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Histomorphological Changes in the Femoral Head after Covid-19 Infection

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Abstract: The article presents the results of histo-morphological studies of 33 operated patients with aseptic necrosis of the femoral head who had been infected with COVID-19. According to the results of this study, microthrombosis and malnutrition of bone tissue can lead to the development of osteonecrosis when endotoxin viruses affect endothelial structures, which are accompanied by the development of inflammation of the vascular wall, as well as increased blood clotting under the influence of pro-inflammatory factors.

Keywords: aseptic necrosis of the femoral head, COVID-19 infection, the Van Gieson method, Bioleg egg, empty cavities, macro preparation, Areas of active osteogenesis, Zones of multiple sclerosis.

Introduction

As a result of the long-term course of COVID-19, the manifestation of pulmonary fibrosis, pulmonary thromboembolism, cardiomyopathy, sensory dysfunction and stroke, as well as muscle and joint pain, which may be a manifestation of aseptic bone necrosis, is often determined [1,2,3,9]. According to literature data, osteonecrosis occurs in 5-58% of patients with severe COVID-19 [4,5]. In most cases, the femoral head is affected. L. Niis and co-authors indicate that 39% of patients with SARS-CoV-2 developed osteonecrosis of the femoral head within a few months after treatment with SARS [7,8]. Osteonecrosis was also observed in the condyles of the femur and tibia, the head of the humerus, the talus and calcaneus, and other areas of the skeleton [4]. Two mechanisms of the pathogenesis of aseptic necrosis after COVID-19 infection are discussed in the literature: damage to bone vessels by the virus and the negative effect on bone tissue of glucocorticoids used in the treatment of infection. Therefore, it is important to conduct morphological studies of the bone structure of patients after coronavirus infection. The duration of the pandemic and the likelihood of severe complications of COVID-19 emphasize the relevance of this study. The purpose of the study. To study morphological features in the development of aseptic necrosis of the femoral head after COVID-19 infection.

Methodology

For morphological studies, materials were taken from 33 operated patients in the form of macro-preparations during hip replacement. Pieces of tissue from various components of the intraoperative macro-preparation of the femoral head, which were fixed in Carnois liquid and in a 12% solution of neutral formalin, were dehydrated in alcohols of increasing concentration and poured into paraffin. Decalcification was performed using a decalcin solution. Serial histological sections were stained with hematoxylin and eosin, as well as using the Van Gieson method. Morphological changes were assessed under an MBI-15 U 4.2 light microscope (Russia). Statistical processing of the material was carried out using generally accepted methods of variation statistics.

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Result

The results of the morphological examination were interpreted using macroscopic and microscopic techniques. Macroscopically (visually), the femoral head of the affected joint was divided into almost even halves on the frontal plane after intraoperative resection. In 4 cases, the deformity is detected visually, and in 29 cases, the surface of the hyaline cartilage coating is detected from the border of the femoral head fossa: firstly, a clouding of color, and secondly, it noticeably loses its smoothness. The slightest indentation with the fingers leads to a "Boiled egg" type fracture. In the sawn surface, necrosis of bone tissue under the hyaline integument is noted, which indicates the onset of trophic disorders (due to avasculation) from the periphery of the head (marginal zones). Active osteogenesis (remodulation) is observed in the border zones between healthy and destroyed tissues, the process is explained by the compensatory accumulation of osteoblasts. The coldness of the vessels of the reticular tissue of the bone cavities already dictates a sharp deterioration in the circulation of the peripheral zone of the bone head. Small osteoporotic areas lead to a relative expansion of bone cavities with the formation of common zones of multiple sclerosis (Fig.1). This macroscopic pattern is characteristic of a systematic disorder of blood vessels and the blood coagulation system (the manifestation always begins from the periphery).

