International Journal of Medical Sciences And Clinical Research

VOLUME Vol.05 Issue10 2025
PAGE NO. 88-91
DOI 10.37547/ijmscr/Volume05Issue10-18

Multiparametric Ultrasound Diagnosis Of Liver Cirrhosis And Portal Hypertension

Yusupaliyeva G.A.
Tashkent State Medical University, Uzbekistan

Kutumov Kh.Yu.
Tashkent State Medical University, Uzbekistan

Received: 31 August 2025; **Accepted:** 26 September 2025; **Published:** 31 October 2025

Abstract: Background: Liver cirrhosis remains a major medical and social problem worldwide due to its high morbidity, mortality, and frequent complications, including portal hypertension. Early diagnosis of cirrhosis is challenging because of the long asymptomatic course of the disease. Multiparametric ultrasound imaging, combining B-mode ultrasound, Doppler sonography, and shear wave elastography (SWE), provides a non-invasive approach for assessing both structural and hemodynamic liver changes.

Aim: To evaluate the diagnostic value of multiparametric ultrasound examination combined with Doppler assessment of portal and arterial blood flow and liver shear wave elastography in patients with liver cirrhosis.

Materials and Methods: The study included 104 patients with liver cirrhosis of various etiologies. All patients underwent B-mode ultrasound, Doppler sonography of portal and arterial vessels, and SWE. Disease severity was assessed using the Child–Pugh classification. Ultrasound and Doppler parameters were compared with data from healthy volunteers and patients with diffuse liver diseases without cirrhosis.

Results: Multiparametric ultrasound revealed characteristic structural and hemodynamic changes depending on cirrhosis stage. Portal vein diameter increased and portal blood flow velocities decreased with disease progression. Liver stiffness values measured by SWE increased significantly from Child–Pugh stage A to C. A significant negative correlation was found between liver stiffness and portal blood flow velocities ($p < 0.05$). SWE enabled detection of fibrosis and cirrhosis at early stages, before the appearance of morphological signs of portal hypertension.

Conclusion: Multiparametric ultrasound examination, including Doppler sonography and shear wave elastography, is a highly effective non-invasive method for early diagnosis, staging, and monitoring of liver cirrhosis and portal hypertension. Regular follow-up examinations every 6 months are recommended to improve prognosis and timely detect complications.

Keywords: Liver cirrhosis; Portal hypertension; Multiparametric ultrasound; Doppler sonography; Shear wave elastography; Liver fibrosis.

Introduction: Liver cirrhosis (LC) represents a significant socio-economic and clinical-epidemiological problem [2,8]. The incidence of LC ranges from 20 to 40 per 100,000 population [2]. Diagnosis is complicated by the late manifestation of clinical symptoms [3]. Regardless of etiology, common pathogenetic mechanisms of cirrhosis include hepatocyte hypoxia and necrosis, leading to pathological regeneration with the formation of pseudolobules and proliferation of connective tissue [3,5]. Liver cirrhosis remains one of the leading global medical and social problems associated with high morbidity and mortality rates [2,8]. Despite advances in modern hepatology, early diagnosis of cirrhosis remains challenging due to the long asymptomatic course of the disease [2,5]. Irrespective of etiology, cirrhosis is characterized by hepatocyte necrosis, hypoxia, fibrogenesis, and

disruption of hepatic parenchymal architecture, resulting in portal hypertension and systemic complications [1,2,3]. Reorganization of the portal and arterial systems of the abdominal cavity is considered a key feature of LC [2,6]. In recent years, multiparametric ultrasound diagnostics, including Doppler sonography and elastography, has enabled assessment of both structural and functional liver changes, allowing earlier diagnosis and monitoring of disease progression [1,4,5]. Ultrasound examination is widely used as a first-line imaging modality in patients with suspected chronic liver disease due to its availability, safety, and cost-effectiveness [1,2,4]. In addition to B-mode imaging, Doppler sonography allows non-invasive evaluation of portal and arterial hemodynamics [2,6]. However, the clinical significance of Doppler parameters, particularly arterial indices, remains debatable, and their role in cirrhosis staging has not been definitively established [8,9].Aim To assess the diagnostic value of multiparametric ultrasound examination combined with Doppler evaluation of portal and arterial blood flow and liver elastography in patients with liver cirrhosis.

