

PRESSURE NECROSIS OF ARTICULAR CARTILAGE ; TYPES OF CONNECTIVE TISSUE FIBERS INVOLVED IN ITS REPAIR

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ABSTRACT

OBJECTIVE: The hypothesis that was evolved in the present study was to investigate the repair of damaged articular cartilage by connective tissue fibers other than collagen fibers. **SETTING:** Anatomy Department. **PERIOD:** Seven Weeks. **RESULT:** At the end of sixth week of immobilization reticular fibers were seen invading the collagenous scar in the floor of ulcer. **CONCLUSION:** The obtained result indicates that it is not only the collagen fibers, which fill the gap, but reticular fibers are also involved in the repair of articular cartilage by fibrosis.

KEY WORDS: Articular cartilage, Immobilization, Necrosis, Remobilization, Repair.

INTRODUCTION

The articular cartilage provides a low friction lubricant surface. It is referred to as hyaline because of its homogenous glossy appearance in gross and microscopic examination¹. Damage to the articular cartilage in human joint, which have ceased to function due to external causes such as contractures in paraplegia, poliomyelitis and severe burns have been observed². Several factors, which may lead to articular cartilage lesions include direct trauma to

the cartilage, obesity and immobilization³. Necrosis of articular cartilage is a painless process but it may act as a starting point of development of degenerative arthritis. Lesions of articular cartilage comprised chondrocyte necrosis, marked decrease in matrix and matrix fibrillation⁴. The response of cartilage to injury differs from that of other tissues because of its avascularity, the immobility of chondrocytes and inability of mature chondrocytes to proliferate⁵. The repair of articular cartilage is different in immature and mature animals. The

defects in fetal limb articular cartilage were filled with cellular matrix and no fibrous scar was observed⁶. The lesion in elderly patients healed with fibrous tissue^{7,8}. Articular cartilage in adults exhibits extremely limited power of repair. The repair is by fibrosis, with collagen fibers only. The fibroblasts from the underlying marrow spaces invade into the necrosed area of articular cartilage and lay down collagen fibers⁹. It is well established that the full thickness articular cartilage defect is repaired with type-II collagen by cells, which are derived from stem cells in marrow spaces¹⁰. The repair of articular cartilage in adult rabbits only by collagen fibers required further study and need to be addressed by careful basic science investigations. The role of other type of corrective tissue fibers in repair of articular cartilage is still a significant question¹¹. So this study was designed to know the role of other types of connective tissue fibers, if any, in the repair process of damaged articular cartilage.

MATERIAL AND METHODS

In the our present study the procedure of necrosis of articular cartilage was adapted same as earlier done by various workers^{9,12,13} by immobilizing the knee joint of adult rabbit in a fixed position, that is extension, followed by re-mobilization of the joints to allow repair of damaged articular cartilage.

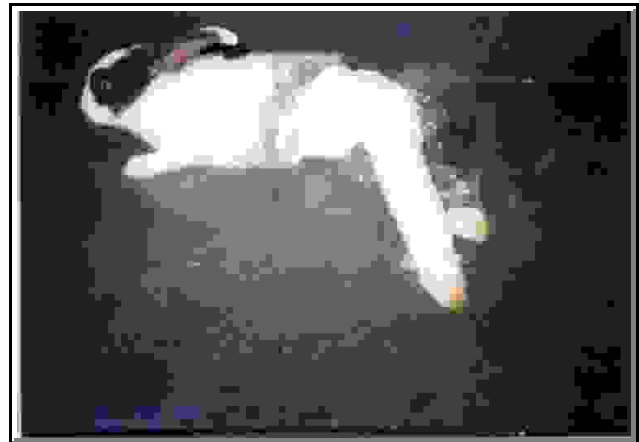
In our present study twenty four healthy, well fed adult male rabbits were taken. They were divided into two groups:-

Group A:- Control group of 12 rabbits who were left un-immobilized.

