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MODERN AND INNOVATIVE METHODS AND PARAMETERS FOR EARLY DETECTION OF MORPHOLOGICAL CHANGES IN THE LIVER IN NEPHROLITHIASIS

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Abstract. Kidney stone disease (urolithiasis) has a significant impact not only on the urinary system, but also on other organs of the body, in particular the liver. Metabolic disorders, oxidative stress, chronic inflammation and endotoxemia lead to morphological and functional changes in the liver. This article analyzes modern innovative methods for early detection of morphological changes in the liver in kidney stone disease, laboratory and instrumental parameters, biomarkers and diagnostic technologies based on artificial intelligence. The results of the study show that by identifying liver pathology at the subclinical stage, it is important to prevent the aggravation of the disease and develop an individual treatment strategy.

Keywords: kidney stone disease, liver morphology, elastography, biomarkers, oxidative stress, metabolomics, MRI

Introduction.

Kidney stones are a chronic metabolic disease characterized by the formation of stones in the urinary system as a result of the crystallization of mineral and organic substances. In medicine, this disease is called “urolithiasis” or “nephrolithiasis”. The disease is widespread throughout the world, has a high recurrence rate and can be accompanied by severe complications.

Kidney stones are mainly formed in the renal calyces and then fall into the urinary tract, causing obstruction, inflammation and impaired kidney function.

Kidney stones are one of the most common urological pathologies in the world. According to epidemiological data, the incidence of the disease has increased significantly in recent decades. Urolithiasis is closely associated with metabolic syndrome, insulin resistance, chronic inflammation and oxidative stress in the body, which cause secondary pathological changes in the liver.

The liver, as the main detoxification organ of the body, is actively involved in metabolic processes. As a result of impaired kidney function, the accumulation of endotoxins and metabolites has a toxic effect on hepatocytes, leading to the development of steatosis, microcirculatory disorders, fibrosis and inflammatory reactions. Therefore, early detection of morphological changes in the liver is one of the urgent issues in clinical practice.

In kidney stone disease, the following morphological changes are observed in the liver:

Hepatocyte dystrophy

fatty degeneration;

vacuolar dystrophy;

hydropic changes.

Microcirculatory disorders

sinusoidal dilatation;

portal venous congestion;

microthromboses.

Inflammatory infiltration

lymphocytic infiltration;

Kupffer cell activation.

Fibrotic changes

collagen deposition;

perisinusoidal fibrosis;

portal fibrosis.

Ultrastructural changes associated with oxidative stress

mitochondrial damage;

endoplasmic reticulum deformation.

Mechanisms of pathogenesis

The following mechanisms play a key role in the development of liver changes:

Oxidative stress

Increased reactive oxygen species increase lipid peroxidation and damage hepatocyte membranes.

Endotoxicosis

As a result of decreased renal filtration, nitrogenous metabolites accumulate in the liver.

Metabolic syndrome

Urolithiasis is often accompanied by obesity, insulin resistance, and dyslipidemia, which contribute to the development of non-alcoholic fatty liver disease.

Cytokine imbalance

Proinflammatory mediators such as IL-6, TNF-α, and TGF-β activate fibrosis.

Modern methods for early detection of morphological changes in the liver

1. Elastography

Liver elastography allows for the non-invasive detection of fibrosis.

FibroScan technology

Advantages:

speed;

painless examination;

high sensitivity.

Main parameter:

liver stiffness (kPa).

2. Multiparametric MRI

Modern types of magnetic resonance imaging are of great importance in detecting microstructural changes in the liver.

MRI-PDFF

Determines the amount of fat in the liver.

Diffusion-weighted MRI (DWI)

Demonstrates ultrastructural damage to hepatocytes.

MR-elastography

Evaluates the degree of fibrosis with high accuracy.

Key parameters:

ADC (Apparent Diffusion Coefficient);

PDFF (%);

T1/T2 relaxation time.

Laboratory biomarkers

Liver enzymes

Biomarker	Clinical Significance
ALT	Hepatocyte Damage
AST	Necrosis and Fibrosis
GGT	Cholestasis
ALP	Bile Duct Damage

Clinical significance:

Early detection of morphological changes in the liver:

Prevents chronic liver failure;

Reduces systemic complications of urolithiasis;

Allows for individual therapy selection;

Improves prognosis.

Conclusion.

Morphological changes in the liver in nephrolithiasis are associated with complex metabolic and inflammatory mechanisms. Modern diagnostic technologies — elastography, multiparametric MRI, metabolomics, artificial intelligence, and liquid biopsy — allow us to detect pathological processes at the subclinical stage. The widespread implementation of these innovative approaches in clinical practice is of great importance for early diagnosis of liver damage and the development of effective preventive measures.

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