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Evaluation Study

EVALUATION OF MORPHOLOGICAL CHANGES OF THE RETRODISCAL TISSUE IN TEMPOROMANDIBULAR DISORDER PATIENTS BY TSE DP/T2 WEIGHTED MR IMAGING

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ABSTRACT

In evaluating temporomandibular (TM) disorders, MRI with T2-weighted and TSE sequences is usually employed to detect intra-articular effusions in traumas or arthritic diseases. In the present study, the authors used the double echo TSE T2/PD weighted sequences to detect and evaluate morphological changes of retro-discal tissue related to TM disorders. The study group included 40 patients, 34 men and 6 women, ages 12 and 66 (mean 28.5 years). 1.5-Tesla MRI with a dedicated surface coil was performed with an open and closed mouth. Double echo PD/T2-weighted TSE sequences were acquired following a plane perpendicularly to the long axis of condyles. The following parameters were evaluated: presence or absence of retro-discal tissue fibrosis; shape and size of retro-discal tissue fibrosis and characteristics of signal intensity within the fibrotic area; histological exam of a specimen of a retro-discal tissue. The presence of fibrosis of the retro-discal tissue was demonstrated in all the TM joints studied; this was more or less evident according to the stage of the dysfunction, mouth opening, and the reducible or non-reducible disc displacement. In patients at stage I, the shape of the fibrosis at opened mouth position was tronco-conic; in patients at stage II, the fibrosis had a conic shape; in patients, at stage III the fibrosis had an aspect similar to a mushroom, horizontally placed; in patients at stage IV, the fibrosis had a ribbon-like and very irregular shape. PD/T2-weighted MRI allowed the identification of sclerotic changes involving the retro-discal tissue in all the TM disorder patients and evaluated their shapes and dimensions.

KEYWORDS: *temporomandibular, disk, joint, disorder, pain, imaging*

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INTRODUCTION

Two fibrous layers surround the retro-discal tissue of the temporomandibular (TM) joint, a highly vascularized connective tissue rich in nervous branches, elastic fibres, and adipose tissue. The upper layer, rich in elastic fibres, extends from the postero-superior margin of the articular disc to the petro-tympanic fissure. In contrast, the lower layer without an elastic component goes from the postero-inferior margin of the disc to the posterior margin of the articular surface of the condyle. Furthermore, the retro-discal tissue provides physiological vascular and nervous supply to the disc and synovial tissue, which covers the surfaces turned towards the postero-superior and the postero-inferior joint compartments.

These joint compartments, however, are virtual cavities since both the upper and the lower layers of the retro-discal tissue strictly adhere to the upper portion of the mandibular fossa and the posterior surface of the condyle neck, respectively. Between them, a thin layer of synovial liquid produced by the synovial membrane is present. The synovia covers only those structures not subjected to excessive loads or tractions since it is a mono-stratified epithelium (1).

A highly vascularized and innervated tissue is interposed between the two layers; during the mouth opening, it expands to fill the space created by the anterior movement of the condyle. The vessels occupy most of the retro-discal tissue (2, 3), and they are highly dependent on the elastic fibres of the retro-discal area, which originate from the posterior portion of the condyle, the retro-tympanic fossa, and the lateral portion of the articular capsule (Fig. 1). When these undergo a tension load, they cause an expansion of the vascular plexus, thus making the blood flow within it. Thanks to these characteristics, the retro-discal area works like a blood pump that fills and empties according to the movements of the condyle. During the mouth opening, the upper and lower layers adhere to the superior part of the mandibular fossa and the condyle and, thanks to the action of the elastic fibres, they create a "bellows" effect: the blood gets into the retro-discal tissue, which, by expanding, fills the articular space created by the condylar translation keeping the intra-articular pressure constant (4, 5).

Vice versa, during the mouth closing, the pressure of the condyle on the retro-discal tissue promotes the emptying of the cavernous plexus.

