RECENT TRENDS IN THE MANAGEMNET OF CHONDRAL AND OSTEOCHONDRAL LESIONS

An essay
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ACI	Autologous chondrocyte implantation
ACL	Anterior cruciate ligament
BMPs	Bone morphogenetic proteins
COR	Consistent Osteochondral Repair
CPM	Continuous passive motion
CT	Computerized tomography
ECM	The extracellular matrix
FDA	The Federal Food and Drug Administration
IGF-1	Insulin-like growth factor-1
Mpa	Megapascals
MRI	Magnetic resonance imaging
NSAID	Non steroidal anti-inflammatory drugs
OA	Osteoarthritis
OATS	Osteochondral Autologous Transplantation System
OCD	Osteochondritis dissecans
TGF-b	Transforming growth factor-beta

Localized articular cartilage defects are a major problem for orthopedic surgeons. Because cartilage has poor ability to heal as a sequence of lack of intrinsic repair capacity, chondral defects do not heal and may increase the risk of early osteoarthritis.[1]

The terms osteochondritis dissecans (OCD), transchondral fracture, osteochondral fracture, and osteochondral defect are known in the literature to cause the separation of a segment of articular cartilage in combination with a varying amount of subchondral bone. Osteochondral defects are rare joint disorders. Most often, they affect the knee, followed by the elbow and the talus**.**[2]

Studies have shown that a trial of conservative therapy does not adversely affect surgery performed after conservative therapy has failed**.**[3]

In the past, articular cartilage lesions have been treated by subchondral bone abrasions or drilling at the site of focal damage with procedures popularized by Pridie and Johnson.[4]

Conventional methods, Pridie's perforations, microfractures or subchondral abrasion (abrasion arthroplasty) lead to imperfect results in around 50% of cases**.**[5]

In order to overcome the drawbacks inherent in traditional methods, alternative methods have been developed: osteochondral or chondrocyte allografts and autografts.[6]

Good results for osteochondral allografts have been published. However, owing to the risk of transmission of viral diseases and uncertainties surrounding maintenance of the properties of the transplanted tissue, many authors have switched to using autografts.

Grafts using autologous chondrocytes involve two surgical procedures: one to remove a disc of hyaline cartilage, the other to implant the chondrocytes after they have been cultivated.

Autologous periosteal grafts involve removing a section of periosteum. The inner face of the periosteum, which contains the stem cells capable of differentiation into chondrocytes, is turned towards the subchondral bone, which has first been prepared (dechondrified). The defect is filled with cement, and then the periosteum, sutured to the periphery of the cartilage. Thus this method is identical with the previous one, except for the fact that cultivated chondrocytes are not used.

More recently, several authors have suggested using not an osteochondral autograft in a single block, but a collection of small osteochondral cylinders inserted side by side, thus making it possible to maintain the radius of curvature of the articular surface, or congruence. This is what is called mosaicoplasty.[7]

An alternative or complementary approach for joint tissue repair would be the controlled delivery of molecular signals to mesenchymal progenitors reported within the joint environment] with support of the subsequent steps of repair, including proliferation, patterning, and differentiation. This is done using tissue engineering. Injuries to the articular cartilage result in activation of the bone marrow and subchondral bone remodeling, suggesting the presence of molecular signals that are released and target the neighboring tissues.[8]

Research showed modulation of the BMP signaling pathway in adult human and mouse articular cartilage following mechanical injury *in vitro* and *in vivo*. These molecular events may contribute to trigger or support a repair response and failure to promptly activate these reparative signals may contribute to poor repair and poor clinical outcome. Hence, activation of the BMP pathway in response to injury may represent a prognostic marker and at the same time a therapeutic target to enhance the early response of the joint surface to acute injury.[9]

Histology

It is remarkable that in most joints, the articular cartilage has a relatively stable collagen architecture, and at some locations supports 1 to 4 megapascals (Mpa) (150 to 600 pounds per square inch) of force an average of 2 million time each year**.**[10]