Group B:- This group comprised of 12 rabbits. Their left knee joint was immobilized in extension

The left knee joint, including hip and ankle joints, were immobilized extension for a total period of six

weeks by applying plaster of paris cast (Fig-I). The lesion produced by immobilizing the joints in extension for a total period of six weeks were similar to the lesions earlier produced by Trias and

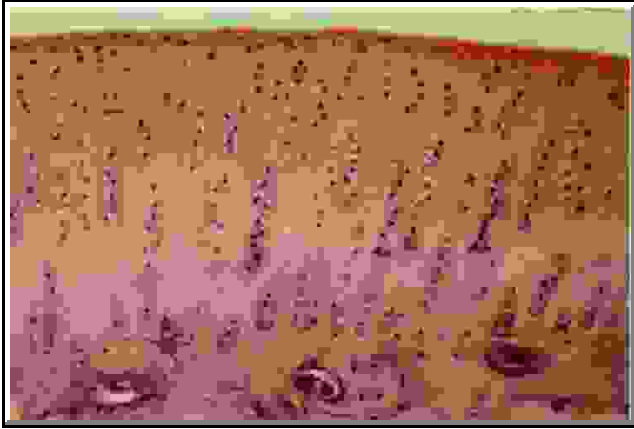


Gritzka et al^{9,12}.

For re-mobilization the plaster cast was completely removed from each rabbit at interval of 1st, 2nd, 3rd, 4th, 5th, and 6th, week of immobilization. The purpose of immobilization for different lengths of period was to induce different degrees of cartilage necrosis, while the purpose of re-mobilization of joints at weekly intervals was to allow repair and observe the extent of expected repair of necrosed articular cartilage. At the end of 7th week all the rabbits were sacrificed by ether inhalation. Joints were dissected and examined for the gross lesion of the articular cartilage and degree of repair. After gross examination the medial femoral condyles were cut.

Specimen consisted of articular cartilage and a portion of subchondral bone (Fig-II). The specimens were fixed in 10% buffered neutral formaline for 18 to 24 hours. Tissues were decalcified in a mixture of equal parts of 50% formic acid and 20% sodium citrate for about 6 to 8 days. The tissues were dehydrated with ascending grades of alcohol, cleared in 2 changes of xylene, infiltrated and then embedded in paraffin.

After processing , eight micron thick sections were made on rotary microtome and stained. Following



stains were used:

- I Hematoxylin and eosin stain for routine histological study.
- II Toluidine blue stain for the demonstration of ground substance.
- III Mallory's connective tissue stain for demonstration of collagen fibers.
- IV Gomori's silver stain for demonstration of reticular fibers.

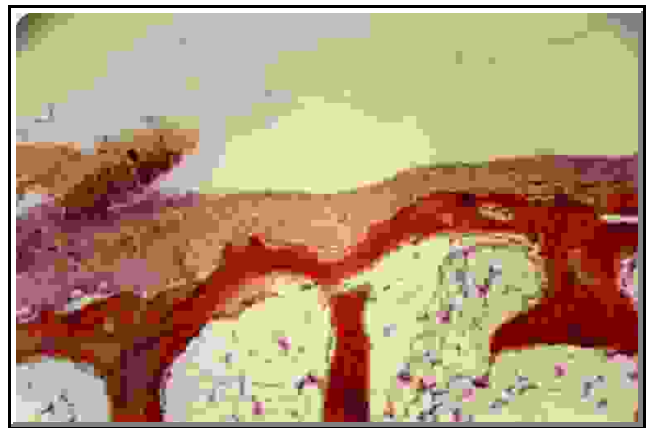
The sections were studied under the light microscope for the type of connective tissue fibers involved in healing process of necrosed articular cartilage.