In the case of posterior displacement of the condyle and the related anterior dislocation of the disc, the articular surface of the condyle does not press against the central portion of the disc but rather against its posterior side causing mutual flattening. The evolution of the disease leads the condyle to exert its pressure more and more distally, thus traumatizing

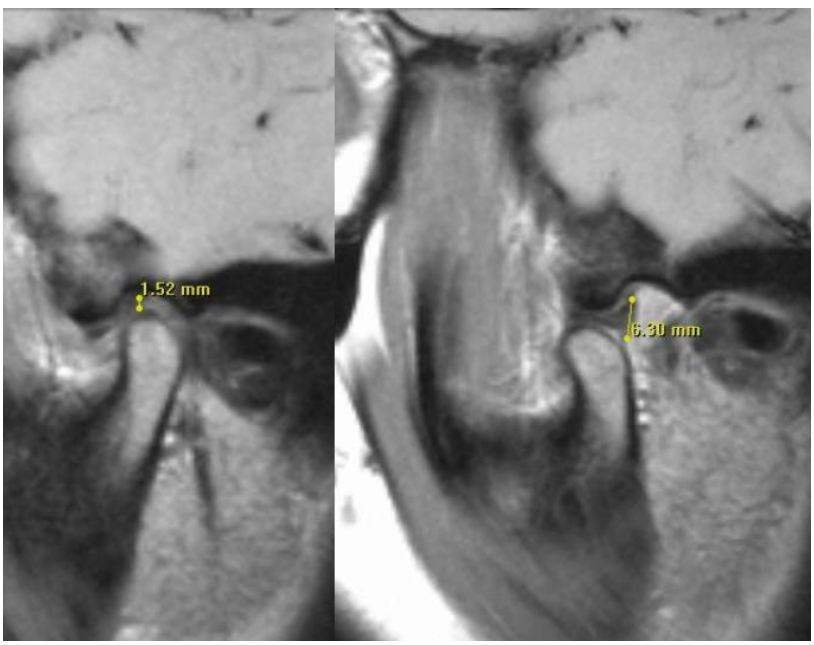


Fig. 1. *Retro-discal tissue fibrosis expansion with MRI DP weighted*

the retro-discal tissue. The response to this chronic trauma is an inflammatory reaction, followed by the fibrotization of the loose connective tissue and chondroid metaplasia.

MR imaging is a non-invasive technique that identifies the articular disc (6) and, above all, investigates the retro-discal tissue. At its maximum opening, it appears as a high-signal intensity area, slightly inhomogeneous, shaped as a triangle; it is defined posteriorly by the anterior wall of the external auditory canal and superiorly by the upper layer which forms a curve with a lower concavity, adhering to the roof of the mandibular fossa. The retro-discal tissue is anteriorly defined by the lower layer with an oblique trend, adhering to the posterior surface of the condyle.

In maximum intercuspation, the retro-discal tissue, which is compressed between the mandibular fossa and the condyle, presents a characteristic "sandwich" signal with a low-signal intensity of the layers and an interposed area with intermediate signal intensity.

In the evaluation of TM joint diseases, MR imaging with T2-weighted and TSE sequences is usually employed to detect intra-articular effusions in traumas or arthritic diseases (7); in the present study, instead, the authors used the double echo TSE T2/PD weighted sequences to detect and evaluate morphological changes of retro-discal tissue related to TM disorders.

MATERIALS AND METHODS

The study group included 40 patients, 34 men and 6 women, with ages ranging from 12 and 66 years (mean 28.5 years). All of them had TM disorder, although none had reported past direct or indirect traumas of the facial bones or other diseases of the TM joint. According to Wilkes' classification (8) (Table I), the TM joints of our study group were subdivided as follows: 10 at stage I, 28 at stage II, 16 at stage III, and 26 at stage IV.

Diagnostic, treatment and consensus for the scientific use of data were obtained from all patients. The study was performed following the Declaration of Helsinki of 2013.

1.5-Tesla MRI (Avanto, Siemens, Erlangen, Germany) with a dedicated surface coil was performed with open and closed mouth position. Double echo PD/T2-weighted TSE sequences (TR 3500, TE 15/102, FoV 140, 2 mm thickness at 0-mm intervals, flip angle 150, matrix 256x256) were acquired following a plane perpendicularly to the long axis of condyles.

The following parameters were evaluated: presence or absence of retro-discal tissue fibrosis; the shape of retro-discal tissue fibrosis in the scans obtained with the mouth open, according to the four stages of Wilkes' classification; the size of retro-discal tissue fibrosis in the scans obtained with the mouth open, according to the four stages of Wilkes' classification, by measuring the maximum distance in parasagittal planes (in an antero-posterior direction), on a horizontal line passing through the posterior border of the disc and the more distal point of the fibrosis, and in a vertical direction by measuring the distance between the higher and the lower points of fibrosis; characteristics of signal intensity within the fibrotic area.

One patient in Stage IV underwent surgery for perforation of retro-discal tissue; a specimen of retro-discal tissue was analyzed.

RESULTS

The presence of fibrosis of the retro-discal tissue was demonstrated in all the TM joints studied; this was more or less evident according to the stage of the dysfunction, the degree of fibrosis in patients in the different stages I-IV (Fig. 2), mouth opening, and the reducible or non-reducible disc displacement.

