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KEY LABORATORY MARKERS IN LIVER PATHOLOGY

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Annotation. *Liver diseases represent a significant medical and social problem due to their high prevalence, diversity of clinical forms, and the risk of developing severe complications. In modern clinical practice, laboratory markers serve as the main tool for early diagnosis, differential assessment, and dynamic monitoring of the course of hepatic pathology. Biochemical indicators of cytolysis, cholestasis, and the synthetic function of the liver are of key importance, along with immunological and serological markers that enable the identification of viral, autoimmune, and metabolic diseases. A comprehensive analysis of laboratory data contributes to уточнение the diagnosis, determination of disease stage, and evaluation of the effectiveness of ongoing therapy.*

Keywords: liver diseases, laboratory markers, liver function tests, biochemical markers, cytolysis, cholestasis, synthetic liver function, immunological markers, serological markers, viral hepatitis, autoimmune liver diseases, metabolic liver disorders, clinical diagnostics

Relevance. Liver diseases occupy one of the leading positions in the structure of overall morbidity and mortality worldwide. The increasing prevalence of viral hepatitis, alcoholic and non-alcoholic fatty liver disease, toxic and autoimmune liver injuries makes the problem of early diagnosis particularly significant. The liver performs vital functions, including participation in metabolism, detoxification, and the synthesis of proteins and blood coagulation factors; therefore, even minor impairments in its function can lead to severe systemic consequences [3,8,11,19].

Laboratory markers are among the key tools in the diagnosis of liver diseases, as they allow the detection of pathological changes at early stages, often before the appearance of clinical symptoms. Determination of liver enzyme levels (ALT, AST, ALP, GGT), bilirubin, protein fractions, and coagulation parameters makes it possible to assess the nature and extent of liver damage, the activity of the inflammatory process, and the functional state of the organ [6,7,10,20].

The relevance of studying laboratory markers in liver diseases is also determined by their important role in monitoring the course of the disease, assessing the effectiveness of ongoing therapy, and predicting outcomes. Modern laboratory methods make it possible to differentiate various forms of liver injury and to timely adjust treatment strategies, which significantly improves patients' quality of life and reduces the risk of developing complications such as cirrhosis and liver failure [1,4,6,19].

The etiology of liver diseases is characterized by considerable diversity and includes a wide range of factors capable of causing structural and functional disorders of this organ. One of the most common causes of liver damage is viral infections, particularly viral hepatitis A, B, C, D, and E. These infections lead to the development of an acute or chronic inflammatory process which, in the absence of timely treatment, may progress to liver fibrosis and cirrhosis. Toxic exposure to various substances also plays a significant role in the etiology of liver diseases. These include alcohol, medications, industrial toxins, and chemical compounds. Prolonged or uncontrolled exposure to toxins causes hepatocellular damage and impairment of metabolic

functions, contributing to the development of toxic and alcoholic liver injury [1,7,15,20].

Metabolic disorders are also an important etiological factor. Non-alcoholic fatty liver disease often develops against the background of obesity, type 2 diabetes mellitus, dyslipidemia, and metabolic syndrome. As a result of excessive fat accumulation in hepatocytes, their function is impaired and the risk of inflammation and fibrosis increases. Other causes of liver diseases include autoimmune processes, in which the immune system mistakenly attacks liver cells, as well as hereditary and genetic disorders such as Wilson–Konovalov disease, hemochromatosis, and α1-antitrypsin deficiency. In addition, diseases of the biliary tract and impaired bile outflow can lead to cholestatic liver injury [3,12,15,18].

The pathogenesis of liver diseases is a complex and multistage process involving molecular, cellular, and systemic mechanisms of hepatic tissue damage. Regardless of the etiological factor, the key link in pathogenesis is hepatocellular injury, accompanied by disruption of their structure and functions. Under the influence of viruses, toxic substances, alcohol, metabolic, and immune factors, intracellular stress mechanisms are activated, leading to dystrophy, necrosis, or apoptosis of liver cells [6,10,17].

Inflammation plays an important role in the pathogenesis. Damaged hepatocytes release inflammatory mediators, activating Kupffer cells and other immunocompetent cells of the liver. This is accompanied by increased production of pro-inflammatory cytokines, chemokines, and free radicals, which contributes to the maintenance and chronicity of inflammation. With a prolonged disease course, the inflammatory response leads to progressive damage to the hepatic parenchyma [3,13,19].

