading of hepatic fibrosis and steatosis among CHB patients using transient elastography (FibroScan) and controlled attenuation parameter (CAP) scores
- To determine the association between liver transaminase levels (aspartate aminotransferase [AST] and alanine aminotransferase [ALT]) and the severity of hepatic fibrosis and steatosis
- To evaluate the relationship between hepatitis B virus (HBV) DNA viral load and the extent of liver fibrosis and steatosis
- To calculate APRI and FIB-4 scores for each patient and assess their diagnostic performance in predicting significant fibrosis and advanced steatosis
- To compare the diagnostic accuracy of APRI and FIB-4 scores with FibroScan findings using sensitivity, specificity, and receiver operating characteristic (ROC) curve analysis
- To explore the utility of non-invasive methods as potential alternatives to liver biopsy, particularly in resource-limited settings, for the early detection and monitoring of liver disease in CHB patients.

MATERIALS AND METHODS

Study design

This cross-sectional study was conducted at Maharani Laxmi Bai Medical College, Jhansi, Uttar Pradesh, from January 2023 to June 2024. A total of 112 patients with CHB meeting the inclusion criteria were enrolled from General Medicine, Gastroenterology, Hepatitis B outpatient department (OPD), and indoor wards.

Inclusion criteria

- Patients with CHB
- CHB was characterized as constant hepatitis B surface antigen (HBsAg) positive for over half a year, and it was confirmed by enzyme-linked immunosorbent assay (ELISA).

Exclusion criteria

- Alcohol-related liver disease – defined by alcohol intake exceeding 40 g/d in males and 20 g/d in females over the past 5 years
- Hepatitis B and C co-infection
- Hepatitis B and human immunodeficiency viruses or hepatitis C virus co-infection
- Drug-induced hepatitis
- Genetic or metabolic disease
- Autoimmune hepatitis.

Methodology

All patients diagnosed with CHB who fulfilled the inclusion criteria were enrolled from the OPD and inpatient wards of General Medicine and Hepatology at Maharani Laxmi Bai Medical College, Jhansi.

Each participant was subjected to a detailed clinical evaluation, which included the recording of demographic details (age and sex), clinical symptoms, and signs relevant to liver disease.

Following clinical assessment, the participants underwent a series of laboratory investigations. Hematological parameters – such as hemoglobin, platelet count, and prothrombin time/international normalized ratio-were analyzed using the ADVIA 2120i automated hematology analyzer. Biochemical markers – including serum bilirubin, albumin, AST, and ALT – were measured using the ARCHITECT i2000SR analyzer (Abbott, IL). Serological confirmation of CHB was done by ELISA testing for HBsAg, and quantitative estimation of HBV DNA levels was carried out using the Smart Cycler II polymerase chain reaction platform (Siemens Healthcare Diagnostics).

All enrolled patients underwent FibroScan examination using a 3.5 MHz M-probe. The procedure was performed after an overnight fast or at least 2 h post-meal to improve accuracy. During the test, 10 valid liver stiffness measurements (LSMs) were recorded for each patient. Measurements were considered reliable when the interquartile range to median ratio was <0.30 and a success rate of 60% or more was achieved.

LSM was recorded in kilopascals (kPa) to assess the degree of fibrosis, whereas CAP values, expressed in decibels per meter (dB/m), were used to quantify hepatic steatosis. CAP values were considered valid only if the LSM measurement was also reliable.

Subsequently, non-invasive fibrosis scores-APRI and FIB-4-were calculated using the following standardized formulas:

APRI=([(AST÷ULN AST)÷Platelet count (10^9/L)]×100)

FIB-4=([(Age in years×AST)÷(Platelet count×√ALT)])

The upper normal limit of AST was taken as 40 IU/L for these calculations. The results were rounded to two decimal points and compared against standard cutoff values for staging fibrosis and cirrhosis as recommended by the World Health Organization.

Steatosis is categorized into 4° (S0-S3) based on the percentage of hepatocytes affected and the corresponding CAP values in dB/m. A CAP value below 248 dB/m corresponds to S0, indicating <10% hepatocyte involvement and essentially no steatosis. Values between 248 dB/m and 267 dB/m represent mild steatosis (S1) involving 10–33% of hepatocytes. Moderate steatosis (S2) is defined by CAP values ranging from 268 dB/m to 279 dB/m, reflecting 34–66% hepatocyte involvement. Severe steatosis (S3), characterized by more than 66% of hepatocytes affected, corresponds to CAP values >280 dB/m. This classification aids in the non-invasive quantification of hepatic fat content, offering a practical alternative to liver biopsy for evaluating and monitoring liver steatosis in clinical settings.

