

STRUCTURAL CHANGES OF HEPATOCYTES UNDER LONG-TERM STRESS

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Annotation: Scientific approaches have concluded that long-term stress leads to various physiological and metabolic changes in the body and negatively affects multiple organs. Among these organs, the liver is particularly sensitive to stress factors when metabolic processes are altered. Liver plates are composed of hepatocytes, which play a critical role in metabolism, detoxification, and synthesis processes in the body. This article examines how long-term stress causes vacuolization, predisposition to fatty degeneration, and nuclear morphological changes in hepatocytes. Research results demonstrate that prolonged stress negatively impacts the morphological state of liver cells.

Keywords: Liver; hepatocyte; stress; dystrophic processes; vacuolization; detoxification; apoptosis; necrosis; WHO; pathology; marginalization.

ДОЛГОСРОЧНЫЙ СТРЕСС ИЗМЕНЕНИЯ СТРУКТУРЫ ГЕПАТОЦИТОВ

Аннотация: Научные подходы пришли к выводу, что длительный стресс приводит к различным физиологическим и метаболическим изменениям в организме и оказывает отрицательное влияние на многие органы. Среди этих органов печень особенно чувствительна к стрессовым факторам при изменении метаболических процессов. Печёночные пластинки состоят из гепатоцитов, которые играют важную роль в процессах метаболизма, детоксикации и синтеза в организме. В данной статье рассматривается, как длительный стресс вызывает вакуолизацию, склонность к жировой дистрофии и морфологические изменения ядер гепатоцитов. Результаты исследований показывают, что продолжительный стресс отрицательно влияет на морфологическое состояние печёночных клеток.

Ключевые слова: Печень; гепатоцит; стресс; дистрофические процессы; вакуолизация; детоксикация; апоптоз; некроз; ВОЗ; патология; маргинализация.

UZOQ MUDDATLI STRESS SHAROITIDA GEPATOTSITLARNING STRUKTURAVIY O'ZGARISHI

Annotatsiya: ilmiy yondashuvlar shu xulosaga keldiki, ko'p yillar davomida stress organizmda turli xil fiziologik, metabolik o'zgarishlarga olib keladi va ko'plab organlarga salbiy



ta'sir ko'rsatadi. Organlar ichida jigar metabolik jarayonlar o'zgarganida stress omillariga juda sezgir hisoblanadi. Jigar plastinkalari gepatotsitlardan tuzilgan, ular organizmda metabolizm, detoksikatsiya va sintez jarayonlarida muhim rol o'ynaydi. Ushbu maqola o'z ichiga uzoq muddatli stress omillari ta'sirida gepatotsitlarda vakuolizatsiya, yog'li distrofiya moyillik hamda yadroviy morfologik o'zgarishlar kuzatilishini qamrab oladi. Izlanishlar natijasida uzoq muddatli stress jigar hujayralarining morfologik holatiga salbiy ta'sir ko'rsatishni isbotlab beradi.

Kalit so'zlar: Jigar; gepatotsit; stress; distrofik jarayonlar; vakuolizatsiya; detoksikatsiya; apoptoz; nekroz; JSST; patologiya; marginalizatsiya.

In modern times, one of the main contributing factors to the development of many diseases is stress. Stress is a nonspecific neurohormonal reaction that develops in the body in response to various stimuli. The term "stress" was introduced into medicine by Hans Selye, who referred to the factors causing stress as "stressors," and the changes occurring in the body under their influence as the "general adaptation syndrome." According to Selye, many pathological conditions that arise as a result of stress are associated either with the excessive intensity of stressors or with an improper response of the endocrine system.

The liver is the largest gland of the digestive system and performs numerous vital functions in the body. Many metabolic by-products are detoxified in the liver. It also plays a protective role: its stellate reticuloendothelial cells are capable of capturing and destroying microorganisms and foreign substances. Glycogen synthesized in the liver helps maintain normal blood glucose levels. In addition, the liver synthesizes important proteins such as globulin, albumin, fibrinogen, and prothrombin. Due to its diverse functions, the liver is often referred to as the biochemical laboratory of the body.

Hepatocytes are the main functional cells of the liver, comprising about 80% of its mass. These cells are responsible for protein synthesis and storage, carbohydrate transformation, synthesis of cholesterol, bile salts, and phospholipids, as well as detoxification, modification, and excretion of both exogenous and endogenous substances. They also play a key role in bile formation and secretion.

