Biochemical and Metabolic Abnormalities in Articular Cartilage from Osteo-arthritic Human Hips. II: Correlation of Morphology with Biochemical and Metabolic Data

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97.4 Abstract

Thirty-two areas of cartilage from nine osteoarthritic and four normal femoral heads were studied and their severity of osteoarthtic process was graded using a histologic-histochemical grade. Their DNA and hexosamine concentrations were used as indicators of cell density and polysaccharide content, respectively, and the incorporation rates of 3H-thymidine and $35SO_4$ were assessed as indicators of DNA and polysaccharide synthesis, respectively. Based on these measurements and subsequent analyses, the following conclusions were made:

1. Osteoarthritis is a focal disease with substantial variation in the severity of the lesion on each osteoarthritic femoral head.
2. The severity of the process and the rates of DNA and polysaccharide synthesis are directly correlated. However at a certain histologic-histochemical degree of "severity," the reparative processes seem to "fail," decreasing with advancing disease.
3. The severity of the process and the polysaccharide concentration are inversely correlated, but the cell density (as reflected by DNA levels) and the severity of the disease do not correlate.
4. The cartilage of osteophytes is histologically less severely involved showing a smaller reduction in polysaccharide concentrations. Polysaccharide synthesis at osteophytes is increased as compared with non-osteophytic arthritic tissue.

On the basis of the above data, a scheme of the biochemical and metabolic response of cartilage to osteo-arthritis is suggested.

97.5 Summary

Mankin et al. investigate the cartilage changes seen in femoral head osteoarthritis in both non-osteophytic and osteophytic areas. Utilising multiple sections from femoral heads of 13 patients, they evaluate cartilage cell content and proliferation, as well as polysaccharide content and synthesis, and relate this to disease severity. Mankin et al. postulate mechanisms to account for their findings.

97.6 Citation Count

1,430

97.7 Related References

1. Mankin HJ, Lippiello L. Biochemical and metabolic abnormalities in articular cartilage from osteo-arthritic human hips. J Bone Joint Surg Am. 1970;52:424–34.
2. Mankin HJ, Johnson ME, Lippiello L. Biochemical and metabolic abnormalities in articular cartilage from osteo-arthritic human hips. III. Distribution and metabolism of amino sugar-containing macromolecules. J Bone Joint Surg Am. 1981;63:131–9.

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97.8 Key Message

Mankin et al. demonstrate that osteoarthritis is a focal disease with various levels of severity even within a femoral head, and this must be taken into account when investigating the osteoarthritic process. Mankin et al. show that polysaccharide content decreases in damaged cartilage. Their results suggest that cellular proliferation and polysaccharide synthesis increase in response to cartilage damage, but these compensatory mechanisms fail above a certain severity point. Thus cartilage was shown to mount a brisk reparative response in response to osteoarthritis.

97.9 Why It Is Important

This paper is important because it was one of the earliest examining the focal cartilage changes in osteoarthritis in human samples and demonstrating that apart from being a simple wear process, cartilage attempts to mount an aggressive reparative response. This reparative response is, up to a certain point, proportional to the severity of damage. A grading system (Histological-Histochemical grading) assessing the severity of cartilage damage in osteoarthritis was also described, which has stood the test of time and highly contributed to the high citation index of this article.

97.10 Strengths

The cartilage changes were examined in human femoral heads, which was quite novel for the time.

97.11 Weaknesses

Samples were obtained from only 13 patients, which for today's standards is a small number given the prevalence of hip arthroplasty surgery.

In four cases femoral heads were from patients who had sustained a fractured neck of femur. Such fractures are often secondary to osteoporosis, which could hence influence the results of the study.

All patients but one were 50 years of age or older.

97.12 Relevance

Understanding the metabolic processes of articular cartilage in osteoarthritis is of paramount importance in elucidating the pathogenesis of the disease. It is also essential in designing appropriate interventions aiming at reversing such pathological processes. Grading the severity of articular cartilage damage is important in communication between researchers and evaluating the success of therapeutic interventions.

Between 1966 and 1970 the orthopaedic biochemistry laboratory at the Hospital for Joint diseases in New York was extensively involved in cartilage research. With the development of hip joint arthroplasty, the increased availability of human samples allowed examination of the cartilage changes in osteoarthritis. The article presented here is the middle of one of three articles on osteoarthritic articular cartilage, linked together due to the use of human osteoarthritic femoral heads. They all led to the further appreciation of the attempted reparative processes that occur in human osteoarthritic cartilage.

In the first article, published in 1970, the group studied cartilage from the femoral heads of 24 patients with osteoarthritis and 24 patients with a fractured neck of femur, obtained at the time of surgery [1]. All cartilage from the femoral heads was removed, pooled and examined. The metabolic changes found, were consistent with cell replication and matrix synthesis in osteoarthritis occurring at a rate much higher than those in normal cartilage. These findings suggested that under conditions of chronic damage, such as those seen in osteoarthritis, chondrocytes can revert to a chondroblastic state, capable at making more cells and matrix at a rate faster than that seen in normal cartilage.

In this second study, published in 1971, cartilage from focal areas of femoral head were sampled, graded for severity and examined in isolation. In this way, Mankin proved that osteoarthritis is a focal disease, with various severity levels. The results of this study suggest that cellular proliferation and polysaccharide synthesis increase in response to cartilage damage, but these compensatory mechanisms fail above a certain severity point. Thus, consistent, with the findings of their first article, cartilage was shown to mount a brisk reparative response in response to osteoarthritis that at least up to certain point parallels the severity of disease. A grading system (Histological-Histochemical grading) assessing the severity of cartilage damage in osteoarthritis was also described, which was subsequently further evaluated [2, 3] and is used today.

The third related article [4] was published in 1981and reported on the distribution and rates of synthesis of glycosaminoglycans in normal and osteoarthritic cartilage from human femoral heads. Mankin found that the number of glucosamine containing macromolecules decreased in osteoarthritic cartilage but the rates of synthesis of the amino sugar components of the matrix increased. This increased synthesis correlated directly with disease severity. These observations further confirmed that osteoarthritic chondrocytes are metabolically hyperactive [5–8].

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