Observation of bilaminar zone in magnetic resonance images of temporomandibular joint

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ABSTRACT

Purpose : To observe the relationship of bilaminar zone of temporomandibular joint retrodiscal tissues to the disc condition.

Materials and Methods : The upper and lower stratum of bilaminar zone were identified on magnetic resonance open mouth images of 148 joints from 74 patients with disc displacements.

Results : Both strata were identifiable in 105 joints which had disc displacement with reduction. Lower stratum was not identifiable in 35 joints which had disc displacement without reduction but 12 of 35 had hyalinized posterior attachment where the disc was. The 8 joints which had partial disc displacement without reduction showed identifiable lower stratum at the reducing site which was medial.

Conclusion : Disruption or no identification of lower stratum which corresponds to the condylar portion of posterior attachment may be the sign of disc displacement without reduction. ***(Korean J Oral Maxillofac Radiol 2001; 31 : 221-5)***

KEY WORDS : diagnostic imaging; temporomandibular joint disorders; magnetic resonance imaging

Introduction

Recent studies with magnetic resonance (MR) imaging of temporomandibular joint (TMJ) have provided better understanding of disc displacement which is the most frequent abnormality in patients with joint pain and dysfunction. MR imaging can demonstrate the margin between the disk and its attachments, which is not possible by arthrography. The combination of sagittal and coronal views would result in a higher accuracy for disc position and configuration,[1] and the multiplanar capabilities of MR were suitable for an assessment of rotational and sideways disc displacements.[2]

In 1998 Orsini et al.[3] tested four closed-mouth and 1 open-mouth criteria for their ability to define normal and abnormal TMJ disk positions on MR images including the Drace and Enzmann's methods[4,5] which quantify meniscus displacement in terms of the number of degrees from a 12 o'clock or vertical position relative to the condyle. Their results suggest that the intermediate zone criterion for disk displacement is the more stringent criterion and the one that would yield the lowest number of false positives when the disk position is being judged in the closed-mouth sagittal view. In both symptomatic and asymptomatic volunteer groups, as the number of normal disk position diagnoses declined, the percentage of joints with a diagnosis of disk displacement with reduction increased. Conversely, the percentage of joints with a diagnosis of disk displacement without reduction did not appear to be substantially affected by the 4 closed-mouth disk position criteria.

Because of the facts that even around 25% to 33% of asymptomatic volunteers reported to have unilateral or bilateral disc displacement[6-9] and the number of disc displacement varies with different diagnostic criteria, the distinction between the disc displacement with reduction and without reduction seems to be more significant.

de Leeuw et al.[10] said that apparently a radiographically stable end stage may be reached within a few years after permanent disc displacement in most cases. They concluded that in TMJs with reducing disk displacement, no or only slight radiographically visible degenerative changes develop, even if this condition persists for several decades. On the other hand, in TMJs with permanent disk displacement, radiographically visible degenerative changes are extensive in the vast majority of cases.

There have been several attempts to identify the difference between the reducing (DDR) and nonreducing discs (DDNR).

Rammelsberg[11] found in his MR imaging-based joint space

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measurements that the patients with bilateral DDR demonstrated a significantly more posterior position of the condyle, as compared with controls and patients with bilateral DDNR. DDNR presented a significant reduction of the anterior and the posterior joint spaces, leading to a mean concentric position of the condyle. Patients with unilateral DDR or DDNR demonstrated a greater variability of anterior and posterior joint spaces, compared with patients with a bilaterally identical type of disc displacement.

Suenaga et al.'s study[12] with dynamic MR imaging suggested that prominent contrast enhancement of the posterior disk attachment might help to differentiate intraarticular and extraarticular causes of pain in and around the TMJ. Furthermore, in the joint pain group, anterior disk displacement without reduction was strongly associated with prominent contrast enhancement.