METHODS

The study included 104 patients with liver cirrhosis of various etiologies who underwent B-mode ultrasound examination and Doppler sonography. Disease severity was assessed using the Child–Pugh classification. The diameters of the portal and splenic veins, as well as linear and volumetric blood flow velocities, were measured. Arterial blood flow parameters were also evaluated in the hepatic artery, splenic artery, and celiac trunk. The results were compared with data from healthy volunteers and patients with diffuse liver diseases. The study population consisted of 104 patients with liver cirrhosis of various etiologies examined between 2003 and 2010. In 61 patients (58.6%), the diagnosis was morphologically confirmed (liver biopsy or autopsy). In 43 patients (41.4%), cirrhosis was diagnosed based on clinical, laboratory, and instrumental findings with dynamic follow-up. The cohort included 57 men (54.8%) and 47 women (45.2%), predominantly aged 35–65 years. The etiology of cirrhosis included alcoholic (39.4%), viral (31.7%), and other forms (biliary, autoimmune, Wilson's disease). Disease severity according to the Child–Pugh classification was as follows: stage A – 21 patients (20.2%), stage B – 38 patients (36.5%), and stage C – 45 patients (43.3%). Two comparison groups were formed: a control group of 18 healthy volunteers and a comparison group of 29 patients with diffuse liver diseases without cirrhosis (chronic hepatitis, fatty liver disease).

Ultrasound examinations were performed using an Aplio 500 ultrasound system with a 3.5-MHz convex transducer.

In B-mode, liver size, contours, echogenicity, and parenchymal homogeneity were assessed, as well as spleen size and the presence of ascites.

Doppler sonography was used to evaluate the portal and splenic veins, hepatic and splenic arteries, and the celiac trunk. The following parameters were recorded: vessel diameter, peak systolic velocity (PSV), end-diastolic velocity (EDV), and resistive index (RI). Linear (LBV) and volumetric blood flow velocity (VBV) for the portal and splenic veins were calculated using the formula:

VBV = vessel radius × LBV × 60.

Liver Elastography

Shear wave elastography (SWE) was performed using a 3.5-MHz convex transducer. The region of interest was placed in the right lobe of the liver, avoiding vessels and bile ducts. Mean liver stiffness values (kPa) were calculated based on five measurements per patient. SWE was used to assess fibrosis severity and its correlation with portal hemodynamics.

Statistical Analysis

Data are presented as mean ± standard error. Comparative analysis was performed between groups and cirrhosis stages. Differences were considered statistically significant at $p < 0.05$.

RESULTS

B-mode ultrasound examination revealed the following findings. Irregular liver contours were detected in 21.2% of patients and were observed exclusively in Child–Pugh stages B and C. This feature was frequently associated with ascites and pronounced clinical symptoms and was absent in early disease stages.

Hypertrophy of the caudate lobe (>35 mm) was detected in 46% of patients. In decompensated cirrhosis, a reduction in the right liver lobe with compensatory enlargement of the left lobe was noted. Increased liver echogenicity and posterior acoustic attenuation were observed in most patients, particularly in alcoholic cirrhosis.

Splenomegaly was predominantly observed in stages B and C. Ascites and collateral venous circulation were detected in 20.2% of patients. No significant association was found between morphological ultrasound features and cirrhosis etiology.

The portal vein diameter in patients with cirrhosis was significantly increased compared to the control group, reaching maximal values at Child–Pugh stage B and decreasing at stage C, presumably due to the formation of portosystemic shunts. Linear and volumetric portal

blood flow velocities progressively decreased with disease severity. Hepatopetal portal blood flow was preserved in most patients, whereas reversed flow was detected only in decompensated cirrhosis (2.8%). No statistically significant cirrhosis-specific changes in arterial blood flow parameters were identified.

Doppler sonography enabled evaluation of portal venous and arterial hemodynamics.

Portal Venous Hemodynamics

The portal vein diameter in cirrhotic patients was significantly greater than in healthy individuals. It increased from stage A to stage B and decreased at stage C. Linear and volumetric portal blood flow velocities progressively declined with increasing disease severity. Hepatopetal flow was preserved in most patients; reversed flow was detected only at stage C (2.8%) and was associated with severe portal hypertension.

Arterial Hemodynamics

No statistically significant differences were found in arterial diameters, velocity parameters, or resistive index between cirrhotic patients, the control group, and the comparison group. Arterial blood flow parameters demonstrated high individual variability and did not correlate with cirrhosis stage.

The results indicate that alterations in portal venous hemodynamics are the most reliable Doppler markers of liver cirrhosis progression. Enlargement of the portal and splenic veins and reduction of portal blood flow reflect increased intrahepatic resistance and the formation of portosystemic anastomoses. At the same time, arterial blood flow parameters do not demonstrate stable cirrhosis-specific changes, which is consistent with published data. Significant influence of physiological factors (respiration, food intake, body position, medications) complicates interpretation of arterial Doppler indices. Doppler sonography remains the only non-invasive method for real-time assessment of hepatic blood flow. Its diagnostic value increases during dynamic follow-up and when interpreted in combination with clinical and laboratory data.

