Comparison of static MRI and pseudo-dynamic MRI in tempromandibular joint disorder patients

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ABSTRACT

Purpose : The purpose of this study was to evaluate comparison of static MRI and pseudo-dynamic (cine) MRI in temporomandibular joint (TMJ) disorder patients.

Materials and Methods : In this investigation, 33 patients with TMJ disorders were examined using both conventional static MRI and pseudo-dynamic MRI. Multiple spoiled gradient recalled acquisition in the steady state (SPGR) images were obtained when mouth opened and closed. Proton density weighted images were obtained at the closed and open mouth position in static MRI. Two oral and maxillofacial radiologists evaluated location of the articular disk, movement of condyle and bony change respectively and the posterior boundary of articular disk was obtained.

Results : No statistically significant difference was found in the observation of articular disk position, mandibular condylar movement and posterior boundary of articular disk using static MRI and pseudo-dynamic MRI ($P > 0.05$). Statistically significant difference was noted in bony changes of condyle using static MRI and pseudo-dynamic MRI ($P < 0.05$).

Conclusion : This study showed that pseudo-dynamic MRI didn't make a difference in diagnosing internal derangement of TMJ in comparison with static MRI. But it was considered as an additional method to be supplemented in observing bony change. (***Korean J Oral Maxillofac Radiol 2006; 36 : 199-206***)

KEY WORD : Temporomandibular Jonit Disorders; Magnetic Resonance Imaging, Cine

Introduction

Temporomandibular joint disorders (TMD) are defined as an assorted set of clinical conditions, characterized by pain and dysfunction of the masticatory muscles, temporomandibular joint and associated hard and soft tissues.[1-3] Pain during mandibular movement, limitation in jaw function, sounds in the temporomandibular joint (TMJ) are common symptoms. McNeil reported that 30% of populations have one more TMD symptoms and 5-7% of these people need to be treated.[4]

Patient's historical reviews, clinical examinations and radiological examinations were used to diagnose the TMD. The issue of structural characteristics in the diagnosis and assessment of TMD is important given that so many clinicians base their diagnoses, etiologic hypotheses and treatment regimens almost entirely on an assessment of the structural characteristics of a particular patient.[5] With the rapid progress made in TMJ imaging techniques, many studies have focused on the importance of internal derangement as the underlying mechanisms in the etiology of TMD.[6-8]

The most common method used to judge disk position has been the closed-mouth position sagittal view assessment of the position of the posterior band relative to the top of the condyle.[9,10] Orsini et al. evaluated the position of the disk and suggested that intermediated zone criterion for disk displacement is the more stringent criterion.[11] TMJ internal derangement (ID) describes an abnormal position relationship between articular disk and the mandibular condyle and articular eminence.[12,13]

Different imaging techniques have been used in the study of

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TMD. Conventional radiography and computed tomography (CT) has been shown to be of limited value in the evaluation of bony structures. TMJ arthrography and MRI have been used to evaluate the positional relationship between the disk and mandibular condyle. Diagnostic accuracy on the TMJ internal derangement was reported about 79-97% with TMJ arthrography and CT.[14] TMJ arthrography may be more useful diagnostic method on the adhesion or perforation of disk.[15-17] Magnetic resonance imaging (MRI) visualizes disk morphology and position and facilitates an interpretation of topographic changes in osseous, muscular and meniscoligamentous structures of the TMJ. The advantages of MRI are non-invasive method, non-irradiated method and non-contrast media method.[18-20] So MRI is the first diagnostic choice of TMJ ID.[21] The disadvantage of MRI is the static imaging.

Pseudo-dynamic MRI may be used to obtain the dynamic image of TMJ. But, This is not true dynamic images. Pseudo-dynamic MRI obtained from the serial multiple static images.

The purpose of this study is to evaluate comparison of static MRI and pseudo-dynamic MRI in temporomandibular joint disorder patients.

Materials and Methods

This study included 33 patients (12 males, 21 females) who were diagnosed on TMJ ID from March, 2005 to March, 2006 in Eul-Ji General Hospital. 33 patients were examined using both conventional static MRI and pseudo-dynamic MRI.