One of the central mechanisms of pathogenesis is the development of liver fibrosis. Under the influence of chronic inflammation, hepatic stellate cells are activated, transform into myofibroblasts, and begin to actively synthesize collagen and other components of the extracellular matrix. Excessive accumulation of connective tissue disrupts the liver architecture, impairs blood supply, and leads to a

decrease in the functional activity of the organ. Progression of fibrosis over time may result in the formation of liver cirrhosis [7,15,19].

Disturbances of intrahepatic circulation and the development of portal hypertension are of significant importance in the pathogenesis. Increased vascular resistance in the liver causes blood congestion in the portal venous system, leading to splenomegaly, ascites, and varicose veins of the esophagus and stomach. These changes significantly worsen the patient's general condition and increase the risk of life-threatening complications. Impairment of the synthetic, detoxifying, and metabolic functions of the liver is another important aspect of pathogenesis. The synthesis of plasma proteins and blood coagulation factors is reduced, and the metabolism of bilirubin, fats, carbohydrates, and vitamins is disrupted. This leads to the development of hypoproteinemia, coagulopathies, jaundice, and endogenous intoxication. In severe cases, liver failure and hepatic encephalopathy develop [6,12,19].

Laboratory diagnosis of liver diseases plays a key role in the detection, differentiation, and monitoring of pathological processes in this organ. Laboratory investigations make it possible not only to confirm the presence of liver damage but also to assess its nature, degree of activity, and functional state of the organ. A comprehensive analysis of biochemical, immunological, and serological parameters allows liver diseases to be identified at early stages, often before the appearance of pronounced clinical symptoms [3,7,15,20].

One of the main directions of laboratory diagnostics is the determination of liver enzyme activity. Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) are sensitive markers of hepatocellular injury. An increase in their blood levels indicates cytolytic syndrome and is characteristic of viral, toxic, and drug-induced hepatitis. The AST/ALT ratio (De Ritis ratio) has diagnostic value in differentiating alcoholic liver disease from other forms of hepatitis. To assess cholestatic syndrome, alkaline phosphatase (ALP), gamma-glutamyltransferase (GGT), and bilirubin levels are used. Elevation of these markers indicates impaired bile outflow and may be

observed in biliary tract diseases, primary biliary cirrhosis, neoplastic processes, and drug-induced liver injury. Determination of total, direct, and indirect bilirubin helps clarify the type of jaundice and the degree of bilirubin metabolism impairment [15,20].

An important aspect of laboratory diagnostics is the assessment of the synthetic function of the liver. For this purpose, total protein, albumin, cholinesterase levels, as well as coagulation system parameters (prothrombin time, INR) are determined. A decrease in these indicators reflects severe liver damage and the development of liver failure, especially in cirrhosis and chronic diffuse liver diseases [7,14,19].

Serological and immunological studies are of particular importance in identifying the etiology of liver diseases. Determination of viral hepatitis markers (HBsAg, anti-HCV, anti-HAV, etc.) makes it possible to diagnose acute and chronic viral infections. In cases of suspected autoimmune liver diseases, autoantibodies (ANA, SMA, AMA, LKM) as well as immunoglobulin levels are assessed [9,14,15,18].

Additional laboratory methods include the determination of metabolic and genetic markers. Assessment of ferritin, ceruloplasmin, copper, and α1-antitrypsin levels is used for the diagnosis of hereditary and metabolic liver diseases. Modern non-invasive laboratory fibrosis indices (APRI, FIB-4) allow evaluation of the degree of fibrotic changes without the need for liver biopsy [5,10,20].

Conclusion. Liver diseases represent a serious medical and social problem due to their high prevalence, diversity of etiological factors, and risk of developing severe complications. Timely and accurate diagnosis of these conditions is crucial for selecting effective therapeutic strategies and preventing progression of the pathological process. Laboratory diagnostics occupies a central place in the detection of liver diseases, as it enables objective assessment of the extent of hepatocellular damage, the severity of inflammatory and cholestatic processes, and the functional state of the organ. A comprehensive evaluation of biochemical, serological, and immunological markers ensures early detection of pathology, clarification of its etiology, and monitoring of treatment effectiveness.

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