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Dynamics of Regeneration of Damaged Cartilage of the Knee Joint after the use of Nuclear Magnetic Resonance Therapy

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Abstract: Even with the existence of various modern methods of treatment, the problem of post-traumatic restoration of hyaline cartilage remains extremely important. The aim of our study is to evaluate the dynamics of regeneration of damaged knee cartilage in rats after the use of nuclear magnetic resonance therapy (NMRT). The study showed that NMRT promotes the formation of regenerated cartilage at the site of damaged cartilage, which is similar in its histological structure to hyaline cartilage.

Keywords: NMRT, rats, cartilage defect, regeneration, chondrocyte proliferation, experiment.

Introduction

Osteoarthritis (OA), a degenerative-dystrophic disease of the joints, is a widespread pathology, especially after the age of 65, which often leads to disability. Knee injuries, accounting for up to 14% of all injuries to the lower extremities, lead to damage to articular cartilage. Restoration of hyaline cartilage is complicated due to its avascular nature and is carried out with the participation of chondrocyte proliferation and matrix synthesis. The destruction of cartilage in the knee joint occurs due to a discrepancy between mechanical load and its resistance. Traumatic injuries often lead to metaplasia or dysregeneration, the replacement of hyaline cartilage with fibrous cartilage. Therefore, despite the variety of modern methods of treatment, the problem of hyaline cartilage regeneration remains quite relevant.

Purpose: to assess the dynamics of regeneration of damaged knee cartilage in rats after the use of NMRT.

Material and methods

All manipulations with animals were carried out in accordance with the Law of Ukraine "On the Protection of Animals from Cruel Treatment" (Law of Ukraine, 2006). The experimental animals were cared for in accordance with the generally accepted recommendations, requirements and regulations for the care of laboratory animals: the Declaration of Helsinki of the General Assembly of the World Medical Association (2000); Provisions of the European Convention on the Protection of Chemical Animals Used for Experiments and Other Scientific Purposes (1986). The research protocol was approved at a meeting of the Bioethics Commission of Vinnytsia National Medical University. M. I. Pirogov (minutes № 7 dated 16.09.2021.)

Surgical interventions. Our study was conducted on 60 rats. Post-traumatic gonarthrosis has been surgically simulated. All rats were given a full-thickness transchondral defect in the cartilage tissue of the left knee joint with the help of a scalpel. We did not damage the right knee joint and used it as the norm. After surgery, all rats underwent postoperative drug treatment for 3 days. In the future, all rats were divided into 2 groups: the main and the control. In the main group NMRT was carried out for 7 days, for 1 hour each. No treatment was carried out in the control group. Rats from the main group were withdrawn from the experiment 2 (№ 1) and 4 (№ 2) weeks after a week-long course of NMRT by administering a

lethal dose of anesthetic. In the control group of animals NMRT was not performed, but rats were withdrawn from the experiment at the same time of the study, which corresponded to 2 weeks + 10 days (№ 3) and 4 weeks + 10 days (№ 4) (Fishchenko et al., 2023).

Morphological analysis. To assess histological changes, the knee joints were fixed in a 10% solution of neutral formalin and decalcified. The specimens were prepared according to the standard method, histological sections with a thickness of 5-7 μm were stained with hematoxylin and eosin (Sarkisov & Perov, 1996).

Statistical studies. The results of the experiment were processed using the Microsoft Excel computer program and presented in the form of M±m. Student's t-test was used to compare averages (Fishchenko et al., 2023; Gerwin et al., 2010).

Results and Discussion

№ 1. In rats that underwent NMRT after the articular cartilage defect, bone tissue was noted that did not differ in structure from the adjacent maternal subchondral bone. In the cartilaginous tissue on the surface of the defect, there are 2-3 rows of isogenic groups, which had 2 chondrocytes each (Fig. 2). The thickness of the regenerated was 48.54 ± 7.03 μm.

№ 2. In rats that did not undergo NMRT after the articular cartilage defect, the defect area was partially filled with regenerative tissue, and the surface contained numerous fibroblasts. Bone tissue was represented by coarse-fibrous bone trabeculae (Fig. 3). The thickness of the regenerated was 35.27±6.64 μm.

№ 3. For 4 weeks after NMRT, in animals of the main group, at the site of the defect, the newly formed cartilage was similar in structure to hyaline cartilage. In the surface layer, chondrocytes formed isogenic groups that contained 3-4 cells and did not differ in structure from those in the intact areas of articular cartilage. In the deep layer, the matrix is slightly basophilic, and the chondrocytes are located zonally. At the bottom of the defect there were full-blooded blood vessels and areas of granulation tissue (Fig 4). Thus, according to the macroscopic crtin, the regenerate had all the properties of the newly formed hyaline articular cartilage. The thickness of the newly formed cartilage was 82.12 ± 8.89 μm.

№4 In the group of animals that were not treated, on day 28, chondrocytes were absent in the surface zone, and the matrix was stained eosinophilically. In the middle zone, isogenic groups contained 3–4 chondrocytes. In the area of calcified cartilage, large areas did not contain chondrocytes, the matrix was colored unevenly. At the bottom of the wound, a high density of fibroblasts was determined. The articular cartilage located at the edge of the wound was degeneratively altered, there was a reduced number of chondrocytes and a thickened area of calcified cartilage (Fig 5). The cells of the superficial layer of articular cartilage were destroyed. The thickness of the cartilage was 56.34 ± 7.82 μm.