MRI of these patients was performed with 1.5 Tesla Twin-speed Excite (GE, Milwaukee, USA). Each patient's head was placed with the Frankfort plane parallel to the opening of the MRI machine to obtain a constant orientation of sagittal images. A light beam in sagittal orientation helped control of head placement at the desired angulation. The head was then fixed with adhesive tape on a foam rubber support.

After obtaining an axial localizer image, the technician obtained four sagittal 3 mm slices perpendicular to the horizontal axis of the head of the condyle two positions in static MRI: (1) closed-mouth position (maximum intercuspidation of teeth), (2) maximum opened position of the mandible. Scanning parameters were as follows; time of repetition (TR), 1,500 ms; time of echo (TE), 25 ms; field of view (FOV), 12 cm; thickness 3 mm; matrix, 256 × 224; and bandwidth, 17.86 kHz.

Pseudo-dynamic MRI was obtained from spoiled gradient recalled acquisition in the steady state (SPGR) with TMJ-2000 (MEDRAD, Pittsburgh, USA) (Fig. 1). Scanning parameters

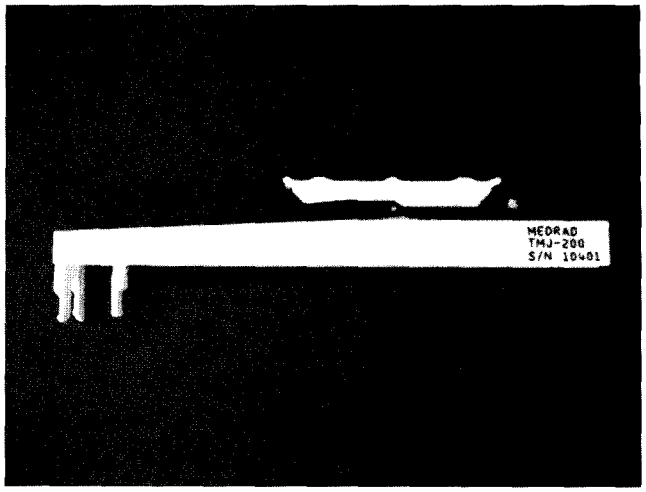

Fig. 1. Burnett bidirectional TMJ device (TMJ-200).

were as follows; TR, 100 ms; TE, minimum full; glip angle, 30°; FOV, 16 cm; thickness, 4 mm; matrix, 256 × 128; and bandwidth, 10.42 kHz. Pseudo-dynamic MRI was reconstructured after scanning at an interval of 2 mm from maximum opening to closed in all the patients.

Two oral and maxillofacial radiologists evaluated location of the articular disk, movement of the condyle, bony change and posterior boundary of the articular disk between static MRI and pseudo-dynamic MRI without knowing the clinical information. Location of the articular disk was classified to normal, anterior disk displacement with reduction and without reduction according to Orsini's classification (Figs. 2-7).[11] Movement of the condyle was classified to normal and limited movement whether the condyle was moved forward to the articular eminence on maximum opening state. Bony change was accepted with one more signs among erosion, osseous change, osteophyte and flattening. Posterior boundary of the articular disk was considered if it was shown on closed position or mouth opening position on static MRI and on one imaging on pseudo-dynamic MRI.

Statistical analyses were conducted on SPSS 12.0 version for Windows. The nonparametric Wilcoxon rank test was used to analyze difference between static MRI and pseudo-dynamic MRI. The significance was set at $P < .05$.

Results

From static MRI, there were 13 cases where the location of articular disk was diagnosed normal, 41 cases where anterior disk displacement with reduction occurred, and 12 cases where anterior disk displacement without reduction occurred.

