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Positional and morphologic changes of the temporomandibular joint disc using magnetic resonance imaging

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ABSTRACT

Purpose : To evaluate displacement and morphologic changes of the temporomandibular joint (TMJ) disc in patient with internal derangement using magnetic resonance imaging (MRI).

Materials and Methods : One hundred and forty five MR images of TMJs in 73 patients were evaluated. Positional and morphologic changes of the TMJ discs were assessed. Lateral or medial disc displacement was also evaluated on coronal images.

Results : Among 63 discs with anterior disc displacement, 37 discs were assessed as a biconcave disc and 21 as a deformed disc. Rotational disc displacement was observed in 35 discs. Anteromedial disc displacement was observed in 29 discs, and anterolateral direction in 6 discs. Among 35 rotational displacement, 5 biconcave discs and 21 deformed discs were observed.

Conclusion : Rotational and sideways displacement of TMJ discs were found to be common and an important aspect of internal derangement. This study also suggests that sagittal and coronal images of the TMJ have complementary abilities for an assessment of joint abnormality. ***(Korean J Oral Maxillofac Radiol 2001; 31 : 235-40)***

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

Introduction

Magnetic resonance imaging (MRI) of the temporomandibular joint (TMJ) has been shown to be valuable in the detection of disc displacement as well as in the delineation of the morphologic change of the TMJ disc.[1-5] Therefore, the high-field MRI is now considered as the gold standard.[6] The most common cause of internal derangement is displacement of the disc.[7,8] Although many investigations were undertaken to determine the disc displacement and morphologic change, most of them focused on the anterior disc displacement on sagittal MRI of the TMJ.[1,8-11] The disc displaces mainly in anterior, anteromedial, or anterolateral direction. Recent studies indicated that medial or lateral displacement of the TMJ disc was relatively frequent and occurred in 25% of patients with symptoms of internal derangement. Liedberg et al.[12] demonstrated that 33% of patients with signs and symptoms of internal derangement showed medial or lateral disc displacement. MRI showed medial or lateral disc displacement from 20% to 26% of the study subjects.[13,14]

Rotational disc displacement implies a combination of anterior and medial or lateral displacement, whereas sideways displacement implies pure medial or lateral displacement without anterior displacement. Disc position depicted by MRI suggested that a combination of sagittal and coronal views would result in a higher accuracy for MRI.

The morphology of a disc is biconcave in a normal state and deforms when it displaces. Murakami et al.[10] demonstrated that discs were distorted after displacement and most of the markedly distorted discs belonged to disc displacement without reduction. The disc morphology has been recognized as an important feature of internal derangement of the TMJ and functional impediments.

The aims of this study were to assess the direction of disc displacement and the TMJ disc morphology in patients with internal derangement using MRI.

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Materials and Methods

1. Materials

One hundred and forty six TMJs in 73 patients representing signs and symptom of internal derangement were examined at the Department of Oral & Maxillofacial Radiology, Chonbuk National University Dental Hospital between February 1995 and September 2001. Twenty one females and 52 males were involved in this study. The mean age of the subjects was 27.2 years old ranging from 10 to 65 years (Table 1). Since one fragmented disc within a cavity was difficult to examine, it was excluded from the study.

2. Methods

MRI of the 145 TMJs were obtained by the 1.5 T MRI system (Magnetom vision, Siemens, Germany) which used a 7.5 cm surface coil and 3 mm section thickness with a 256 × 256 matrix. A spin echo (SE) multisection imaging method was used for T1-weighted images (repetition time msec/echo time msec = 400/15), T2-weighted images (TR/TE = 2000/10^5) and proton density images (TR/TE = 2000/52). Sagittal and coronal images were also obtained.

The several images of one joint were examined according to the classification by Murakami et al.[10] Discs in the closed mouth position were allocated on a basis of the position of the posterior band of a disc in relation to the functional surface of a condyle. In the closed mouth position, a disc was divided into four compartments (Fig. 1). A line (H0) was drawn joining points e, the most inferior point on the articular eminence, and g, the most inferior point on the postglenoid process. A second line (H1) was drawn parallel to H0 passing through point a, the most anterior point of the functional surface of the condyle. Two further parallel lines were then drawn perpendicular to H1-L1 passing through the posterior edge of the functional surface and L2 through point a. The disc space was thus divided into four compartments A, B, C and D.