The fibrosis stages are graded from F0 to F4. An LSM value of ≤6 kPa corresponds to F0-F1, indicating no or mild fibrosis. Values between 6.1 and 9 kPa suggest moderate fibrosis (F2), whereas readings from 9.1 kPa to 10.9 kPa indicate advanced fibrosis (F3). A measurement of ≥11 kPa is classified as F4, which denotes cirrhosis. This classification system enables a reliable, non-invasive assessment of liver fibrosis in CHB patients, aiding in the early detection and appropriate management of progressive liver disease.

Finally, all collected data were tabulated in Microsoft Excel, and appropriate statistical tests were applied using SPSS software to determine correlations between non-invasive markers and FibroScan findings.

Data analysis

All collected patient data were systematically entered into a Microsoft Excel master chart and subsequently analyzed using SPSS software. Descriptive statistics such as range, frequencies, percentages, means, and standard deviations were calculated. To assess the significance of differences between quantitative variables, the Chi-square test was employed. A P<0.05 was considered statistically significant.

Ethical considerations

The trial was approved by the M.L.B. Medical College Institutional Review Board Certificate No. 1509/IEC/I/2022-23 Date June 19, 2024. Informed consent was obtained from each of the patients fulfilling the inclusion criteria before their enrolment in the study.

RESULTS

Advanced fibrosis (F4) was most frequently seen in the 41–50 years age group with 14 (12.5%) and was more common in males – 33 (39.76%) – than females – 9 (31.03%) (Table 1). A significant association was observed between elevated AST and ALT levels (>2×ULN) and advanced fibrosis, with 33 (29.4%) in the F4 group having elevated AST and 33 (29.4%) showing elevated ALT (P=0.001 for both). HBV DNA levels >20,000 IU/mL were seen in 59 (52.67%), among which 32 (28.57%) were in the F4 fibrosis group (P=0.007) (Table 1).

Severe steatosis (S3) was most common in the 31–40 years group – 14 (12.50%) – and more prevalent in males – 35 (42.17%) – compared to females – 6 (20.69%) (Table 2). AST and ALT levels showed no significant association with steatosis grades (P=0.98 and 0.47, respectively). However, a significant correlation was found between high HBV DNA levels (>20,000 IU/mL) and S3 steatosis – 22 (19.64%) (P=0.02) (Table 2).

APRI score >1.5 was significantly associated with F4 fibrosis – 36 (32.14%) – with a Chi-square value of 49.533 (P=0.001). APRI showed a sensitivity of 85.71%, a specificity of 79.55%, and an area under the curve (AUC) of 0.837 for fibrosis detection (Table 3). For steatosis, APRI >1.5 was present in 21 (18.75%) in S3, but the association was not significant (P=0.76, AUC=0.517) (Table 4).

FIB-4 score >3.25 was strongly associated with F4-27 (24.11%) – with high diagnostic value (Chi-square=74.946, P=0.001), sensitivity of 64.29%, specificity

Table 1: Correlation of fibrosis with demographic and biochemical parameters in chronic hepatitis B patients

	Fibrosis					
Parameters	**F0 and F1 (%)**	**F2 (%)**	**F3 (%)**	**F4 (%)**	**Chi-square value**	**P-value**
Age						
18–30 years	10 (8.93)	5 (4.46)	3 (2.68)	8 (7.14)	12.510	0.40
31–40 years	12 (10.71)	12 (10.71)	2 (1.79)	10 (8.93)		
41–50 years	5 (4.46)	6 (5.36)	3 (2.68)	14 (12.50)		
51–60 years	2 (1.79)	3 (2.68)	3 (2.68)	9 (8.04)		
>60 years	1 (0.89)	2 (1.79)	1 (0.89)	1 (0.89)		
Sex						
Male	19 (22.89)	23 (27.71)	8 (9.64)	33 (39.76)	12.331	0.41
Female	11 (37.93)	5 (17.24)	4 (13.79)	9 (31.03)		
AST						
<2 ULN	26 (23.2)	20 (17.8)	03 (2.67)	09 (8.03)	37.896	0.001
>2 ULN	04 (3.57)	08 (7.14)	09 (8.03)	33 (29.4)		
ALT (IU/L)						
<2 ULN	26 (23.2)	18 (16.07)	3 (2.67)	9 (8.03)	35.133	0.001
>2 ULN	4 (3.57)	10 (8.92)	9 (8.03)	33 (29.4)		
Correlation of HBV DNA with steatosis						
Not detected	6 (5.36)	7 (6.25)	2 (1.79)	2 (1.79)	22.321	0.007
<2000	10 (8.93)	3 (2.68)	2 (1.79)	6 (5.36)		
2000–20,000	4 (3.57)	6 (5.36)	3 (2.68)	2 (1.79)		
>20000	10 (8.93)	12 (10.71)	5 (4.46)	32 (28.57)		