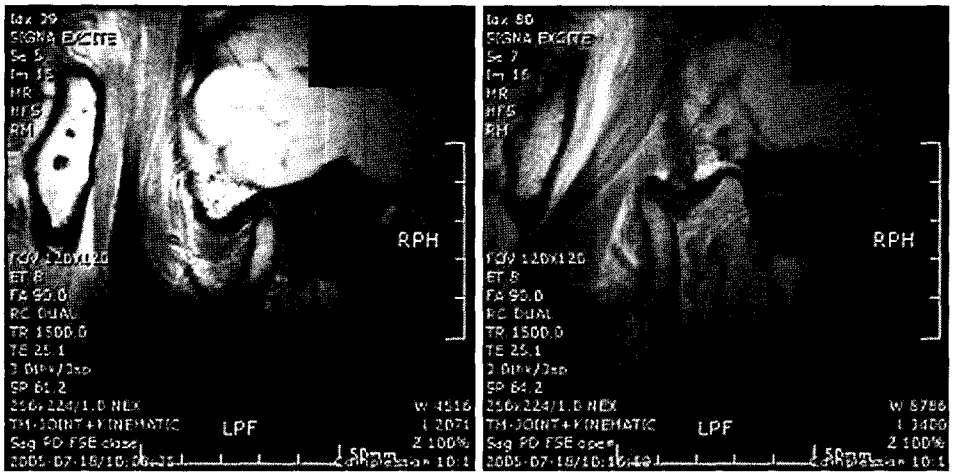

Fig. 2. The static MRI of normal TMJ.

Fig. 3. The pseudo-dynamic MRI of normal TMJ.

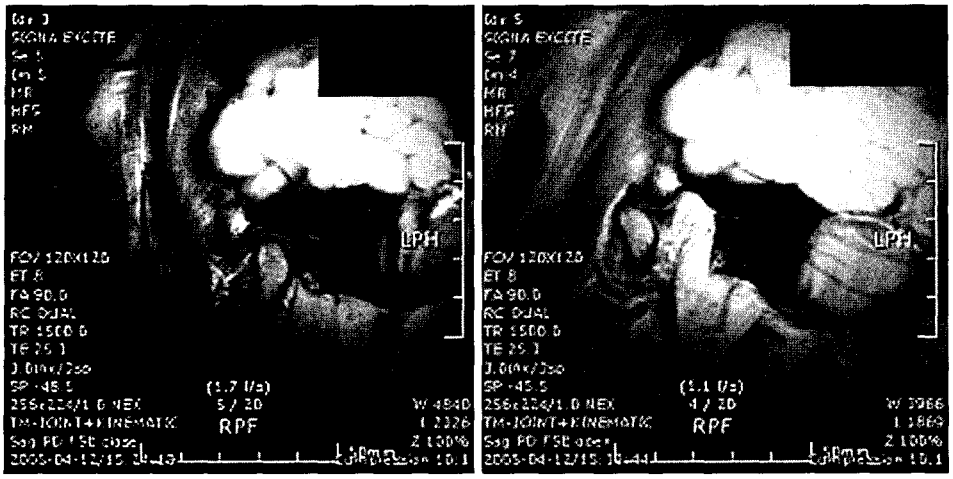

Fig. 4. The static MRI of TMJ ID with reduction.

