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Influence of Hypodynamia on Joints and Synovial Membranes in Hypothyroidism Syndrome and Morphological Features of Synovial Membranes

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Annotation: According to the World Health Organization (WHO), 75% of the world's population suffers from diseases of the musculoskeletal system. This epidemic situation has been studied for many years in scientific research in the field, linking it to various causes. Some scientists link diseases of the musculoskeletal system to abnormal fetal development, others to hereditary predisposition, and another group of researchers to ecology and lifestyle.

Keywords: Joint capsule, synovial membrane, hypodynamia, hypothyroidism, bone and joint.

Relevance. The lack of a system of fundamental knowledge about the morphofunctional features of the musculoskeletal system of the free extremities leads to serious shortcomings and errors in the prevention and treatment of injuries and deformities in this area. Thus, the solution of these problems has not only scientific, but also practical significance.

In recent years, much attention has been paid to the systemic impact of endocrine system diseases, in particular hypothyroidism, on the tissues and organs of the body. Thyroid hormones play an important role in metabolism, blood circulation, trophic processes, and tissue regeneration. As a result of their deficiency, a number of morphofunctional changes have been noted, including the development of degenerative-dystrophic processes in the musculoskeletal system.

According to the data, in the case of hypothyroidism, the accumulation of glycosaminoglycans in ligaments, tendons, and joint tissues, interstitial edema, increased fibrous processes, and microcirculation disorders are observed. This negatively affects the structure and function of the

synovial membrane of the joint, disrupting the production of synovial fluid and trophic supply.

At the same time, hypodynamia, widespread in the modern lifestyle, also negatively affects joint tissue as an independent pathogenetic factor. As a result of decreased motor activity, blood circulation slows down, hypoxia develops in the tissues, which leads to the development of atrophic and fibrous changes in the synovial membrane. In experimental studies, a decrease in the activity of synoviocytes, stasis, and dystrophic changes in the walls of blood vessels were noted under conditions of hypodynamia.

Although there are works in the literature devoted to the separate effects of hypothyroidism or hypodynamia, the combined effect of these two pathologies on the synovial membrane of the joint has not been sufficiently studied.

Purpose of the study. Study of the dynamics of morphological development of synovial structures of large joints under the influence of experimental hypothyroidism and hypodynamia in the early stages of postnatal ontogenesis.

Materials and methods. The experiments were conducted on 60 laboratory white rats weighing 180-200 g in accordance with ethical norms and recommendations on humane treatment of laboratory animals, reflected in the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes. The animals were kept under standard vivarium conditions in natural light, in the standard diet of laboratory animals.

Experiments were conducted during the spring-autumn seasons. Each animal was fed within the established normative diet. Sexually mature rats were kept in a separate cage from the 15th-16th day of pregnancy, and their offspring were separated by age and used for research. For morphological studies, the animals are decapitated using chloroform ether anesthesia.

From the tendons of the samples, pieces measuring 5-8 mm were separated from the bone and tendon joints, and the material was placed in a 5% solution of neutral formalin. Bone and tendon junction samples decalcified in a 5% nitric acid solution for 36 hours were treated with a 5% quast solution. During the day, bone and tendon joint samples were washed in running water and dehydrated in high-concentration alcohols: 50, 70, 96, 100% and poured into wax paraffin.

Synovial structures of large joints of animals were isolated for histological examination.

On a universal microtome, sections 8-10 microns thick were prepared from paraffin blocks. The sections were stained with xylene and stained with hematoxylin and eosin and Van Gieson. Morphometry of the structures was performed under an MBI-15 microscope.

The set of conducted studies is aimed at demonstrating the morphofunctional features of the tissues of the synovial structures of large joints in rats. Their identification helps to determine the metabolic properties of tissues, as well as the specifics of the reactive and adaptive potential of the synovial membrane, which determine its function as an organ. According to modern concepts, synovial structures of large joints are a complex, multi-component biological system consisting of cells and intercellular substance.

Results and discussions. The joint capsule (capsula articularis) is an integral part of the synovial joints and plays an important role in isolating the joint from the external environment, ensuring its stability, and distributing mechanical loads during movement (Standring, 2020). Morphologically, the joint capsule consists of two main layers: the outer fibrous layer and the inner synovial layer (Moore et al., 2018).

The fibrous layer consists of dense connective tissue, mainly collagen fibers, a small number of elastic fibers, and fibroblast cells. In the literature, it is noted that the thickness of the fibrous layer, the direction and mechanical strength of the fibers depend on the type and functional load of the joint (Benjamin, McGonagle, 2009). For example, in joints with wide mobility, the fibrous layer is relatively thin, but rich in elastic elements, while in joints with high load, it has a dense and thick structure (Junqueira, Carneiro, 2013).

The presence of blood vessels and nerve fibers in the fibrous layer ensures its trophic and receptor functions. Some authors have shown that proprioceptors are located in this layer, which is important for sensing joint position (Petersen, Tillmann, 1999).

The synovial layer covers the inner surface of the joint capsule, extends towards the joint cavity, and plays a key role in the production of joint fluid (Krenn et al., 2006). Morphologically, the synovial layer consists of thin connective tissue and is distinguished by its richness in synoviocytes, blood vessels, lymphatic elements, and nerve fibers (Ross, Pawlina, 2016).

Inflammation is one of the main risk factors for morphological changes in the synovial membrane. Under conditions of rheumatoid arthritis and synovitis, cellular hyperplasia of the intima layer, infiltration of macrophages and lymphocytes, as well as the development of neoangiogenesis have been noted (Firestein, 2003; Krenn et al., 2006). The authors describe the ability of the synovial membrane to form a "pannus" as a morphological feature characteristic of this pathological condition.

Metabolic disorders, including diabetes mellitus, obesity and dyslipidemia, negatively affect the structure of the synovial membrane. The literature describes a tendency towards inflammation in the synovial membrane, thickening of the vessel wall, and an increase in connective tissue elements in these cases (Berenbaum, 2013). It has been noted that endocrine disorders, especially thyroid hormone deficiency, can lead to atrophic-dystrophic changes, reducing the metabolic activity of synoviocytes (Brent, 2012).

Bacterial and viral infections cause acute or chronic inflammatory processes in the synovium. Histologically, in these cases, edema, neutrophilic infiltration, exudation, and sometimes necrotic changes are observed in the intima layer (Goldenberg, Cohen, 1976).

With age, natural involutional changes are observed in the synovial membrane. In the process of aging, a decrease in the number of synoviocytes, vascular sclerosis, and a decrease in the synthesis of hyaluronic acid are noted (Loeser, 2010). This condition is associated with a deterioration in the rheological properties of the joint fluid.

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