ULN: Upper limit of normal, ALT: Alanine aminotransferase, HBV: Hepatitis B virus, AST: Aspartate aminotransferase

Table 2: Correlation of steatosis with demographic and biochemical parameters in chronic hepatitis B patients

	Steatosis (S)					
Parameters	**S0 (%)**	**S1(%)**	**S2 (%)**	**S3 (%)**	**Chi-square value**	**P-value**
Age						
18–30	13 (11.61)	3 (2.68)	1 (0.89)	9 (8.04)	12.331	0.41
31–40	10 (8.93)	6 (5.36)	6 (5.36)	14 (12.50)		
41–50	9 (8.04)	4 (3.57)	3 (2.68)	12 (10.71)		
51–60	7 (6.25)	0 (0.00)	4 (3.57)	5 (4.46)		
>60	4 (3.57)	1 (0.89)	0 (0.00)	1 (0.89)		
Sex						
Male	29 (34.94)	11 (13.25)	8 (9.64)	35 (42.17)	5.949	0.11
Female	14 (48.28)	3 (10.34)	6 (20.69)	6 (20.69)		
AST						
<2 ULN	23 (20.5)	9 (8.03)	5 (4.46)	21 (18.75)	0.129	0.98
>2 ULN	20 (17.85)	5 (4.46)	9 (8.03)	20 (17.85)		
ALT (IU/L)						
<2 ULN	23	9	5	20	2.484	0.47
>2 ULN	20	5	9	21		
Correlation of HBV DNA with steatosis						
Not detected	6 (5.36)	1	4	6	19.462	0.02
<2000	4 (3.57)	7	1	6		
2000–20000	7 (6.25)	0	4	7		
>20000	26 (23.21)	6	5	22		

ULN: Upper limit of normal, ALT: Alanine aminotransferase, HBV: Hepatitis B virus, AST: Aspartate aminotransferase

of 85.37%, and AUC of 0.815 (Table 5). While FIB-4 >3.25 was also seen in S3-13 (11.61%) – the association with steatosis was not significant (P=0.13, AUC=0.51) (Table 6).

DISCUSSION

The cross-sectional study we conducted aimed to assess the accuracy of APRI, FIB-4, and FibroScan in assessing the stages of hepatic steatosis and fibrosis in CHB patients and studying their clinical and biochemical profile. The study was performed on 112 patients diagnosed with CHB. The major findings of the study are discussed below: Our study indicates that middle-aged adults, particularly those between 31 and 50 years, were most affected, with significant percentages showing both fibrosis and steatosis progression. Severe fibrosis (F4) was most prevalent in the 41–50 age group (12.5%), whereas severe steatosis (S3) was

Table 3: Correlation of APRI score with hepatic fibrosis stages in chronic hepatitis B patients

Fibrosis stage	APRI			Chi-square	P-value
	No fibrosis (<0.5) (n, %)	Moderate/significant fibrosis (0.5–1.5) (n, %)	Severe fibrosis/cirrhosis (>1.5) (n, %)		
F0 and F1	9 (8.04)	18 (16.07)	3 (2.68)	49.533	0.001
F2	3 (2.68)	17 (15.18)	8 (7.14)		
F3	1 (0.89)	4 (3.57)	7 (6.25)		
F4	1 (0.89)	5 (4.46)	36 (32.14)		
Sensitivity			85.71		
Specificity			79.55		
ROC curve			0.837		

ROC: Receiver operating characteristic

Table 4: Correlation of APRI score with hepatic steatosis grades in chronic hepatitis B patients

Steatosis stage	APRI				
	No fibrosis (<0.5) (n, %)	Moderate/significant fibrosis (0.5–1.5) (n, %)	Severe fibrosis/ cirrhosis (>1.5) (n, %)	Chi-square	P-value
S0	5 (4.46)	19 (16.96)	19 (16.96)	3.314	0.76
S1	2 (1.79)	7 (6.25)	5 (4.46)		
S2	1 (0.89)	4 (3.57)	9 (8.04)		
S3	6 (5.36)	14 (12.50)	21 (18.75)		
Sensitivity			51.22		
Specificity			68.27		
ROC curve			0.517		