Elastography made it possible to quantitatively assess the degree of fibrosis and to detect early cirrhotic changes in the liver. In combination with Doppler sonography of the portal system, it provides a comprehensive evaluation of both structural and hemodynamic alterations.

In contrast to conventional ultrasound features (irregular contours, changes in echogenicity), which appear at later stages, shear wave elastography (SWE) enables detection of pathology at an early stage. This approach improves early diagnosis, monitoring, and prediction of complications, including portal hypertension.

The following liver parenchymal stiffness values were characteristic for elastography:

Stage A: 9.8 ± 1.6 kPa

Stage B: 15.7 ± 2.4 kPa

Stage C: 23.9 ± 3.8 kPa

Control group: 5.6 ± 0.9 kPa

Comparison group (diffuse liver diseases): 6.8 ± 1.2 kPa

Correlation between liver stiffness and linear blood flow velocity (LBV) in the portal vein was $r = -0.62$, $p < 0.05$; and with volumetric blood flow velocity (VBV) $r = -0.58$, $p < 0.05$. SWE detects fibrosis and cirrhosis before the appearance of morphological signs of portal hypertension.

Study Limitations

The limitations of the study include its single-center design, the operator-dependent nature of Doppler measurements, and the lack of complete longitudinal follow-up for all patients.

CONCLUSION

Multiparametric ultrasound examination combined with Doppler assessment of portal circulation is a valuable non-invasive method for diagnosing liver cirrhosis and for early detection of portal hypertension. Follow-up examinations every 6 months are recommended to monitor disease progression and to ensure timely identification of potentially life-threatening complications.

In addition to standard ultrasound and Doppler assessment, the use of shear wave elastography (SWE) allows quantitative evaluation of liver stiffness, enabling detection of early fibrotic and cirrhotic changes. No significant alterations in arterial blood flow parameters of the abdominal vessels were identified in patients with liver cirrhosis.

Multiparametric liver ultrasound diagnostics, including B-mode imaging, Doppler sonography, and SWE, represents a highly effective non-invasive method for detection and monitoring of liver cirrhosis. SWE enables quantitative assessment of fibrosis, while Doppler sonography reflects functional hemodynamic changes. Dynamic follow-up of patients with liver cirrhosis every 6 months is recommended.

REFERENCES

1. Şirli R, Sporea I, Popescu A, Dănilă M. Ultrasound-based elastography for the diagnosis of portal hypertension in cirrhotics. World J Gastroenterol. 2015;21(41):11542–11551. doi:10.3748/wjg.v21.i41.11542.

2. Petta S, et al. Non-invasive evaluation of portal hypertension using ultrasound elastography. J Hepatol. 2017;67(2):221–223.
3. Roccarina D, Rosselli M, Genesca J, Tsochatzis EA. Elastography methods for the non-invasive assessment of portal hypertension. Expert Rev Gastroenterol Hepatol. 2018;12(2):155–164.
4. Piscaglia F, Salvatore V, Mulazzani L, et al. Ultrasound shear wave elastography for liver disease. Ultraschall Med. 2016;37(1):1–5.
5. Villani R, Lupo P, Sangineto M, et al. Liver ultrasound elastography in non-alcoholic fatty liver disease: a state-of-the-art summary. Diagnostics. 2023;13(7):1236.
6. Yamaguchi K, Seko Y, Sakai T, et al. Comparison of portal vein hemodynamics with ultrasound-based elastography for the prediction of liver fibrosis in patients with chronic liver disease. Sci Rep. 2023;13:3425.
7. Chinese expert consensus on the diagnosis of cirrhotic portal hypertension by ultrasound elastography (2023 version).
8. Petta S, Marchesini G. Role of liver and spleen stiffness measurements in chronic liver disease and portal hypertension assessment. J Hepatol. 2017.
9. Doppler ultrasound compared to shear wave elastography for assessment of liver cirrhosis. Egyptian Journal of Internal Medicine. 2025.
10. Non-invasive diagnosis of portal hypertension in cirrhosis using ultrasound-based elastography. Iuliu Haţieganu Medical Publishing House.
11. Petta S, et al. Ultrasound elastography in advanced chronic liver disease: rationale and applications. J Hepatol. Review.
12. Relevant international consensus and guidelines on SWE in portal hypertension.
13. Magnetic resonance elastography in cirrhosis and portal hypertension. Gastroenterology Reports.
14. Hybrid models combining ultrasound and artificial intelligence for cirrhosis assessment.
15. Clinical use of hepatic venous pressure gradient (HVPG) measurements in chronic liver disease. Nat Rev Gastroenterol Hepatol.