RESULTS

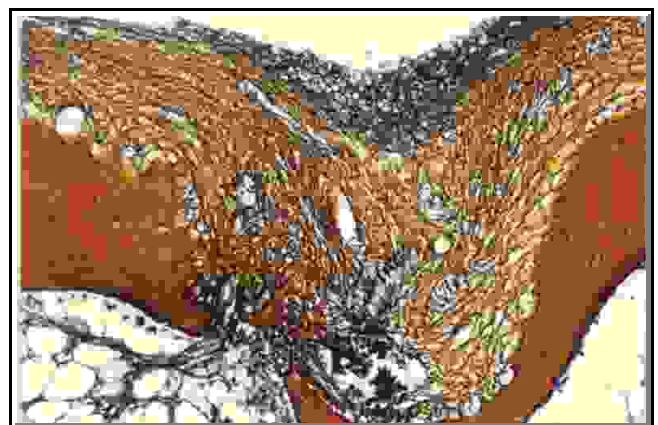
The microscopic structure of the articular cartilage of all control rabbits exhibited the normal histological architecture when examined on weekly interval. After first week of immobilization, the articular cartilage showed normal histological structure but on gross examination the cartilage was dull in appearance and on second week of

immobilization few linear vertical cuts were seen in the cartilage. On the third week of immobilization an ulcer in the contact area. The fibrous tissue derived from marrow spaces of the underlying subchondral bone (Figure-III) occupied the floor of the ulcer.

In articular cartilage's of rabbits immobilization for four weeks, the fibrous tissue occupying the ulcer was composed of only collagen fibers, but on the six weeks immobilization it was observed that



reticular fibers were also seen migrating from the underlying marrow spaces into the ulcer(Figure-IV).



DISCUSSION

Articular cartilage is composed of chondrocytes embedded within the extracellular matrix of collagen proteins. Articular cartilage can tolerate a tremendous amount of intensive and repetitive physical stress. However it shows a striking inability to heal satisfactory even the most minor injury⁵. The repair of the damaged articular cartilage takes place by poor fibrous tissue substitute, insufficient healing and incomplete filling of cartilage defects.

Articular cartilage has been damaged in experimental animals and the subsequent healing process has been studied by a number of investigators^{2,14}. Sizeable defects in tissues are replaced by a combination of young fibroblasts and capillary buds proliferating together to fill in the defects^{12,15}. Such a combination of fibroblasts and capillaries is known as granulation tissue. As time passes fibroblasts make more and more collagen fibers, which squeeze the capillaries so that blood no more passes through them and hence the granulation tissue becomes a collagenous scar. In most of the studies it was observed that the repair occurred by collagen fibers of inferior quality^{11,16}. The present study was designed to know the role of other types of connective tissue fibers in cartilage repair.

In the present study, earliest microscopically demonstrable lesions were detected after first week of forced immobilization and fully developed ulcer was observed within three to four weeks of immobilization. The signs of repair by fibrosis were detected in the late 4th week of immobilization and well developed fibrosis was observed during the 6th week. The severity, extent of lesion and subsequent repair of articular cartilage produced by immobilizing the knee joints in the present study were similar to observations reported^{1,2,4,9}. The only difference being that the reticular fibers also participated in the repair process in addition to the collagen fibers.

The most striking microscopic feature of articular cartilage is the preponderance of intracellular substances over the cells (Fig-II). The articular cartilage is avascular and its major source of nutrition is synovial fluid. The chondrocytes appear to be too highly differentiated to give rise to new cartilage occur by fibrosis. Fibroblasts grow up into necrosed cartilage from marrow spaces. In the present study, the reticular fibers were also seen migrating from the underlying marrow spaces and occupying the floor of ulcer. The presence of reticular fibers stained by silver stain, indicate that reticulocytes also migrated from marrow spaces into the ulcer and laid down reticular fibers along with collagen fibers. By observing our obtained result we may conclude that it is not only the fibroblasts which lay down collagen fibers during repair of necrosed articular cartilage, but reticulocytes also play an important role in laying down reticular fibers to fill the gap during healing.

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**That is the road we all have
to take - over
the Bridge of Sighs into
eternity.**

Soren Kierkegaard