ROC: Receiver operating characteristic

Table 5: Correlation of FIB-4 score with hepatic fibrosis severity in patients with chronic hepatitis B

Steatosis stage	FIB4				
	No fibrosis (<1.45) (%)	Significant fibrosis (1.45–3.25) (%)	Advanced fibrosis or cirrhosis (>3.25) (%)	Chi-square	P-value
S0	23 (20.54)	6 (5.36)	1 (0.89)	74.946	0.001
S1	6 (5.36)	19 (16.96)	3 (2.68)		
S2	1 (0.89)	3 (2.68)	8 (7.14)		
S3	1 (0.89)	14 (12.50)	27 (24.11)		
Sensitivity			64.29		
Specificity			85.37		
ROC curve			0.815		

ROC: Receiver operating characteristic, FIB-4: Fibrosis-4

Table 6: Correlation of FIB-4 score with hepatic steatosis grades in patients with chronic hepatitis B

Steatosis stage	FIB4				
	No fibrosis (<1.45)	Significant fibrosis (1.45–3.25)	Advanced fibrosis or cirrhosis (>3.25)	Chi-square	P-value
S0	16 (14.29)	12 (10.71)	15 (13.39)	9.746	0.13
S1	6 (5.36)	4 (3.57)	4 (3.57)		
S2	1 (0.89)	6 (5.36)	7 (6.25)		
S3	8 (7.14)	20 (17.86)	13 (11.61)		
Sensitivity			31.71		
Specificity			73.20		
ROC curve			0.51		

ROC: Receiver operating characteristic, FIB-4: Fibrosis-4

more common in the 31–40 age group (12.5%). Although fibrosis and steatosis were present across all age groups, older individuals exhibit more advanced stages. However, the p-value was not significant.

This finding was consistent with other studies, such as one conducted by Moosavy et al.,[6] where middle-aged CHB patients also showed significant fibrosis progression. Their study using FibroScan identified

that 14.2% of patients had F3 fibrosis and 7.5% had F4 fibrosis, confirming that fibrosis tends to worsen with age.

The study population comprised males 74.10% and females 25.9% out of which fibrosis (F4) was found in 39.76% of males and 31.03% of females, and steatosis (S3) was found in 42.17% of males and 20.69% of females. A study by Hui RW, et al. (2018)[7] found that the presence of hepatic steatosis was strongly associated with fibrosis progression, regardless of sex.

In our study, 48.21% of patients exhibited AST levels above twice the ULN. Importantly, they were strongly associated with advanced fibrosis, particularly at the cirrhotic stage (F4) (P=0.001), whereas AST levels showed no significant correlation with the degree of hepatic steatosis (P=0.98). A similar study by Moosavy et al.[6] also revealed that elevated AST levels have a strong correlation with advanced liver fibrosis, particularly at stages F3 and F4, and were significantly associated with fibrosis progression.

In our study, elevated ALT levels were observed in 50.89% of patients, and there was a strong correlation (P=0.001) between elevated ALT and advanced fibrosis (F4), which was observed in 29.4% of patients with ALT levels above twice the ULN. However, while ALT was a reliable indicator for fibrosis, its correlation with hepatic steatosis stages was not statistically significant (P=0.47). A study by Moosavy et al.,[6] observed similar results.

In our study, significant correlation between high HBV DNA levels and liver disease progression, with a majority of patients (52.67%) exhibiting active viral replication above 20,000 IU/mL. This was strongly associated with advanced fibrosis (28.57% in F4 stage) (P=0.007) and, to a lesser extent, severe steatosis (19.64% in S3 stage) (P=0.02). A study by Sanai et al.,[8] revealed patients with significant (F2-4) fibrosis were identified by higher HBV DNA values >2,000 IU/mL compared to those with non-significant fibrosis. A study by Wang et al.,[9] indicated that hepatic steatosis might correlate with HBV DNA levels, suggesting that viral suppression could reduce fat accumulation in the liver.

Our study showed that advanced fibrosis (F4) is frequently associated with ultrasound findings such as altered echotexture, irregular liver margins, and portal hypertension. Similarly, the correlation of USG with steatosis revealed that severe steatosis (S3) was linked with USG findings, which included heterogeneous liver echotexture. Kim et al., (2024),[10] also emphasized the utility of non-invasive tools such as FibroScan alongside ultrasound in detecting liver abnormalities.