Kurita et al.[13] suggested that the permanently displaced disks are located more anteriorly than the reducibly displaced disks. And when the disk displacement was moderate, disk reduction was influenced by less disk displacement at either the medial or lateral part of the TMJ. However they sometimes observed joints in which severely displaced disks showed reduction in the open-mouth position. On the other hand, they also observed cases in which slightly displaced disks were pushed far anteriorly by the condylar translation. They suggested that in these joints, other factors, such as sticking or tearing of the TMJ disk, may influence disk reducibility.

The author paid attention to the posterior attachment of the disc because they could be more susceptible than the disc itself showing various changes associated with disc displacement or joint pain.

Isberg and Isacsson[14] found in their study with 10 TMJ specimens that all joints with permanently displaced disc demonstrated perforation of a hyalinized posterior disc attachment. And they added that without tissue identification such an attachment is likely to be misinterpreted as being the disc itself.

Isacsson et al.[15] also found that joint with severe pain, the posterior disc attachment failed to show adaptive change characterized by connective tissue hyalinization.

Westesson et al.[16] analyzed MR images of the TMJs of 69 patients with disc displacement and 28 asymptomatic volunteers. Decreased signal intensity from the retrodiskal tissue was seen in 16 joints in the patients (12%). None of the asymptomatic volunteers exhibited this feature. It was seen in one joint with disk displacement with reduction, in nine joints with disk displacement without reduction, and in six joints with disk displacement without reduction and arthrosis. And they concluded that decreased signal intensity from the retrodiskal tissue was most frequently associated with later stages of disk displacement and its clinical significance remains unclear because there was no appreciable correlation to patient symptoms of pain.

In 1998 Hollender et al.[17] reported successful demonstration of two distinct strata forming the bilaminar zone of the TMJ disc using proton-density MR imaging. They said their findings confirmed earlier anatomical descriptions of the behaviour of the upper stratum during mouth opening. And they conclude that the upper stratum of the bilaminar zone will not stretch across the glenoid fossa during normal opening movement but stay in close contact with the dome-shaped fossa.

So the author tried to observe the bilaminar zone of temporomandibular joint retrodiscal tissues in proton-density MR images and studied the relationship of the bilaminar zone to the disc condition.

Materials and Methods

The upper (temporal part of posterior attachment) and lower stratum (condylar part of posterior attachment) of bilaminar zone were identified on MR proton density open mouth images of 148 joints from 74 patients (male; 38, female; 36) with disc displacements (106 DDR, 8 partial DDNR and 34 DDNR). The study materials were selected from the MR images of patients who were diagnosed through clinical examination and to have disc displacement by the intermediate zone criteria.[3] They were between 12 and 68 years of age (mean age; 26.3 yrs.). The MR images were taken by 1.5 Tesla Magnetom Vision (Siemens, Benshiem, Germany) at TR 2,000-3,000 msec,

Fig. 1. Upper (A) and lower (B) stratum of bilaminar zone are shown.

TE 15 msec, SL 3 mm, FOV 135 × 135 mm, Matrix 210-252 × 256.

The upper stratum was identified as a dome-shaped structure which follows the outline of the glenoid fossa and has a signal intensity higher than that of the disc but clearly lower than the retrodiscal pad. The lower stratum was identified as a structure which extends from the posterior band of the disc and appears to attach to the posterior aspect of the condylar head and has a similar signal intensity as that of the upper stratum as described by Hollender et al.[17] (Fig. 1).

Results

The TPAs showed quite consistent features as described above, but the CPAs showed a short or wavy projection from the disc to the variable point of the posterior surface of the condyle. The wavy and rather long CPAs were associated with the discs which were farther anteriorly displaced.