Conclusions

Studies have shown that with fresh transchondral damage to articular cartilage under the influence of NMRT, it promotes the formation of cartilaginous regeneration in the cartilage defect, which in its

histological structure is close to hyaline cartilage. However, the newly formed cartilage tissue does not completely cover the defect. Therefore, a longer period is needed for the formation of a full-fledged regenerate.

Figure 1

Structure of intact articular cartilage. Magnification x100. Hematoxylin and eosin staining. 1 – articular cartilage of the femur. 2 – articular cavity. 3 – anterior horn of the meniscus. 4 – articular cartilage of the tibia.

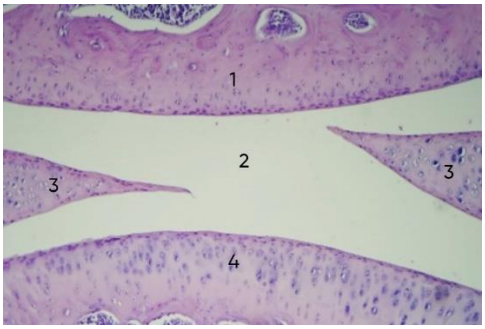


Figure 2

Structure of articular cartilage №1. Magnification x400. Hematoxylin and eosin staining. 1 – granulation tissue. 2 – isogenic groups of chondrocytes. 3 – subchondral bone tissue

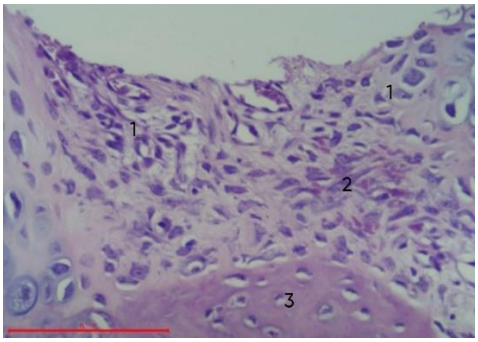


Figure 3

Structure of articular cartilage №2. Magnification x400. Hematoxylin and eosin staining. 1 – subchondral bone tissue. 2 – coarse fibrous bony trabeculae. 3 – blood vessels

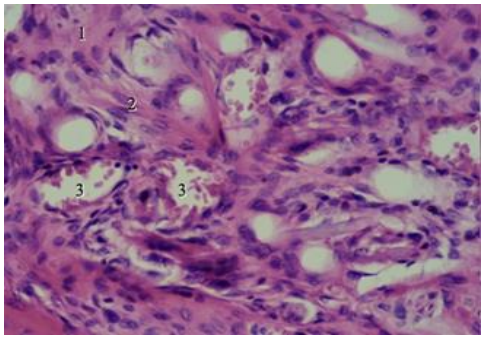


Figure 4

Structure of articular cartilage №3. Magnification x400. Hematoxylin and eosin staining. 1 – granulation tissue. 2 – basophilic line. 3 – coarse fibrous bone tissue. 4 – blood vessel

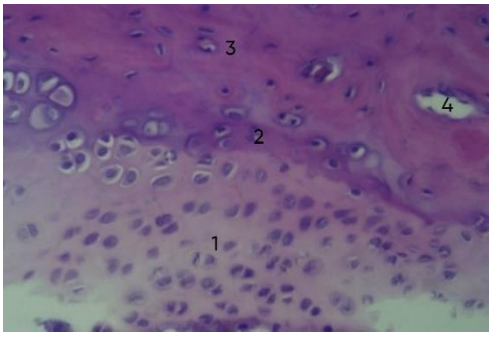
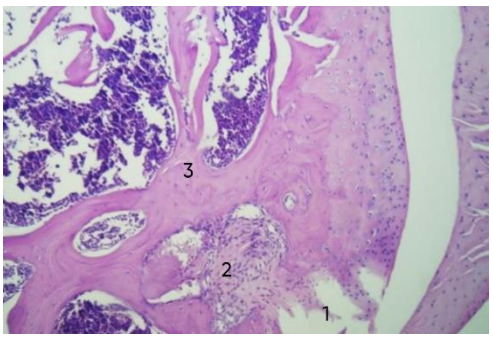


Figure 5

Structure of articular cartilage №4. Magnification x100. Hematoxylin and eosin staining. 1 – defect zone. 2 – granulation tissue. 3 – coarse fibrous bone tissue



References

European Convention for the Protection of Vertebrate Animals Used for Research and Other Scientific Purposes (1986). https://rm.coe.int/168007a67b

Gerwin, N., Bendele, A. M., Glasson, S., & Carlson, C. S. (2010). The OARSI histopathology initiative — recommendations for histological assessments of osteoarthritis in the rat. *Osteoarthritis and Cartilage, 18*(3), S24–S34. https://doi.org/10.1016/j.joca.2010.05.025

Law of Ukraine "On the Protection of Animals from Cruelty", No. 3447-IV. (2006). https://zakon.rada.gov.ua/laws/show/3447-15#Text

Sarkisov, D. S., & Perov, Yu. L. (1996). Microscopic technique. *Medicine*.

Fishchenko, V. O., Korol, A. P., & Yusupova, D. V. (2023). Morphohistological study of regeneration of knee joint cartilage defects in an experimental model under the influence of nuclear magnetic resonance therapy. *Reports of Morphology, 29*(4), 19–26. https://doi.org/10.31393/morphology-journal-2023-29(4)-03