Also it is more remarkable that the cartilage can remain attached to bone without separation for a lifetime. In addition the structure and chemistry vary from location to location within one joint and from joint to another**.**[11]

Articular cartilage does not ossify, the thickness of articular cartilage varies from joint to joint, and in humans it is thickest over ends of femur & tibia, ranging from 2-4 mm. it is molded to the shape of the underlying bone. It often accentuates and modifies the surface geometry of the bone. It is thickest centrally on convex osseous surfaces, and the reverse is true on concave surfaces. Its thickness decreases from maturity to old age. Young cartilages are typically thick, white, smooth, glistening and compressible. Ageing cartilages are thinner, less cellular, firmer and more brittle, with a less regular surface and a yellowish opacity. The glassy moistness of fresh, wet articular cartilage and early measurements supported the early impression of smoothness. Later, several authors emphasized the microscopic roughness of its free surface, said to be much inferior to mechanical bearings; but when covered by synovial fluid the surface has a very low coefficient of friction**.** The surface of articular cartilage

lacks a perichondrium; synovial membrane overlaps and then merges into its structure circumferentially**.**[12]

Structure and Composition:

Articular cartilage consists primarily of a large extracellular matrix (ECM) with a highly specialized cells (chondrocytes) distributed throughout the tissue. The primary components of the ECM are water, proteoglycans, and collagens, with other proteins and glycoprotein present in lower amounts. These all combine to provide the tissue with its unique and complex structure and mechanical properties**.**[13]

The articular cartilage throughout its depth from the articular surface to the subchondral bone can be divided into 4 zones:

zone 1: the superficial or tangential layer.

zone 2: the transitional or intermediate layer.

zone 3: the deep or radiate layer.

zone 4: the calcified cartilage layer.

The structure and composition of these zones differ from each other, These differences include cell shape and volume, collagen fibril diameter and orientation, proteoglycan concentration, and water content **(Fig 1).**[11]

In addition to the 4 zones, the ECM of articular cartilage is arranged around the chondrocytes in 3 regions: pericellular, territorial and interterritorial regions, depending on its proximity to the

chondrocyte, These regions differ in their content (collagen, proteoglycan, and other matrix components), and in the collagen fibril diameter and organization. The interterritorial matrix is the largest of the matrix regions and contributes most of the material properties of the articular cartilage **(Fig 2).**[13]