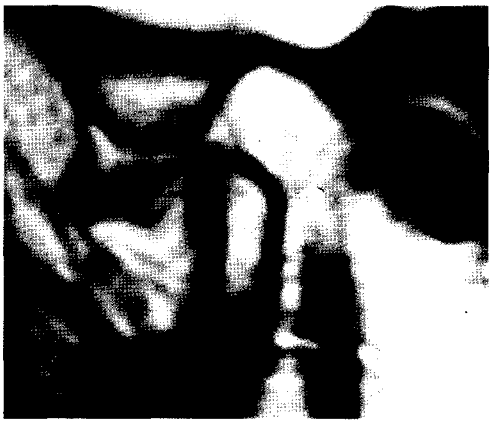

Fig. 2. Lower stratum is not identifiable in disc displacement without reduction.

Fig. 3. Posterior disc attachment is hyalinized.

Both strata were identifiable in 105 joints which had disc displacement with reduction. Lower stratum was not identifiable in 35 joints which had disc displacement without reduction (Fig. 2) but 12 of 35 had hyalinized posterior attachment where the disc was (Fig. 3). The 8 joints which had partial disc displacement without reduction showed identifiable lower stratum at the reducing site which was medial.

Discussion

Bilaminar zone is also called retrodiscal tissue or pad, and posterior disc attachment or posterior attachment (PA).[18]

Scapino described precisely about the posterior attachment (PA) and its MR appearance[19,20] that the PA of the TMJ disc is a highly compliant tissue, capable of large volumetric fluctuations. And MR imaging allows observation of the PA without the artifact of dilation of the joint spaces required in arthrography. When the condyle is moved, the shape of the PA and arrangement of its constituent parts change. And he said the PA contains three intimately related groups of collagen fibers, that is, temporal part of the posterior attachment (TPA), intermediate part of the posterior attachment (IPA) and condylar part of the posterior attachment (CPA).

The TPA fibers arise from the cartilagenous auditory meatus lateral to the postglenoid process. And many fibers of the TPA enter the surface of the postglenoid precess as Sharpey's fibers. The author think this can be one of the reasons that TPA shows no disruption even in severe disc displacement cases. In the open jaw position, the TPA becomes arched superiorly between the posterior band of the disc (PB) and the its temporal fixation, above an expanded venous plexus contained within the IPA.

The CPA fibers extends upward from their attachment on the posterior aspect of the condyle to the PB. But Kino et al.[21] insisted that most of the collagen fibers that compose the PB were attached to the condylar poles and to those vicinities behind them, and no diskal attachment was found to the posterior aspect of the condyle, therefore they concluded that there were no upper and lower strata. And they considered the term "posterior attachment of the disk" to be misleading, because the disk was chiefly attached to the condylar poles and not to the posterior wall of the articular fossa nor to the posterior aspect of the condyle. So they said it should be termed the retrodiskal tissue or area. When the jaws were fully closed, these fibers formed a thin but compact sheet that followed the contour of the condyle.

The fibers of the TPA appear to be mostly interwoven with those of the CPA as they pass into the PB. The pattern of the collagen fibers, in which TPA fibers are interwoven with the fan-like radiation of CPA fibers as both enter the PB, is characteristic of about the central half of the union between the PA and PB. When the PB is thinner, as it tends to be in the lateral part of the joint, the pattern may not be observed, and the TPA and CPA may join the PB in a more parallel-fibered organization. The author think this can be a reason for the lateral part of the fibers tend to disrupt before the medial part which has the fan-like radiation organization of fibers.

The PA also contains a branching meshwork of elastic fibers that are reported to be concentrated in its upper, medial part. The caliber of fibers varies considerably. Those of the TPA and IPA appear to be generally thicker than those of the CPA, and they are clearly thicker than those of the disc. The elastic fibers of the CPA, in addition to being smaller than those of the TPA and IPA, appear to run more parallel with the collagen fibers and branch less often than the above fiber groups. The author think these also may be the reasons that the CPA disrupts easily and especially in the medial part. Hall et al.[22] also said that there is a tendency for patients with complete dislocation to exhibit less elastin than those with partial dislocation of the meniscus.