Table 1. Distribution of age and gender of subject of patients with internal derangement of TMJ

Age	Gender	
	Male (n = 52)	Female (n = 21)
10-19	13	4
20-29	26	8
30-39	7	5
40-49	3	3
50-59	3	
60-		

To assess disc morphologic change, discs were categorized according to their shape as shown in Fig. 2. The section with the most marked deformation of a disc was used as a reference. The disc morphology was classified into five types, i.e.; biconcave; both upper and lower surfaces of a disc are concave, biplanar; disc has even thickness, hemiconvex; the upper surface of a disc is concave, while its lower surface of a disc is convex, biconvex; both upper and lower surfaces of a disc are convex, folded; a disc is folded at its center.

The functional aspects of disc displacement include dis-

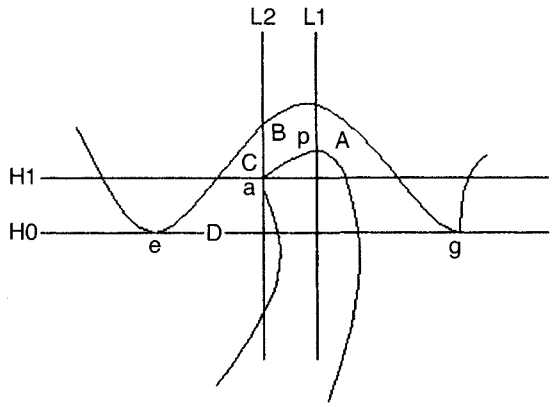

Fig. 1. Criteria for disc position.
The disc position was classified according to its location of the posterior band in relation to the compartment A, B, C or D in the closed mouth position.
H0 : a tangent from the postglenoid process (g) to the articular eminence(e).
H1 : a line parallel to H0 passing the anterior edge (a) of the functional surface of the condyle.
L1 : a line perpendicular to H0 passing through the posterior edge(p) of the functional surface of the condyle.
L2 : a line perpendicular to H0 passing through the anterior edge (a) of the condylar functional surface.

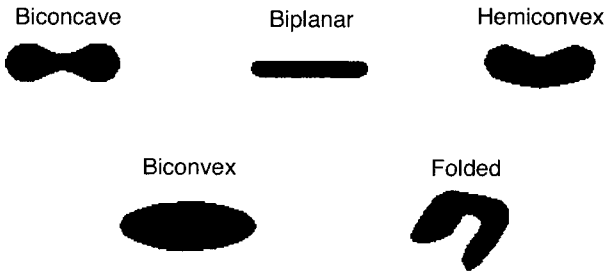

Fig. 2. Classification of a disc morphology.
Biconcave; both upper and lower surface of a disc are concave, biplanar; a disc is of even thickenss, hemiconvex; the upper surface is concave, while its lower is convex, biconvex; both upper and lower surface of the disc are convex, folded; the disc is folded at its center

placement with or without reduction. In disc displacement with reduction, the anteriorly displaced disc reverted to a normal superior position during mouth opening. In disc displacement without reduction, the disc was laid on the anterior to a condyle during all mandibular movements and the normal condyle-disc relationship was not reestablished.

The position of a disc in the coronal plane was classified as "superior", "medial", or "lateral".[13,14] In the superior position, the central part of the disc covered the superior surface of a condyle, reaching down to the medial and lateral poles of the condyle in all the coronal sections from anterior to posterior. In the medial position, the disc was overextended to cover the medial pole of the condyle and did not cover the lateral pole of the condyle. In the lateral position, the disc was overextended to cover the lateral pole of the condyle and did not cover the medial pole of the condyle.

Results

1. Disc morphology and anterior displacement (Table 2)

One hundred and forty two of 145 discs in total subjects were seen in the superior or anterior position to a condyle and 3 discs were seen in posterior position to a condyle. In this study, the posterior disc displacement was not included.

Forty three of 44 discs in stage A and 50 of 57 discs in stage B were found to be reduced in the open-moth position. In contrast, 10 of 19 discs in stage C and 19 of 22 discs in stage D were not reduced in the open-mouth position.

Forty one of 44 discs in stage A, 35 of 57 discs in stage B, 6 of 19 discs in stage C and 1 of 22 discs in stage D were biconcave.

