

HÅKAN CARLSON: Reactions of Rabbit Patellary Cartilage Following Operative Defects.

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(Author's Abstract)

The literature on articular cartilage reactions to operatively created defects is rather confusing. Inadequate numbers of experimental animals have been used for many investigations; and the observation periods have often been too short. The author's study was confined to the intrinsic ability of the patellary cartilage to react following operative interventions and therefore only shallow defects were made centrally in the patellary cartilage.

The reactions due to such defects in patellary cartilages from 98 adult and 21 young rabbits were studied by routine histological methods supplemented with metachromatic toluidine blue staining. In order to bring into better perspective the histological findings and to elucidate the functional conditions in articular cartilage following operative interventions, the sulphate metabolism in the cartilage was investigated with the aid of labelled sulphur. Autoradiographs were recorded from articular cartilage sections from 33 additional rabbits which had been given intravenous injections of radiosulphate in the form of $\text{Na}_2 \text{S}^{35} \text{O}_4$.

The results were:

1. Removal from the patellary cartilage of a central chip projecting about half way into the radiate stratum gave rise to regenerative and degenerative changes, singly or in combination, or failed to produce any manifest changes. Regeneration was manifested mainly by the development of atypical chondrons which differed from regular chondrons in being composed of an abnormally large number of cells and probably came into existence through proliferation of the chondrocytes themselves. The frequency of atypical chondrons was 3 times higher peripherally than centrally near the actual defect in the patellary cartilage. The frequency of atypical chondrons increased with lengthening postoperative survival times. These formations thus occurred in about 33 per cent of all patellary cartilages operated on up to 3 months previously and in approximately 68 per cent of all those operated on 3 to 6

months previously; subsequently the frequency of regeneration showed no significant increase. The atypical chondrons exhibited a high uptake of S^{35} , which presumably should be interpreted as a sure sign of vitality of their component cells. While atypical chondrons occurred in all strata, they tended to predominate in the intermediate and outer radiate strata of the patellary cartilage. Moreover, dominance of autoradiographic blackening over the superficial and intermediate strata, as compared with the radiate stratum, tended to be more characteristic of operated than of unoperated patellary cartilage.

2. Creation of an operative defect in the patellary cartilage also gave rise to degenerative changes. Occurring in all strata, these were twice as common centrally—that is close to the defect—as peripherally in the patellary cartilage. The frequency of degeneration lay practically unchanged at about 45 per cent for all patellary cartilages operated on up to more than a year previously. Degenerated chondrocytes incorporated little or no S^{35} . The histological and autoradiographic visualisations of degeneration were thus in good agreement.

3. No relationship existed between regeneration and degeneration in the patellary cartilage considered as an integral unit. However, when the occurrence of these two modes of reaction was analyzed in the patellary cartilage considered as three layers or zones, it appeared that regeneration would more probably be encountered in a zone lacking degeneration than in a zone with degeneration.

4. Patellary cartilages from young rabbits tended to show a higher frequency of regeneration than those from adults.

5. Application of a plastic film over the defect on the patellary cartilage tended to increase the frequency of degeneration.

6. The chondrocytes in both operated and unoperated articular cartilage showed S^{35} incorporation commencing 7 hours and increasing up to 48 hours after the radiosulphate injection. After that time the intercellular matrix also began to show radioactivity and after 7 days the radioactivity of the chondrocytes equalled that of the intercellular matrix.

7. Operated patellary cartilage incorporated more S^{35} than the corresponding cartilages on the contralateral unoperated side. The augmented S^{35} uptake was regarded as evidence of increased cell activity and as a first and as a first sign of a regenerative or reparative reaction shown by the articular cartilage in response to the injury. The femorocondylar cartilage articulating with the operated patella also incorporated more S^{35} than the corresponding cartilage from the contra-

lateral unoperated joint. Apart from a reduction by about 13 per cent of the cell density, no signs of regeneration or degeneration could be manifested histologically 4 weeks after the operation, i.e. the time at which the autoradiographs were produced in this series.

8. The cell density in both operated and unoperated articular cartilage was strongly correlated to the degree of autoradiographic blackening, that is to the S^{35} uptake. In operated cartilage this correlation was almost equally strong whether the degree of blackening was correlated to the total cell area per unit area of the section or to the number of cells per unit area of the section. Irrespective of their size the chondrocytes in a given articular cartilage would seem to possess the same unit capacity for taking up S^{35} , this unit capacity being higher in operated than in unoperated cartilage.

9. The degree of metachromasia in histological sections was not consistently paralleled by the degree of blackening of the corresponding autoradiograph.

The autoradiography with S^{35} is a valuable adjunct to routine histological techniques in the study of articular cartilage and in the future it will probably provide much valuable information about those changes which take place in articular cartilage in response to various injuries. This applies particularly to the study of early osteoarthritic changes, of the healing mechanism and of the final stages of an intra-articular fracture.