Table I. *Wilkes classification of TMJ internal derangement (1989)*

Stage 1	Early reducing disk displacement, no pain no limitation, early open click
Stage 2	Late reducing disk displacement, one or more episodes of pain mid to late opening click, transient catch & lock
Stage 3	Nonreducing disk displacement acute/subacute multiple painful episodes locked restricted mobility
Stage 4	Nonreducing disk displacement: chronic increasing functional disturbance
Stage 5	Nonreducing disk displacement: chronic with osteoarthritis, crepitus, scraping, grating, grinding symptoms. Pain-restricted motion, difficult function.

In patients at stage I, the shape of the fibrosis at opened mouth position was tronco-conic, with the smaller basis turned towards the disc and the greater posterior basis with a curvilinear shape and its convexity turned posteriorly. At this initial stage, the disc's layer insertions and fibrotic area were not always well-defined. It is not possible to see the posterior recesses with an open mouth, but it could be possible to see the anterior ones in a closed-mouth position.

In patients at stage II, the fibrosis had a conic shape, with its apex turned towards the disc and a posterior basis. The upper and the lower layers showed a regular outline on their outer side and were slightly separated from the bone surfaces by some synovial fluid highlighting the posterior recesses next to their discal insertion.

In patients at stage III, the fibrosis had an aspect similar to a mushroom, horizontally placed with its stalk turned towards the disc and its cap towards the external auditory canal. In addition, the layers presented a shape like a "curly bracket", and posterior articular recesses were more markedly depicted, especially the upper one. Finally, in those patients at stage IV, fibrosis had a ribbon-like and very irregular shape.

Stage-I patients had fibrosis measuring less than 2 mm; stage II patients presented fibrosis measuring from 3 to 5 mm in an antero-posterior direction and from 3 to 4 mm in a vertical dimension; fungiform fibrotic changes, typical of stage-III patients, measured from 5 to 8 mm in an antero-posterior direction, and 5 to 7 mm in a vertical dimension, while ribbon-shaped fibrosis of stage-IV patients was greater than 8 mm in an antero-posterior direction, and was 3 or 4 mm in a vertical dimension. All fibrotic changes presented a hypointense signal with dishomogeneous areas always localized in the posterior portion of the fibrosis. A histological exam of the specimen demonstrates marked fibrosis involving the whole sample, partially preserving fat and vascular tissue (Fig. 3).

DISCUSSION

Fibrotic lesions involving the retro-discal tissue are due to the trauma exerted by the condylar head and are more extensive in an advanced stage of the dysfunctional disease; this does not mean that larger lesions are more evident. Fibrosis of the retro-discal tissue can be better appreciated in cases that report numerous lock episodes spaced out by periods of reciprocal clicking (stages II and III of Wilkes' classification) rather than in those with a chronic lock or more serious lesions (stage IV of Wilkes' classification). This can be related to the fact that, in the presence of a remarkable limitation in the mouth opening, a vast portion of the retro-discal tissue cannot swell and stretch as it should; the fibrosis, then, even when largely diffused, is less evident as compared with stages II and III, being ribbon-shaped and therefore of reduced size.

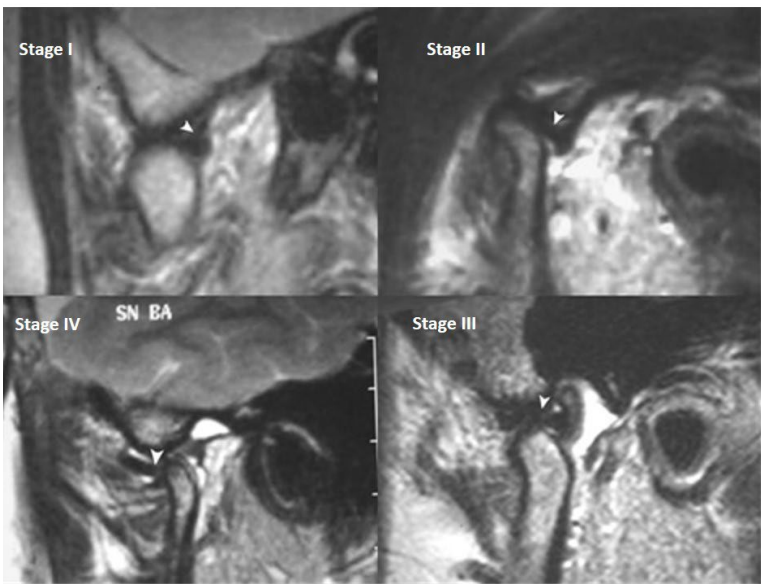


Fig. 2. *Limit between posterior margin of the disc and proximal part of the retro-discal tissue fibrosis in the four stages of Wilkes classification. MRI TSE T2 weighted (arrow tip).*