Three of 44 discs in stage A, 12 of 57 discs in stage B, 12 of 19 discs in stage C and 18 of 22 discs in stage D were distorted (convex or folded).

Among 45 distorted discs, 28 discs were hemiconvex, 9 discs were biconvex and 8 discs were folded.

2. Disc morphology and other direction of disc displacement (Table 3)

Discs in stage B, C, D were classified as anterior disc displacement, while discs in stage A were classified as sideway displacement.

Pure anterior disc displacement was observed in 63 discs, rotational disc displacement in 35 discs, and sideway displacements in 7 discs. Thirty seven of 63 discs in the pure anterior displacement were biconcave and 21 discs were deformed, whereas 5 of 35 discs in the rotational displacement were biconcave and 21 discs were deformed. Thirteen of 21 deformed discs in the rotational displacement were hemiconvex.

Twenty nine of 35 rotational discs were displaced anteromedially and 6 discs displaced anterolaterally. All of the 7 discs having sideway displacement were displaced medially.

Table 2. Disc morphology and the degree of anterior displacement

Disc morphology	Degree of anterior displacement								Total
	A		B		C		D		
	W	Wo	W	Wo	W	Wo	W	Wo	
biconcave	41		35		4	2		1	83
biplanar			9	1	1		1	2	14
hemiconvex	2	1	4	4	2	4	2	9	28
biconvex			1	1	1	2		4	9
folded			1	1	1	2		3	8
subtotal	43	1	50	7	9	10	3	19	142
Total	44		57		19		22		

A, B, C, D: referred to Fig. 1
W; with reduction, Wo; without reduction

Table 3. Disc morphology and other direction of disc displacement

Disc morphology	Anterior	Rotation		Sideway	
		Antero-medial	Antero-lateral	Medial	Lateral
biconcave	37	3	2	6	
biplanar	5	7	2		
hemiconvex	12	12	1	1	
biconvex	4	4	1		
folded	5	3			
Total	63	29	6	7	0

Discussion

The reason for imaging the TMJ is usually one of the following: (1) to confirm suspected pathology, (2) to screen for unsuspected pathology, (3) to identify the staging of a disease, (4) to evaluate the effects of a given treatment, (5) to help evaluate the range of motion of the joint.[15] A choice of a particular technique is determined by the nature of a suspected pathology and the availability of instrumentation and trained personnel. A patient's physical or mental state may also limit the choice of a technique. Of various methods of imaging the TMJ, arthrography and MRI are indicated for evaluation of soft tissue components.[15] MRI has the highest accuracy to demonstrate both joint structures and soft tissues surrounding