Discussion

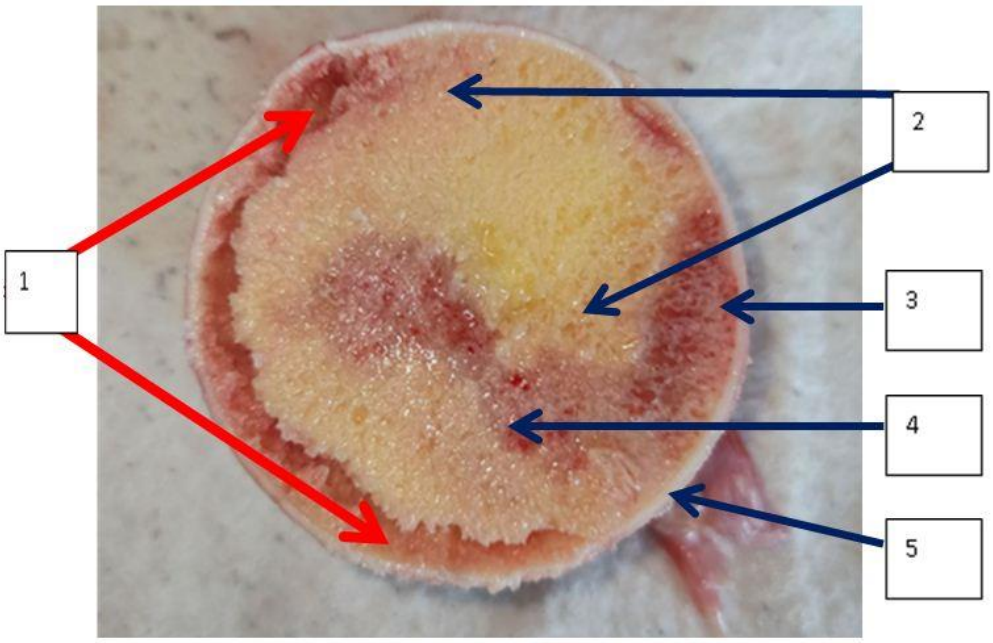

Fig. 1. Macro preparation No. 1. Frontal sawing of the femoral head. Patient R. is 65 years old. 8 months ago, she was treated with a diagnosis of Coronavirus bilateral pneumonia. Субхондральная линия некроза костной ткани;

1. Areas of active osteogenesis (remodulation) (compensatory accumulation of osteoblasts)

2. Fullness of the vessels of the reticular tissue;

3. Zones of multiple sclerosis (relative expansion of bone cavities);

4. Hyaline covering of the articular surface of the femoral head.

Vacuolization of hyaline cartilage from the bone matrix is noted. Subchondral sclerotic changes cover a large area in the visual field. Marginal necrotic areas are identified in bone beams. In some

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intraosseous vessels, there is endothelial destruction, and in some, narrowing of the lumen or complete destruction of the wall (Fig. 2).

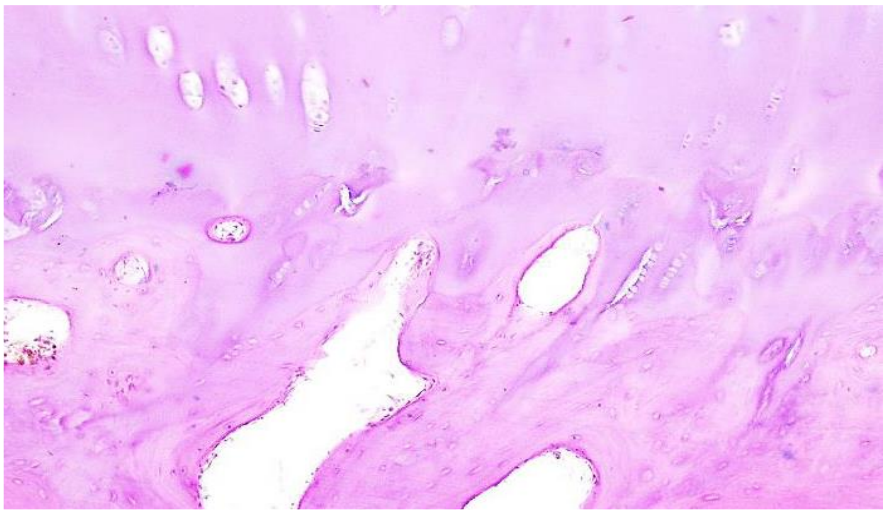

Fig. 2. Avascular necrosis of the femoral head. B.K. 44g. Sclerotic changes with vascular wall destruction. Coloring - GE.uv 100. In areas where osteonecrosis is progressing, the structure of bone architectonics undergoes significant changes. Osteoclast activity increases in the subchondral zone of necrotic areas, and this is accompanied by increased osteoblast activity in the sclerotic zone. At the sites of bone necrosis, empty cavities are determined in the direction of fibrous growths, compensatory mesinchymal growths appear. Along the edges of the trabeculae of the subchondral and necrotic regions, a mass of osteoclasts is revealed, but their number is noticeably small in the sclerotic zone (Fig. 3). As a compensatory transformation, in some places, foci of newly forming bone tissue can be seen in the field of vision next to empty lacunae. This statement confirms the literature data, because Histologically, osteonecrosis is characterized by the formation of empty lacunae with vascular fibrous tissue around it in combination with adjacent bone tissue [6].

