HEALING OF ARTICULAR CARTILAGE

A THESIS

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(Orthopaedic Surgery)

By

AMR EL SAYED WAHB

M. B, B. Ch.

Supervised by

Prof. Dr. HASSAN EL ZAHER HASSAN

Prof. of Orthopaedic Surgery, Ain Shams University

Prof. Dr. HUSSEIN EL KHATEEB

Assis. Prof. of Orthopaedic Surgery, Ain Shams University

Faculty of Medicine

Ain Shams University

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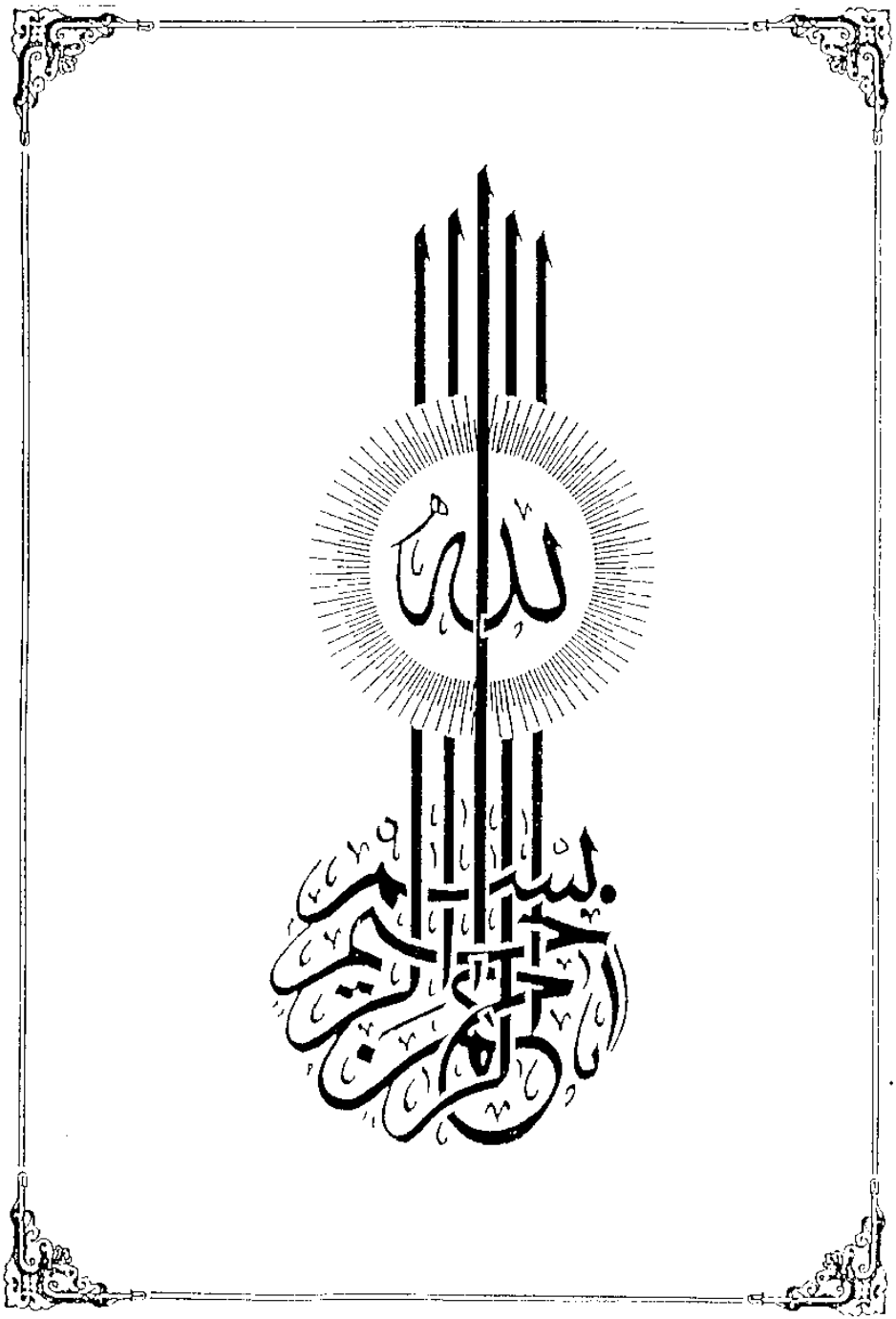

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The articular cartilage is formed of hyaline cartilage that covers the articular ends of long bones . The word hyaline cartilage is derived from [Hyalos (in Greek)] , means glass , which [cartilage (in Latin)] means gristle . (Bullough P.G., 1980).