The relevance of this topic lies in the fact that stress alone can lead to severe pathological conditions. Prolonged stress may result in dystrophic liver damage, liver fibrosis, liver cirrhosis, primary biliary cirrhosis, infectious liver diseases, liver tuberculosis, syphilitic liver damage, liver abscess, hereditary disorders such as hemochromatosis and Wilson-Konovalov disease, congenital liver defects, and Gilbert's syndrome.

To prevent such conditions, it is necessary to ensure a peaceful and stable social environment, reduce stress-inducing situations, and significantly increase public awareness and attention to individual health. Otherwise, these conditions may lead to reduced life expectancy and premature death.

The aim of this research is based on global statistics. According to the World Health Organization (World Health Organization), 257 million people worldwide live with hepatitis B, and 71 million people with hepatitis C. Viral hepatitis is a major cause of liver cirrhosis and liver cancer.

In summary, the main objective is to reduce stress and prevent liver-related pathologies. Under prolonged stress conditions, changes occurring in hepatocytes can be studied in several stages:



Ultrastructural destruction

Mitochondrial swelling: In the early stages of stress, mitochondria enlarge. In chronic stages, their matrix becomes dense, cristae shrink, and vacuolization begins. This leads to impaired ATP synthesis and cellular energy crisis.

Endoplasmic reticulum response: Ribosomes detach from the rough endoplasmic reticulum, reducing protein translation. Meanwhile, the smooth endoplasmic reticulum expands pathologically in an attempt to detoxify toxins.

Nuclear apparatus: Under hormonal influence, chromatin shifts toward the nuclear periphery (marginalization), and the nuclear membrane becomes deformed. The appearance of multinucleated hepatocytes reflects an attempt at liver regeneration, although this process is impaired due to stress.

Histomorphological changes (microscopic analysis)

Hydropic and vacuolar dystrophy: As the name suggests, this condition is characterized by the uncontrolled of water and electrolytes into the cell, resulting in the formation of “clear vacuoles” in the cytoplasm. As a consequence, hepatocytes swell and acquire a spherical shape.

Lipidosis (Steatosis): Under the influence of stress, lipid metabolism is disrupted, leading to the accumulation of fat inclusions within hepatocytes. This condition resembles the morphological picture typical of non-alcoholic fatty liver disease.

Hepatocyte death: Chronic stress accelerates both apoptosis (programmed cell death) and necrosis (tissue death). The presence of “Councilman bodies” (apoptotic remnants of hepatocytes) in histological preparations is considered an important diagnostic indicator.

Hematovascular changes

Narrowing of sinusoidal capillaries and capillarization of the space of Disse (i.e., accumulation of collagen fibers) are observed. These changes impair blood flow and nutrient exchange to hepatocytes.

Pathophysiological mechanisms

Structural alterations are associated with several pathophysiological mechanisms:

Chronic activation of the hypothalamic–pituitary–adrenal (HPA) axis:

Prolonged stress leads to persistent activation of the HPA system. Elevated levels of glucocorticoids stimulate gluconeogenesis in hepatocytes, resulting in excessive consumption of intracellular resources and ATP deficiency. Mitochondrial destruction is a direct consequence of this energy crisis.

Development of steatosis:

Histologically observed steatosis is explained by the increased influx of free fatty acids from peripheral adipose tissue into the liver under stress. The liver is unable to fully metabolize these lipids, leading to their accumulation in the cytoplasm of hepatocytes.

Oxidative stress:



Oxidative stress plays a crucial role. The breakdown of phospholipids leads to increased production of free radicals. This process increases membrane permeability, contributing to hydropic degeneration and ultimately leading to cell lysis.

It should be noted that these changes are initially reversible. However, if the stress factor persists, the risk of liver fibrosis and liver failure significantly increases.

Conclusion

In conclusion, prolonged stress induces both functional and irreversible structural changes in hepatocytes. Thus, chronic stress can be considered a “slow-acting destructive factor” for liver cells. It leads not only to temporary functional disturbances but also to persistent morphological changes that may result in chronic hepatitis, steatohepatitis, and fibrosis.

In modern hepatology and psychosomatic medicine, controlling stress is an essential component of early diagnosis and effective treatment of liver diseases. Based on these findings, in individuals exposed to long-term stress, liver condition should be monitored not only through enzyme levels but also through modern diagnostic methods such as elastometry and antioxidant status assessment, which indirectly reflect ultrastructural changes.

The results of this study demonstrate that the morphological and functional state of hepatocytes is significantly impaired under prolonged stress conditions. These findings provide a scientific basis for the diagnosis, prevention, and management of stress-related liver pathologies.

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