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Review

Morphological and biomechanical features of the temporomandibular joint disc: An overview of recent findings

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ABSTRACT

The temporomandibular joint is a type of synovial joint with unique structure and function. Between the mandibular condyle and the mandibular fossa there is a dense fibrocartilaginous oval articular disc, temporomandibular joint disc. This disc serves as a nonossified bone, thus permitting the complex movements of the joint, and plays a major role in jaw function by providing stress distribution and lubrication in the temporomandibular joint. Pathological mechanical loads are one of the principal causes of temporomandibular joint disc displacement.

There is a high frequency of temporomandibular joint disc disorders and treatment options are very limited. For this reason, it is necessary to examine possible alternatives to current treatment options like physiotherapy, drugs, splints or surgical techniques. Recent discoveries in the field of structure and functions of temporomandibular joint disc have created the need for their particular systematization, all in order to create an implant that would be used to replace the damaged disc and be more similar to the natural one. There is a need to more fully meet the morphology and biomechanical properties of the temporomandibular joint disc, and using tissue engineering, make a substitute for it, as faithful as possible, in a case where the natural TMJ disc is damaged so much that the normal function of the joint can be preserved only through implanted disc. Therefore, the aim of this paper was to describe morphology and structure, as well as biomechanical properties of the TMJ disc, in light of the possible applications of this knowledge for the purposes of tissue engineering.

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1. Introduction

The temporomandibular joint (TMJ) is a type of synovial joint that acts as a modified hinge.[1] Among its various other functions, it plays a key role in the orofacial system. As a ginglymo-arthrodial joint, it provides for hinging movements in one plane, and, at the same time, gliding movements in a second plane. The TMJ is the only joint of the human body that harbours a growth centre, resulting in the perpetual need for cooperation between the left and right joints.[2] The articular surfaces involved in the TMJ are the mandibular fossa and the articular tubercle of the temporal bone, as well as the mandibular condyle. Unlike most synovial joints, whose articular surfaces are covered with hyaline cartilage, the bones that make up the TMJ are covered with a layer of fibrous cartilage. Between the mandibular condyle and the mandibular fossa there is a dense fibrocartilaginous oval articular disc (TMJ disc; articular disc). This disc divides the joint cavity into two separate compartments: the superior and the inferior.[3] The upper and lower sides of the TMJ disc conform to the opposing articular surfaces. The anterior and posterior components of the TMJ disc thicken, delimiting a central thinner component.[4] The articular disc serves as a non-ossified bone, thus permitting the complex movements of the TMJ.[5] At the same time, this articular disc plays a major role in jaw function by providing stress distribution and lubrication in the TMJ. Pathological mechanical loads, such as increased friction between moving surfaces, are the one of principal causes of TMJ disc displacement.[6]

The aim of this paper was to describe morphology and structure as well as biomechanical properties of the TMJ disc, in an attempt to get the reader closer to its role which is so important for the normal functioning of the TMJ. At a minimum, knowledge of structure and biomechanical behaviour of the TMJ disc is of great significance for the successful use of tissue engineering for the purpose of replacing the diseased disc.

2. Research methodology

In order to describe new knowledge about the structure and biomechanical properties of the TMJ disc, we used the more recent literature (more than three-quarters of the references are from the last ten years). Older references were used to the extent that reflects knowledge that is still current in this area. Several databases were used for the literature search, and some references came from personal collection. All studies were potentially included, but we used only available data. In the literature review, we used original articles, retrospective studies, data from appropriate textbooks and a few review articles. The authors of some papers have used different biomechanical models, especially the finite element method. Many of the cited papers describe different animal models (e.g. rat, marmoset, pig, primate) as well as human studies (cadaveric material or TMJ discs removed after surgical procedures on patients). The studies of the effect of mechanical forces on TMJ disc mechanics required the use of non-preserved human specimens. There is a difficulty in procuring and maintaining fresh human specimens, and for this reason fresh animal TMJ discs are used. For example, there are anatomical and biochemical similarities between pig and human TMJ discs in the areas normally subject to compressive loads.[7] Of course, there are many limitations in the use of animal models and, despite how good they are, they can not faithfully mimic the structure and biomechanics of the human TMJ.

3. Morphology of the TMJ disc

In the sagittal plane, the TMJ disc can be divided into three regions according to thickness. The thinnest part is the central area, called the intermediate zone. This zone separates the articular surface of the mandibular condyle from the slope of the articular tubercle. Anterior and posterior to the intermediate zone, the TMJ disc becomes considerably thicker. The thickened posterior part, called the posterior band, is situated between the condyle and the floor of the mandibular fossa. The anterior band, also thicker than the intermediate zone, lies slightly in front of the condyle. Consideration of the coronal section indicates that the disc is generally thicker medially than laterally. It is attached to the fibrous capsule of the joint not only anteriorly and posteriorly, but also medially and laterally, which divides the TMJ into two distinct cavities.[5] In the posterior region the TMJ disc is divided into two laminae: the superior retrodiscal lamina, consisting of fibrous and elastic fibres, which attaches the disc to the tympanic plate; and the non-elastic inferior retrodiscal lamina, which, consisting entirely of collagen, rotates in a downward