So it is a bloodless tissue which in young people is translucent and bluish white , while in older individuals it becomes more opaque and slightly yellowish in colour .

Articular cartilage is devoid of nerves and is generally considered to be avascular , although a few blood vessels may be found in its deepest parts adjacent to the bone (Freeman , 1973). The articulating cartilages are most happily contrived to all purposes of motion in those parts . Therefore , the articulating cartilages have soft , smooth slippery surfaces so that they move upon one another with ease and mutual abrasion is prevented .

Also due to their elasticity , the violence of any shock , which may happen in running , jumping , etc. , is broken and gradually spent , which must been extremely damaging if the hard surfaces of bones had been immediately contigous . (Hunter W., 1743).

Also the articulating cartilages are flexible and therefore the contiguous surfaces are constantly adapted to each other and the friction diffuses equally over the whole .

The surfaces of the articular cartilage is smooth , however recent electron microscopic studies have revealed a gentle surface undulation . (Gardner and Woodward ,1969) . This undulation entrapes synovial fluid like pools in the valleys , facilitating the lubrication of the articular surfaces . (Walker et al , 1969).

The average thickness of the articular cartilage in the larger joints is 2-4 mm . The thickness varies over an articular surface and in general is greater at the joint pereiphery of concave surfaces and at the centers of convex surfaces . It also varies from joint to joint , being thickest on the patella (5mm or more) and thinnest on the interphalangeal joint . (Bullough & Goodfellow , 1968) . The thickness of the articular cartilage remains unchanged during the adult life , provided that its surface remains healthy . (Meachim , 1971) . It is formed of a relatively small number of cells embeded in abundant extracellular matrix .

Chondrocyte activity is necessary for the synthesis and probably the physiologic degradation and removal of the matrix . (Turek , 1984).

* ZONAL CLASSIFACTION OF ARTICULAR CARTILAGE

This classification was suggested by COLLINS (1949) . For descriptive purposes , the articular cartilage is divided into zones aligned parallel to the articular surface .(Fig. 1) .

Zone 1 , Superficial Or Tangential:

At the surface , fibres are arranged tangential to the surface , the cells are ovoid or elongated and are disposed parallel to the surface . Lamina splendens is the most superficial part of this zone .

Zone 2 , Intermediate Or Transitional:

Collagen fibres form a coiled interlacing network , cells are more numerous , spheroidal , and dispersed but equally spaced.

Zone 3 , Deep Or Radial:

Spheroidal cells are larger and are arranged in columnar fashion , often in groups of two to eight cells . The collagen fibres are thick and form a more tight meshwork and are arranged somewhat radial to the articular sturface .

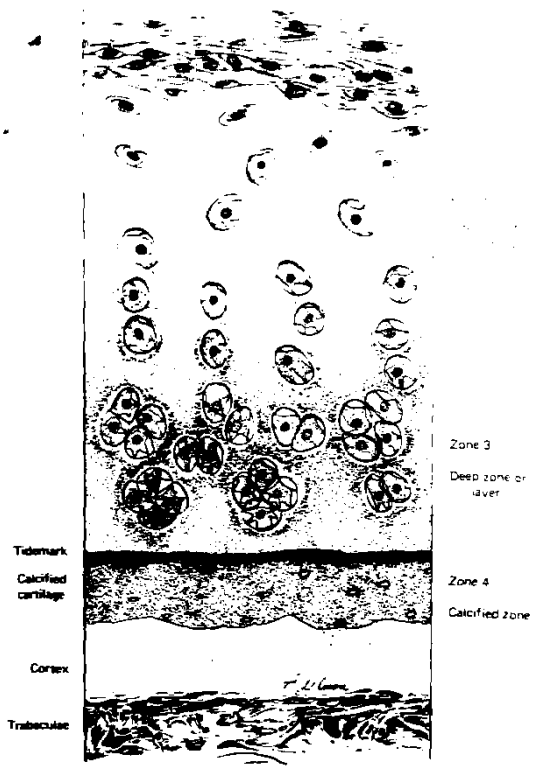

Fig. 1 : Zones of adult articular cartilage .

Zone 4 , Calcified:

This zone is adjacent to the subchondral bone . The cells are sparse and smaller and the matrix is heavily impergnated with calcium salts .

The junction between the non calcified cartilage and calcified cartilage (zones 3 & 4) appears as a basophilic line known as "Tide-mark" . (Fawns & Landells , 1953) .

* THE CELL (Fig. 2)

The cartilage cells "chondrocytes" vary considerably in size, shape and number of cells per unit volume of tissue . It has been suggested that the latter is inversly proportional to cartilage thickness .