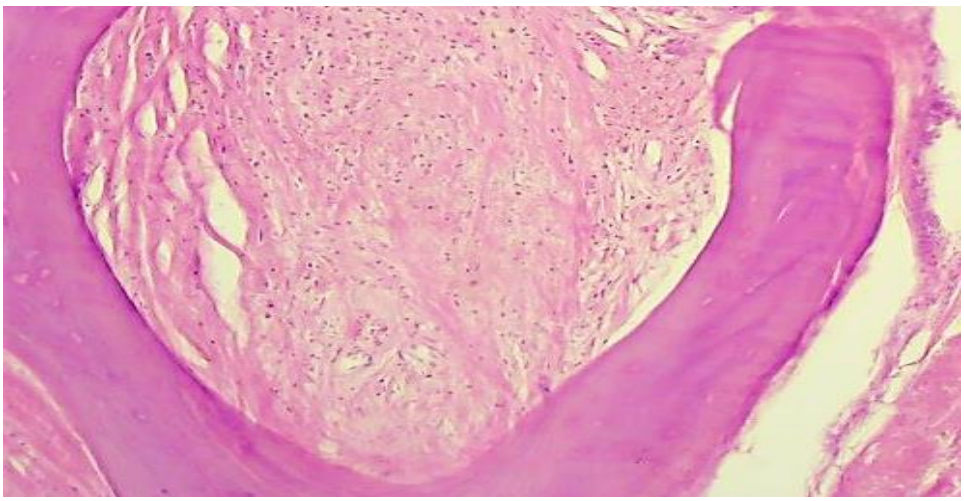

Fig. 3. Avascular necrosis of the femoral head. B.L. 57g. Fibrosis overgrowth. Necrosis of bone beams. The appearance of mesenchymal striae. Coloring - GE.uv 100. Calcified fragments and compensatory fibrosis in the mesenchyme are noted in necrotized bone tissue (Fig. 4). The mesenchyme is moderately preserved with foci of necrosis, vascular components are blood-filled with moderate changes in the walls.

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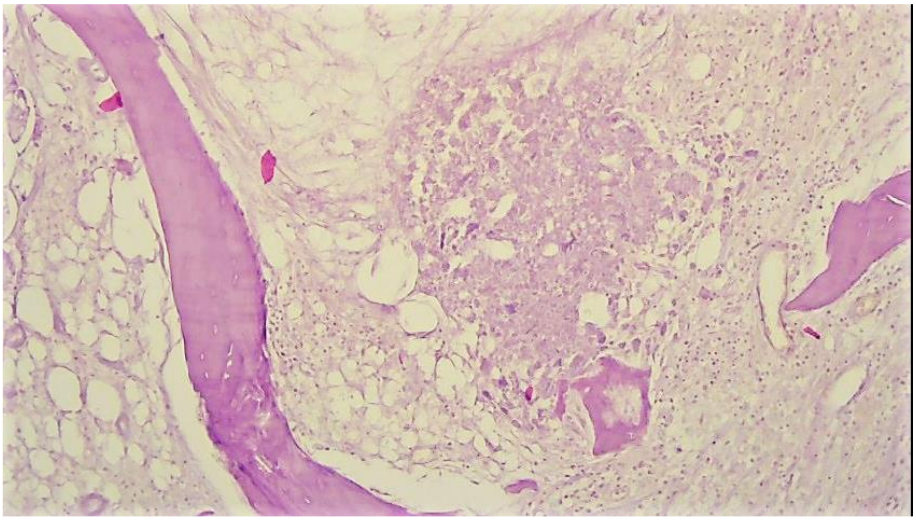

Fig. 4. Avascular necrosis of the femoral head. B.G. 62g. There are compensatory mesenchymal changes in the necrosis zones. Coloring - GE.uv 200. In other areas of the drug, total necrosis of the bone girder is determined, there are no vascular structures in it. In the subchondral region, especially further from the fossa of the femoral head, the bone beams are noticeably thinned, separated from each other by a fibroreticular stroma with large areas of fibrosis, and in the upper sections it is infiltrated by mononuclear cellular elements (Fig.5).

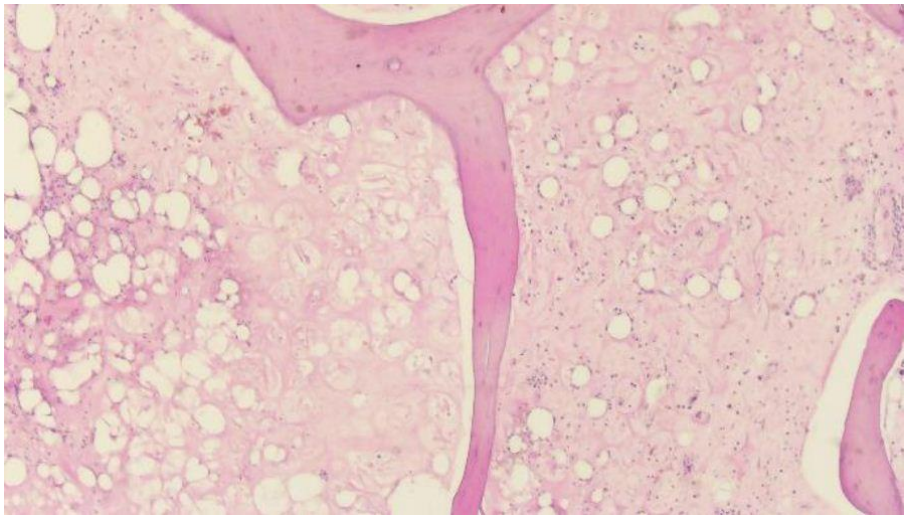

Fig. 5. Avascular necrosis of the femoral head. B.G. 64g. Thinning of bone beams with infiltrated tissue. Coloring - GE.uv 200.

Conclusion

According to the results of this study, microthrombosis and malnutrition of bone tissue can lead to the development of osteonecrosis when endotoxin viruses affect endothelial structures, which are accompanied by the development of inflammation of the vascular wall, as well as increased blood clotting under the influence of pro-inflammatory factors.

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