Our study showed that the relationship between APRI (AST to Platelet Ratio Index) and fibrosis stages was statistically significant. The data showed that higher APRI scores were closely linked to advanced fibrosis (32.14%), particularly cirrhosis (F4), with a Chi-square value of 49.533 and a P=0.001. The sensitivity of APRI in detecting fibrosis was 85.71%, with a specificity of 79.55% and an area under the ROC curve (AUC) of 0.837. This confirms APRI's role as a reliable non-invasive marker for fibrosis, particularly in patients with CHB. In contrast to its correlation with fibrosis, there was no significant association between APRI and steatosis stages, with a Chi-square value of 3.314 and a P=0.76. The sensitivity of APRI for detecting steatosis was 51.22%, and the specificity was 68.27%, with an AUC of only 0.517. Our study aligns well with previous studies that also reported significant associations between APRI and fibrosis. As observed in a study by Moosavy et al.,[6] APRI had a strong correlation with FibroScan for detecting liver fibrosis, with an AUC of 0.852 for APRI. A study by Badawi et al.,[11] showed that APRI with an AUC of 0.642 was positively correlated to the degree of fibrosis in CHB patients.

In our study, a significant correlation between FIB4 scores and various stages of fibrosis was evident (P<0.001). Specifically, FIB4 scores above 3.25 were strongly associated with advanced fibrosis (F4), with 24.11% of patients exhibiting these elevated scores. The sensitivity of the FIB4 index for detecting advanced fibrosis was moderate at 64.29%, whereas the specificity was relatively high at 85.37%, indicating that FIB4 was particularly effective at ruling out significant fibrosis when values were low. The ROC curve further supports the utility of FIB4 in detecting fibrosis, with an AUC of 0.815, underscoring its diagnostic accuracy. The patients with advanced steatosis (S3) had higher FIB4 scores, with the overall association was not statistically significant (P=0.13). The sensitivity of the FIB4 index in predicting steatosis was considerably lower at 31.71%, though the specificity remains reasonably high at 73.20. The ROC curve for steatosis further supports this observation, with an AUC of 0.51. Our study aligns with other studies, such as by Moosavy et al.,[6] showed that FIB-4 had a sensitivity of 81.1% and specificity of 62.3% at the low cutoff (1.45) to rule out significant fibrosis (≥F3), whereas at the higher cutoff (3.25) FIB-4 showed a specificity of 92.6% for ruling in severe fibrosis or cirrhosis. Li et al.[12] showed that FIB-4 performs better for predicting advanced fibrosis (S3-S4) with an AUROC of 0.67 compared to significant fibrosis (S2-S4) with an AUROC of 0.60. A study by Badawi et al. (2020)[11] showed

that FIB-4 with an AUC of 0.601 was positively correlated to the degree of fibrosis in CHB patients.

Limitations of the study

This single-center study was limited by its cross-sectional design, absence of liver biopsy validation, modest sample size, and exclusion of co-infected or comorbid patients. Non-invasive scores like APRI and FIB-4 showed limited utility for steatosis, and FibroScan results may vary with operator skill and patient factors.

CONCLUSION

Based on the findings of this study, it can be concluded that non-invasive tools such as FibroScan, APRI, and FIB-4 scores are valuable and reliable alternatives to liver biopsy for assessing hepatic fibrosis and steatosis in patients with CHB. A significant association was observed between elevated AST and ALT levels, high HBV DNA viral loads, and the severity of liver involvement. FibroScan proved particularly effective in detecting advanced fibrosis and steatosis, whereas APRI and FIB-4 also demonstrated good diagnostic accuracy, especially for fibrosis. These markers offer a practical, accessible, and safer means of evaluating liver pathology in CHB patients, especially in resource-limited settings, and can aid in timely diagnosis, risk stratification, and management planning, thereby potentially reducing the progression to cirrhosis and hepatocellular carcinoma.

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Recommendations

This study recommends incorporating non-invasive tools such as FibroScan, APRI, and FIB-4 into the routine assessment of patients with CHB for evaluating liver fibrosis and steatosis. These methods serve as practical substitutes for liver biopsy, especially in settings with limited resources. APRI and FIB-4 were effective in identifying significant fibrosis, while FibroScan was useful for both fibrosis and fat assessment. Monitoring liver enzymes (AST and ALT) and HBV DNA levels is important, as they correlate with the severity of liver damage. Using these tests can support early diagnosis and help prevent complications such as cirrhosis and liver cancer.

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