Generally , the cells at the surface of the cartilage are flatter , smaller and more closely packed than the cells , deeper in the matrix and are arranged to the surface . The chondrocytes may appear single or in pairs two or four forming cell nests and the cells are situated in well defined spaces called lacunae . Freshly isolated living chondrocytes exhibit amoeboid movement . They are constantly changing their shape by putting on and withdrawing their pseudopodia . (Chestrman and Smith , 1968).

Superficial cells are less active than those in the deeper layers . But as we go deeper from the surface , the cells become more rounded , larger and metabolically more active as indicated

by the prominant well defined organells , and by the increased concentration of matrix components in the pericellular area . The largest cells might be as six times active than the smallest cells . (Stephen et al , 1980).

Cells are most numerous near the articular surface and the number of cells per unit volume decreases with increasing distance from the surface to a depth of 0.5 mm or more , beyond which the number remains relatively unchanged . In the normal human articular cartilage , cell density remains unchanged with advancing age . (Turek , 1984).

Mitotic division can be observed in immature rapidly growing cartilage , but not in mature adult articular cartilage. Actual mitosis is almost impossible to observe except under certain circumstances such as damage to the articular cartilage . This fact can be demonstrated by the increased uptake of tritiated thymidine which is incorporated into DNA , just prior to mitotic division which explains the reactive attempts at repair . This appears within the nucleus after the adminstration of the tritiated thymidine (H3-thymidine) . (Turek , 1984).

Occasionally , the chondrocytes in damaged cartilage exhibit phagocytic activity , but phagocytosis is not seen in intact cartilage . (Bullough P.G. , 1980).

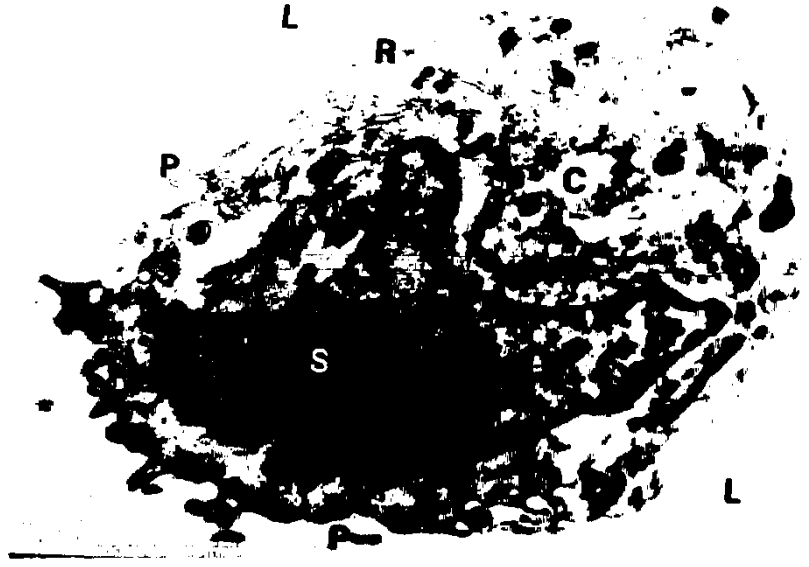

Fig. 2 : Transmission electron micrograph showing a chondrocyte with nucleus (N) with nucleolus (S) , cytoplasm (C) , limiting cell membrane (R), and cell processes (P) . Pericellular (L) and itercellular (T) matrix .

Ultra Structural Characteristics Of Cartilage Cells

Under the electron microscope , the cartilage cells appear to have all the known cell organells (Fig. 3) . Mitochondria are sparse in cartilage cells due to their compartively low rates of oxygen consumption . (Bullough P.G. , 1980).

The rough endoplasmic reticulum studded with ribosomes are responsible for protein synthesis of the cartilage matrix .

The function of the golgi apparatus in the cartilage cells is to complete the addition of the carbohydrate side chains to the glycoproteins arriving from the rough endoplasmic reticulum . (Turek , 1984).

Most of the matrix synthesis takes place in the deeper uncalcified zone of the articular cartilage . That is why , the cells in such a zone have the most prominant endoplasmic reticulum and golgi apparatus . (Bullough P.G. , 1980).

Lysosomes are vesicles budding of from the golgi apparatus and contain digestive enzymes called hydrolases that break down macromolecules originating either intracellularly or extracellularly . So , to some extent, they play a role in the breakdown of cartilage matrix . (Mankin and Lippiello , 1969).

The nucleus is either oval or elongated and its outline is smooth or indented and is surrounded by two membranes forming the