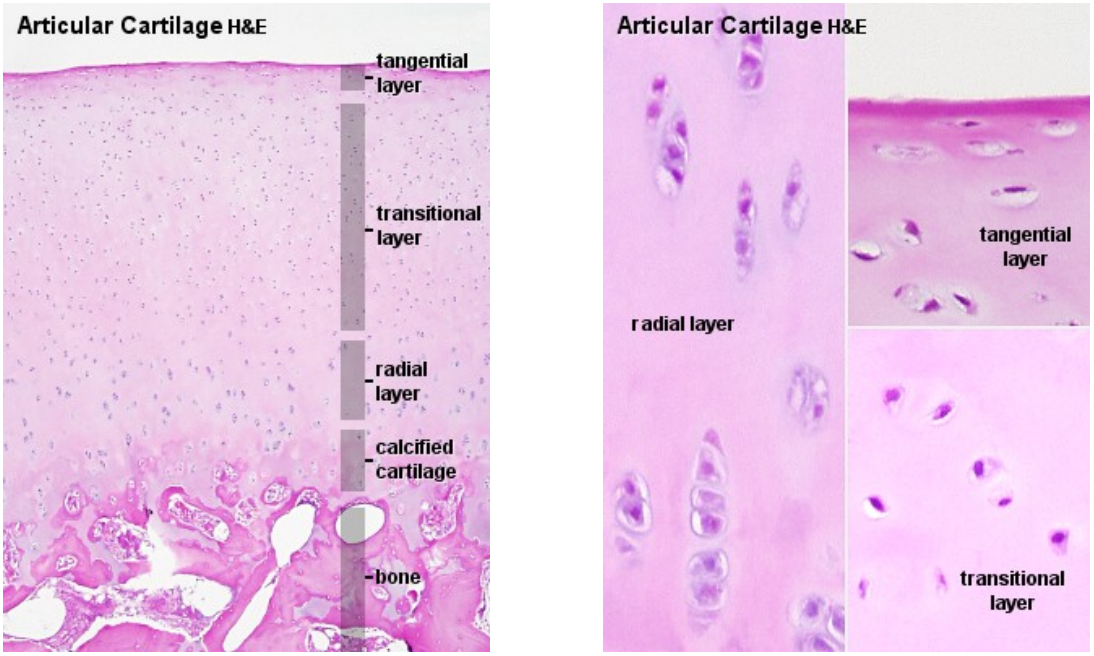

Fig. (1): Histological zones of articular cartilage.[14]

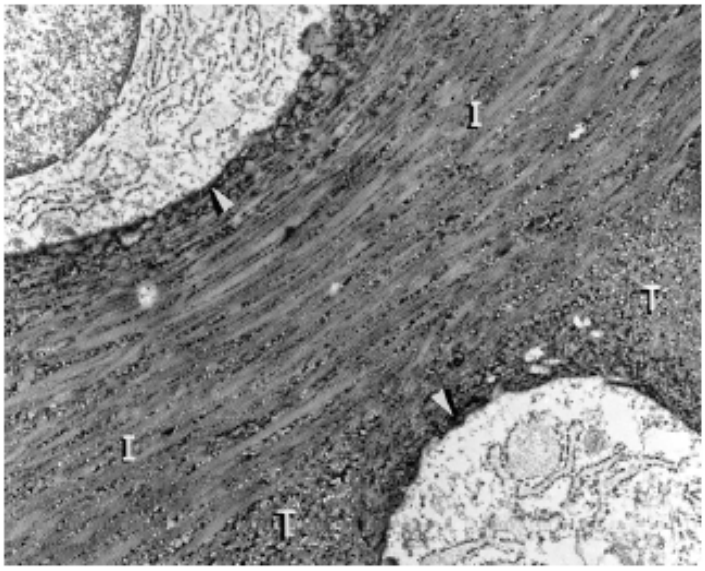

Fig. (2): Electron microscopic view of mature articular cartilage from the radial zone of the medial femoral condyle. Micrograph shows: pericellular matrix (arrow), territorial matrix (T), and interterritorial matrix (I).[13]

Chondrocytes:

The formation and maintenance of articular cartilage depends on the chondrocytes. They are derived from mesenchymal cells, which differentiate during skeletal growth and development to form chondrocytes. During skeletal growth, these cells increase the volume of ECM, and in mature tissue, where they occupy less than 10% of the total tissue volume; they are responsible for the maintenance of the ECM. The cartilage has no nerve supply; therefore, neural impulses cannot provide information, and the immune responses (cellular and humoral) are not likely to occur in cartilage because the tissue tends to be free from both monocytes and immunoglobulins**.**[13]

Matrix Composition:

Because the chondrocytes of articular cartilage occupy only a small proportion of the total volume of the tissue, its composition is determined primarily by the matrix. Normal cartilage has water contents ranging from 65% to 80% of its total wet weight. The remaining wet weight of the tissue is composed mainly of 2 major classes of “structural” macromolecular materials, collagens and proteoglycans. Several other classes of molecules, including lipids, phospholipids, proteins, and glycoproteins, make the remaining portion of the ECM. Although their role in the ECM has not been determined yet.[13]

The interaction of the fluid and the extracellular macromolecules allows the matrix to resist compression without permanent deformation.[15]

Nutrition:

Cartilage is often described as totally avascular. This is not totaly true but most cartilage cells are unusually distant from exchange vessels, which are mostly perichondrial, so articular cartilage may derive nutrients by diffusion from three sources: vessels of synovial membrane, synovial fluids and hypochondral vessels of an adjacent medullary cavity, this limitation of nutrition is reflected in the fact that most living cartilage tissue is restricted to a few millimeters in thickness. Cartilage cells situated further than this from a nutrient vessel do not survive, and their surrounding matrix becomes calcified.[12]