In the closed jaw position, the three groups of PA fibers are pressed together so that the distinction between them and their associated structures is obscure. In jaw closed MR images, the PA characteristically appears as a line of hypointense signal, approximately comparable to that of the disc, which extends between the PB and the parotid gland. The anatomic subdivisions of the PA are not distinguishable.

When the jaws are opened, the TPA moves upward and forward against the posterior slope of the articular eminence and roof of the glenoid fossa. The upward flextion of the TPA at its junction with, and infolding of the CPA beneath, the PB appear to compact these structures, causing them to produce an MR imaging signal of intensity similar to that of the disc. In MR jaw open images, an arc-like region of the relatively low signal intensity, approximately comparable to that of the disc, is characteristically observed extending from the PB posteriorly along the articular eminence and glenoid fossa. The thickness of the arch decreases with mouth opening. When the jaws are widely open, the PA is markedly expanded. Most of the expansion occurs within the IPA.

In some of the MR images, the tissue located at the postero-inferior corner of the PB produces a low signal, approximately comparable to that of the disc. This is the site of infolding of the CPA observed in the anatomic specimens and is presumed to represent the image of it. If the walls of the inferior joint space are not breached and the condyle is moved forward, the CPA becomes folded beneath the PB. Fixation of the specimen under such conditions maintains the CPA in the folded state. Scapino[19,20] says maybe this part is observed in his MR image study as CPA.

Kurita et al.[13] speculated that the looseness of the connection in both the medial and lateral part of the disk might cause permanent disk displacement. They thought the prevalence of the antero-medial displacement in DDNR was responsible for a lesser amount of disk displacement at the medial depth. But they did not understand why in the joints with moderate-severe displacement, a difference was observed at the lateral depth. They also observed that the disks, of which the medial attachment was stretched, would be displaced more anteriorly than those of which the lateral attachment was stretched. The result of this present study might be only an observation that reducing disc tends to show bilaminar zone but Kurita et al.'s doubt could be explained.

Rammelsberg et al.[23] studied the variability of disk position in asymptomatic volunteers and patients with internal derangements of the TMJ in 1997 and found that the disk position in asymptomatic TMJs varied considerably with a tendency toward farther anterior placement in more lateral images. The results suggest that disk positions of up to +15 degrees on medial tomograms and +30 degrees on lateral tomograms should be regarded as normal variations. Furthermore, multisection analysis of all parasagittal images improved the separation between disk displacement and asymptomatic TMJs.

In this study, in 105 cases of DDR, both strata were identifiable and even in very far anteriorly displaced discs the loosened CPAs continued to function trying to replace the disc during opening. The degree of looseness or slackness of CPA was less at medial side which could explain the medial reduction in 8 joints of partial DDNR. On the other hand, the CPAs of 35 DDNRs were not identifiable possibly from disruption or perforation of the hyalinized posterior disc attachments as Isberg and Isacsson described.[14] But 12 of 35 had some form of hyalinized posterior attachment connecting the area where the disc was and the TPAs.

Scapino[19] reivewed papers and commented on the pathology associated with disc displacement that the PA, in regions where it is subject to compressive loading, is capable of remodeling-ie, it may become fibrotic and infiltrated with polyanionic glycosaminoglycans. It appears that these changes make the PA better able to withstand the applied loads. Since the PA is profusely innervated, it is widely believed that it is largely responsible for the arthralgia seen in disc displacement patients. In such patients, remodeling of the PA presumably does not occur, occurs but is inadequate, or occurs and is adequate for a time and then fails. Injury to the PA results and presumably initiates the arthralgia via the C nerve fiber pathway. Differences in the clinical histories of patients suggest that all of these modes of failure may occur. Isacsson et al.[15] studied the TMJs with severe pain and found that the nonhyalinized posterior disc attachment was intensely red and showed advanced histologic alterations of the vessels, deposits of extravasated erythrocytes and fibrin, and altered composition of the connective tissue. Understanding the pathology of the PA is essential in evaluation of the appearance of the soft tissues in TMJ imaging studies.

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