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Comprehensive Ultrasound Assessment Of Liver Cirrhosis And Portal Hypertension

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Abstract: Objective: to assess the diagnostic value of multiparametric liver ultrasound combined with Doppler evaluation of portal and arterial blood flow and shear wave elastography (SWE) in patients with liver cirrhosis.

Material and methods: 104 patients with liver cirrhosis of various etiologies were examined. B-mode ultrasound, Doppler assessment of portal and arterial circulation, and liver SWE were performed. Disease severity was assessed using the Child–Pugh classification. Results: progressive reduction in linear and volumetric portal blood flow velocities was observed with increasing cirrhosis severity, along with a significant increase in liver stiffness on SWE showing strong correlations with portal hemodynamic parameters.

Conclusion: multiparametric ultrasound is an effective noninvasive method for early diagnosis of liver cirrhosis and portal hypertension.

Keywords: Liver cirrhosis, ultrasound imaging, Doppler ultrasound, portal hypertension, elastography, SWE.

Introduction: Liver cirrhosis (LC) is a significant socio-economic and clinical-epidemiological problem. The incidence of LC ranges from 20 to 40 per 100,000 population. Diagnosis is complicated by the late onset of clinical symptoms. Regardless of etiology, the pathogenesis of cirrhosis is characterized by hepatocyte necrosis, hypoxia, fibrogenesis, and disruption of hepatic parenchymal architecture, leading to the development of portal hypertension and systemic complications.

In recent years, multiparametric ultrasound diagnostics, including Doppler sonography and elastography, has enabled assessment of both structural and functional liver changes, providing earlier diagnosis and monitoring of disease progression. 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.

Aim

To evaluate the diagnostic value of multiparametric ultrasound examination combined with Doppler assessment 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 examined between 2003 and 2010. Morphological confirmation of the diagnosis was obtained in 61 patients (58.6%). The etiology of

cirrhosis included alcoholic (39.4%), viral (31.7%), and other forms (biliary, autoimmune, Wilson's disease). Disease severity was assessed according to the Child–Pugh classification: stage A – 21 patients (20.2%), stage B – 38 patients (36.5%), and stage C – 45 patients (43.3%). The control group consisted of 18 healthy volunteers, and the comparison group included 29 patients with diffuse liver diseases.

Ultrasound examinations were performed using an Aplio 500 system with a 3.5-MHz convex transducer. In B-mode, liver size, contours, echogenicity, parenchymal homogeneity, spleen size, and the presence of ascites were assessed. Doppler sonography was used to evaluate the portal and splenic veins, hepatic and splenic arteries, as well as the celiac trunk. Shear wave elastography (SWE) was performed in the right lobe of the liver, avoiding vessels and bile ducts; mean liver stiffness values were calculated based on five measurements.

Statistical Analysis

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

RESULTS

B-mode ultrasound revealed irregular liver contours, caudate lobe hypertrophy, increased echogenicity, and splenomegaly, predominantly in Child–Pugh stages B and C. Ascites and collateral venous circulation were

Table 1. Portal hemodynamic parameters in liver cirrhosis (Child–Pugh classification)

Parameter	Control	Child–Pugh A	Child–Pugh B	Child–Pugh C
Portal vein diameter, mm	11.2 ± 1.1	13.4 ± 1.3*	15.1 ± 1.6*	13.8 ± 1.5*
Portal vein linear velocity, cm/s	18.6 ± 2.4	14.9 ± 2.1*	11.3 ± 1.9*	8.7 ± 1.6*
Portal vein volumetric flow, mL/min	980 ± 110	760 ± 95*	540 ± 88*	410 ± 72*
Direction of blood flow	Hepatopetal	Hepatopetal	Hepatopetal	Hepatopetal / reversed (2.8%)

Note: * $p < 0.05$.

Table 2. Liver stiffness values according to SWE and correlation with portal blood flow

Group	Liver stiffness, kPa (M ± m)	Correlation with linear velocity (r)	Correlation with volumetric flow (r)
Control	5.6 ± 0.9	-	-
Diffuse liver diseases	6.8 ± 1.2	-0.21	-0.18

Child–Pugh A	9.8 ± 1.6*	-0.42*	-0.39*
Child–Pugh B	15.7 ± 2.4*	-0.56*	-0.52*
Child–Pugh C	23.9 ± 3.8*	-0.62*	-0.58*

Note: * $p < 0.05$.

DISCUSSION

The results demonstrate that alterations in portal hemodynamics are reliable markers of liver cirrhosis progression. Linear and volumetric portal blood flow velocities significantly decrease with increasing disease severity, whereas arterial parameters remain variable and nonspecific. Shear wave elastography (SWE) enables quantitative assessment of fibrosis at early stages and allows detection of pathology before the appearance of morphological signs of portal hypertension. Comparison with published data (Petta et al., Şirli et al., Roccarina et al., Villani et al.) confirms the high diagnostic value of integrating SWE and Doppler sonography for dynamic follow-up and complication prediction. The study findings emphasize the importance of a comprehensive approach in assessing functional and structural liver changes.

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 method for non-invasive detection and monitoring of liver cirrhosis. SWE provides quantitative assessment of fibrosis, while Doppler sonography reflects functional hemodynamic changes. Dynamic follow-up of patients with liver cirrhosis every 6 months is recommended.

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