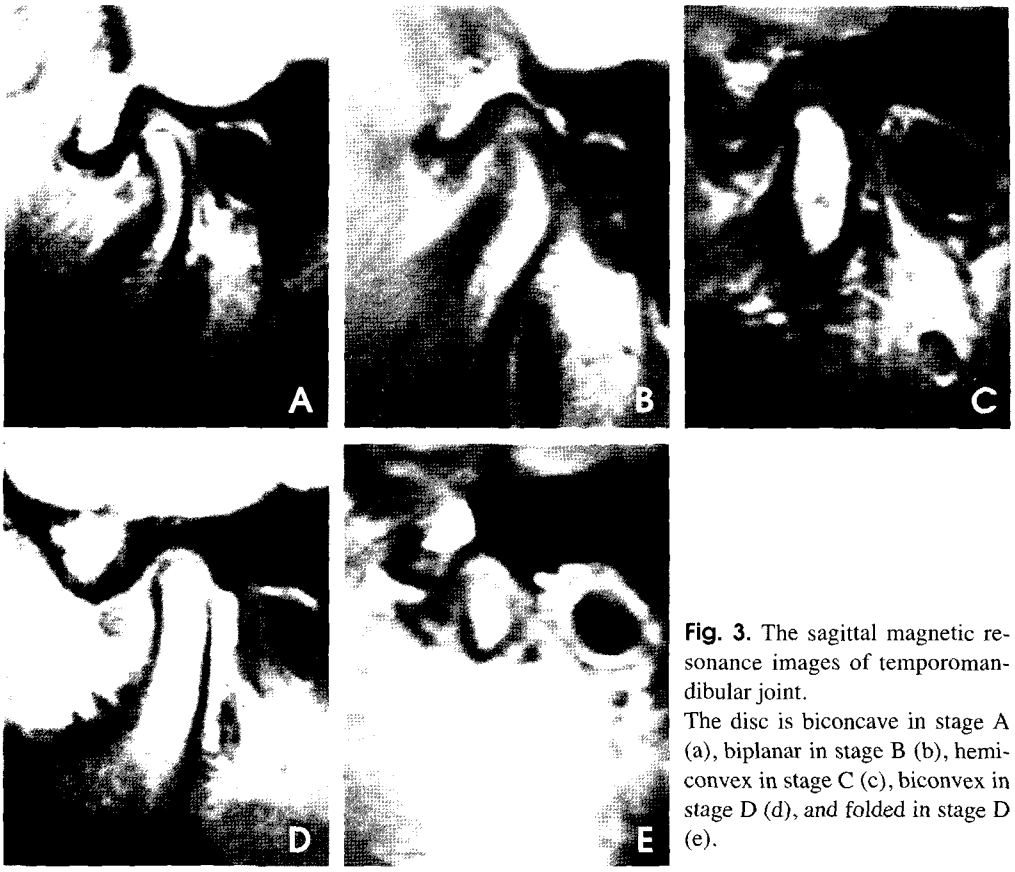

Fig. 3. The sagittal magnetic resonance images of temporomandibular joint.
The disc is biconcave in stage A (a), biplanar in stage B (b), hemiconvex in stage C (c), biconvex in stage D (d), and folded in stage D (e).

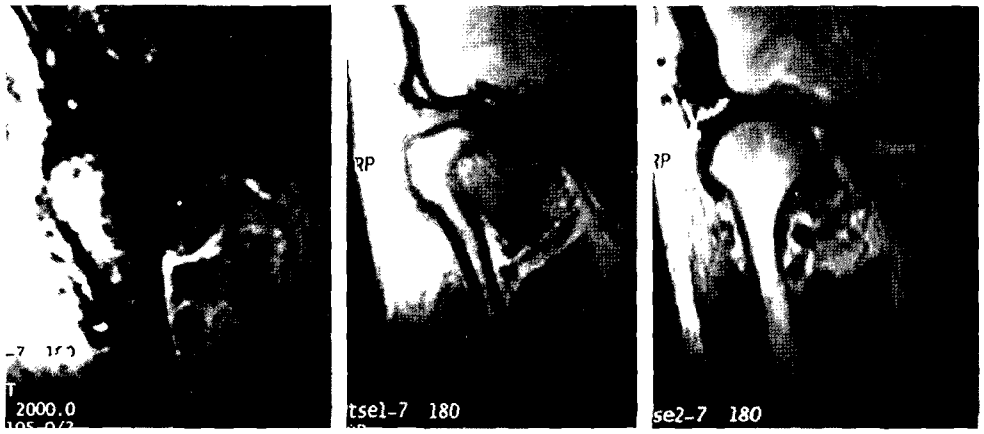

Fig. 4. The coronal magnetic resonance images of temporomandibular joint. The disc appears to be in the central position (a), displaced medially (b), and displaced laterally (c).

the joint.[7] The high-field MRI was considered as a gold standard, with an accuracy from 85 to 100% for the identification of TMJ abnormalities, such as disc displacement, abnormal disc morphology and condylar deformation.[6] Clinical signs and symptoms of internal derangement are nonspecific in each stage. Therefore, it may be necessary to use MRI or arthrography to confirm the clinical impression.

Katzberg et al.[16] found that there was no difference between patients and volunteers in the distribution of the disc displacement in TMJs. Isberg et al.[17] performed a bilateral arthrotomography in 50 consecutive patients with a unilateral symptom of disc displacement to evaluate the frequency of temporomandibular joint disc displacement in asymptomatic joints. Sixty percent of the patients had a non-reducing displaced disc in the asymptomatic joint. When bilateral arthrograms were performed in patients with a unilateral symptom, the non-painful joint showed evidence of disc displacement 88% of the time.[18] The frequency of displaced disc in asympto-

matic joints in patients with unilateral symptom was four times as high as that found in other arthrographic study of volunteers without joints symptoms.[19] A majority of patients in this study had a unilateral sign and symptom of internal derangement of the TMJ and 25 patients had bilateral. In addition, all patients with symptoms of the internal derangement, regardless of involving the TMJ sites, were assessed. Hence, it was thought that patients selection criteria in the present study could affect the findings which many discs were positioned in the normal superior position to the condyle.