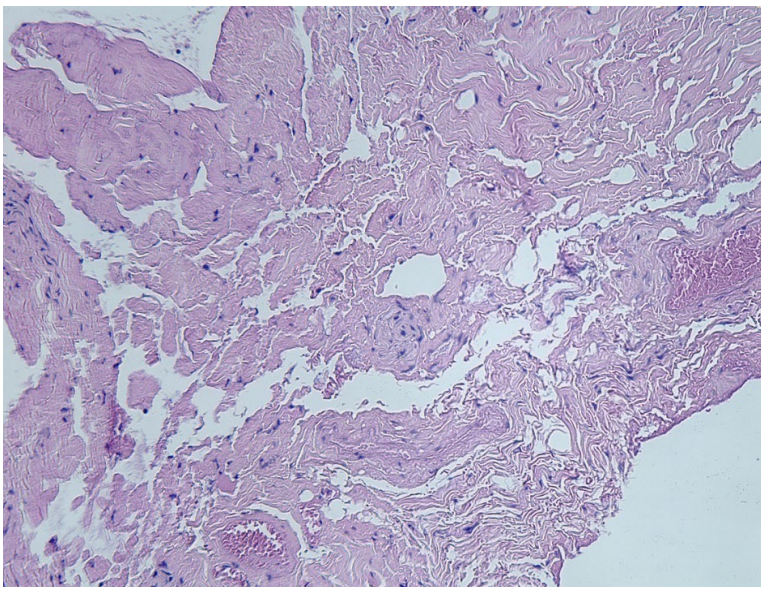


Fig. 3. *Histological sample of retro-discal tissue fibrosis (5X) highlights marked fibrosis involving the whole sample, with partial preservation of fat and vascular tissue.*

The portion of the retro-discal tissue damaged by chronic trauma cannot work correctly anymore. The upper and lower layers are involved in the fibrotic area and, during the mouth opening, prevent the expansion of the bilaminar zone. The fibrotic process involves both layers and the interposed vascular and adipose tissue as well; it presents a remarkable reduction of signal intensity with a homogeneous structure close to the disc (to such an extent that it is nearly impossible to be distinguished by the disc itself) becoming more and more inhomogeneous in more distant areas.

In patients at stage III of Wilkes' classification, the fibrosis takes the characteristic shape of a mushroom, whose stalk is the sclerotic tissue near the disc which, having been traumatized longer, has the two layers completely attached, whereas more distal tissue still able to expand under the pressure of the blood coming from healthy retro-discal tissue open like a fan, thus taking the shape of a mushroom's cap. In addition, the distal end of the fibrotic tissue may appear either well-delineated or not, showing a concavity turned towards the articular disc.

The decreased expansion of the retro-discal tissue allows the visualization of both upper and lower posterior articular recesses immediately behind the disc, where the fibrotic retro-discal tissue cannot expand and completely fill up the articular cavity. If the fibrosis of the retro-discal tissue is largely diffused or in the presence of a remarkable inflammatory exudate within the joint, the upper layer appears completely separated from the upper portion of the articular cavity; the posterior recess, therefore, takes the shape of a sickle, with its concavity turned down.

Additional evidence that during the mouth opening position, a remarkable blood flow within the retro-discal tissue is present is that both upper and lower layers, distally to the more sclerotic area, have a curved shape with their concavity turned posteriorly; this means that within the retro-discal tissue, there is a positive pressure stretching the tissue by pushing the two layers; therefore, these take the shape of a "curly bracket". Our results are in agreement with those of recent literature (9-12).

CONCLUSIONS

PD/T2-weighted MRI allowed the identification of those sclerotic changes involving the retro-discal tissue in all the TM disorder patients and to evaluate their shapes and dimensions.

Furthermore, it pointed out both the pathognomic morphology of retro-discal tissue fibrosis (similar to a mushroom) and the characteristic shape of upper and lower layers (like a "curly bracket") acquired during the opening of the mouth in those joints showing a reducible dislocation of the disc.

Authors contribution

DM: acquisition of clinical and imaging data and interpretation of data; FC: drafting the manuscript; MDG: revising the manuscript, and LB: approving the final version of the manuscript.

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