In the present study, a disc position was classified into four groups according to the position of the posterior band in relation to the functional surface of the condyle according to the classification by Murakami et al.[10] The reason for the adoption of this classification is that the symptoms of TMJ disorder, such as pain, noise, limitation of opening, are mostly caused by an abnormal relationships in the position of these two elements.[20,21]

Murakami et al. stated that 94% of the discs in stage A, 22 % in stage D was biconcave, and 70% of the discs in stage D, none of the discs in stage A was deformed.[10] In the present study, 93.1% of the discs in stage A was found to be biconcave and 81.8% of the discs in stage D was deformed.

The disc position in stage A close to the 12 o'clock position was considered to be normal.[22] A majority of discs in stage B were in the normal position when the mouth opening, therefore some of these discs were either normal, partial anterior displacement or anteriorly displaced with reduction. When the discs were in stage B, C, and D, it must be considered in the rotational displacement as well as anterior displacement.

A disc mainly displaces in an anterior, anteromedial, or anterolateral direction. However, it rarely displaces in a posterior direction.[23] Anterolateral or anteromedial disc displacement is more common than pure lateral or medial disc displacement. Medial or lateral displacement without anterior component has been called sideways displacement. Rotational disc displacement implies a combination of anterior and medial or lateral displacement of a disc. Katzberg et al.[13] documented that sideway and rotational displacement of the TMJ disc were relatively frequent and occurred in up to about 25% of patients with symptoms of internal derangement.

Khoury and Dolan[24] detected sideways displacement of the TMJ disc on arthrograms of 49 patients with a symptom of internal derangement, and sideways displacement of the TMJ disc was confirmed by surgery in only 7 cases, i.e., six lateral and one medial. Kobayashi et al.[25] showed sideway disc displacement was found in 6 of 138 patients. Liedberg et al.[12] revealed that sideways or rotational displacement of the discs observed on arthrography or arthrotomography were about one third of the joints investigated. Simple sideways disc displacement was observed relatively in a low frequency and medial disc displacement was more common than the lateral disc displacement.[1,9,26] These findings are similar to those of the present study.

These results showed that disc morphology in stage A, B or C were mostly biconcave, whereas in stage D, a majority of discs were distorted. Most of deformed discs belonged to stage D and they were displaced without reduction. Extensive morphologic changes of a disc were found in a joint with anterior disc displacement without reduction,[1,10] which also agreed with this present study. Deformation of the disc in 45 of 142 discs and the hemiconvex discs were observed in 28 of 45 deformed discs.

In the disc displacement direction, biconcave discs were found in 58.7% of the pure anterior disc displacement and 14.2% of the rotational disc displacement. Deformed discs were found in 33.3% as pure anterior disc displacement and 60% as rotational disc displacement. In the sideways disc displacement, biconcave discs were found in 6 joints and deformed in 1 joint. This study demonstrated a surprisingly high prevalence of the deformed discs in the rotational disc displacement. Therefore, MR findings of disc morphology were found to be correlated with rotational disc displacement.

The current clinical significance of rotational and sideways displacement of the disc is not fully understood. In a recent study, Westesson and Lundh[27] found that patients with a suspected medial component displacement were more difficult to treat with protrusive splint than patients with a simple anterior displacement of the disc. In surgical treatment, the concept that both anterior rotational and sideways displacement of the TMJ disc occurred with some frequency must be seriously considered. If the disc was displaced anterolaterally or laterally, a simple plication of the posterior ligament of the disc did not appear to be an optimal surgical technique. Therefore the multiplanar MRI is suitable to assess sideways and rotational displacement of a disc in patients displaying signs and symptoms of internal derangement.[13] A more detailed analysis of rotational and sideways displacement is necessary to interpret these findings with regard to the treatment option to reestablish normal anatomy, to improve function, and to reduce or eliminate pain. Further work is underway to compare rotational and sideways displacement with clinical findings or treatment in patients with symptoms of internal derangement.

In summary, rotational and sideways displacement of the TMJ discs were shown in about 28% of the joints with signs and symptoms of internal derangement, and disc deformation was found to be more common in rotational disc displacement than in pure anterior displacement. Sagittal and coronal planes of MRI of the TMJ have complementary abilities for an assessment of joint abnormality.

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