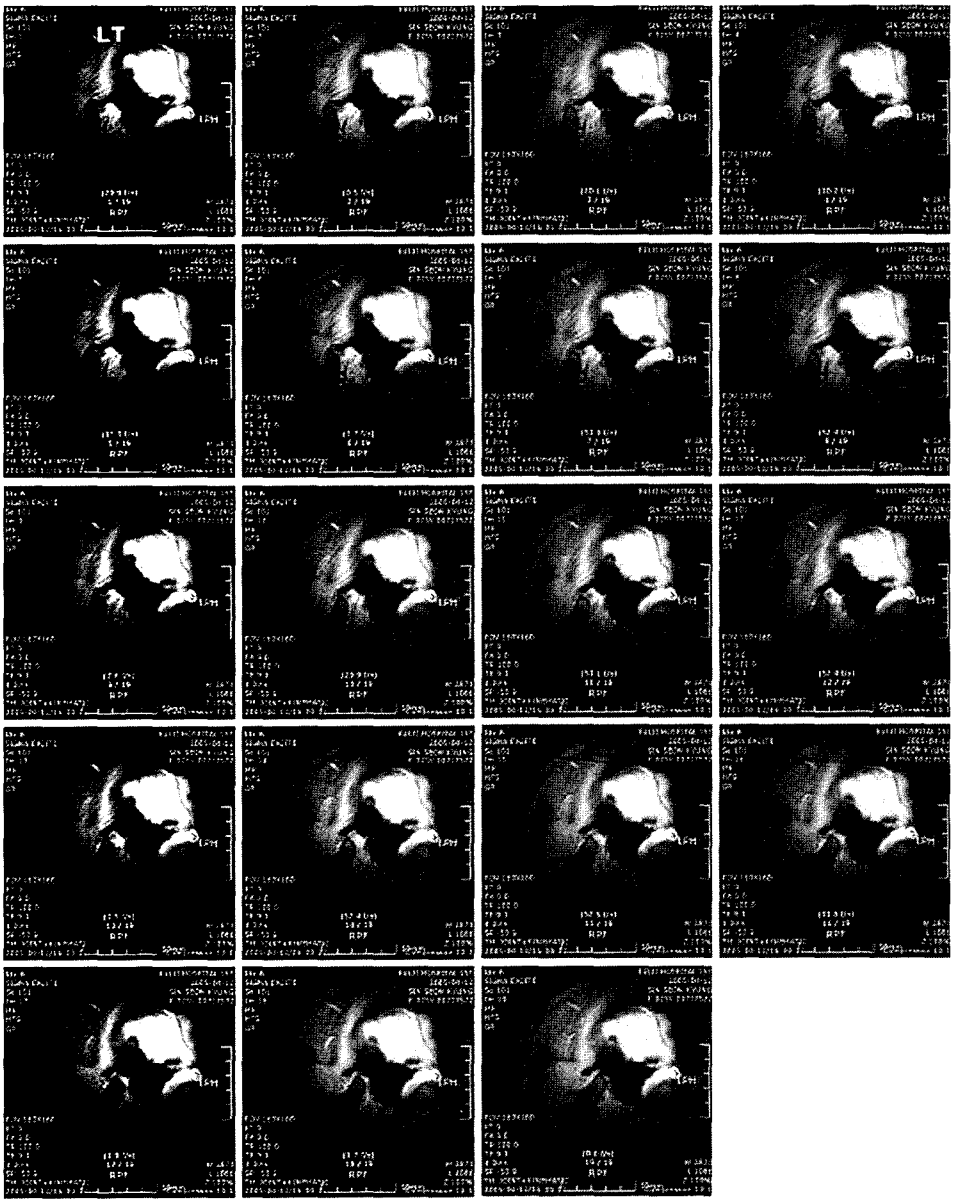

Fig. 5. The pseudo-dynamic MRI of TMJ ID with reduction.

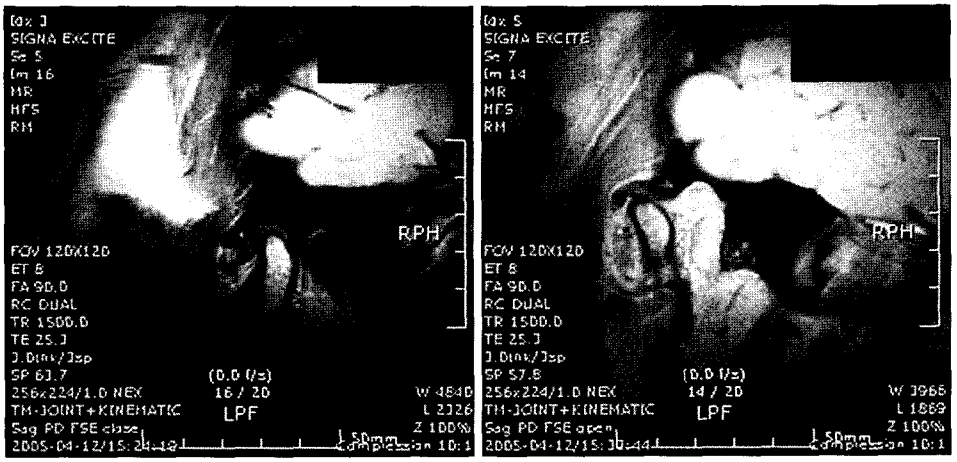

Fig. 6. The static MRI of TMJ ID without reduction.

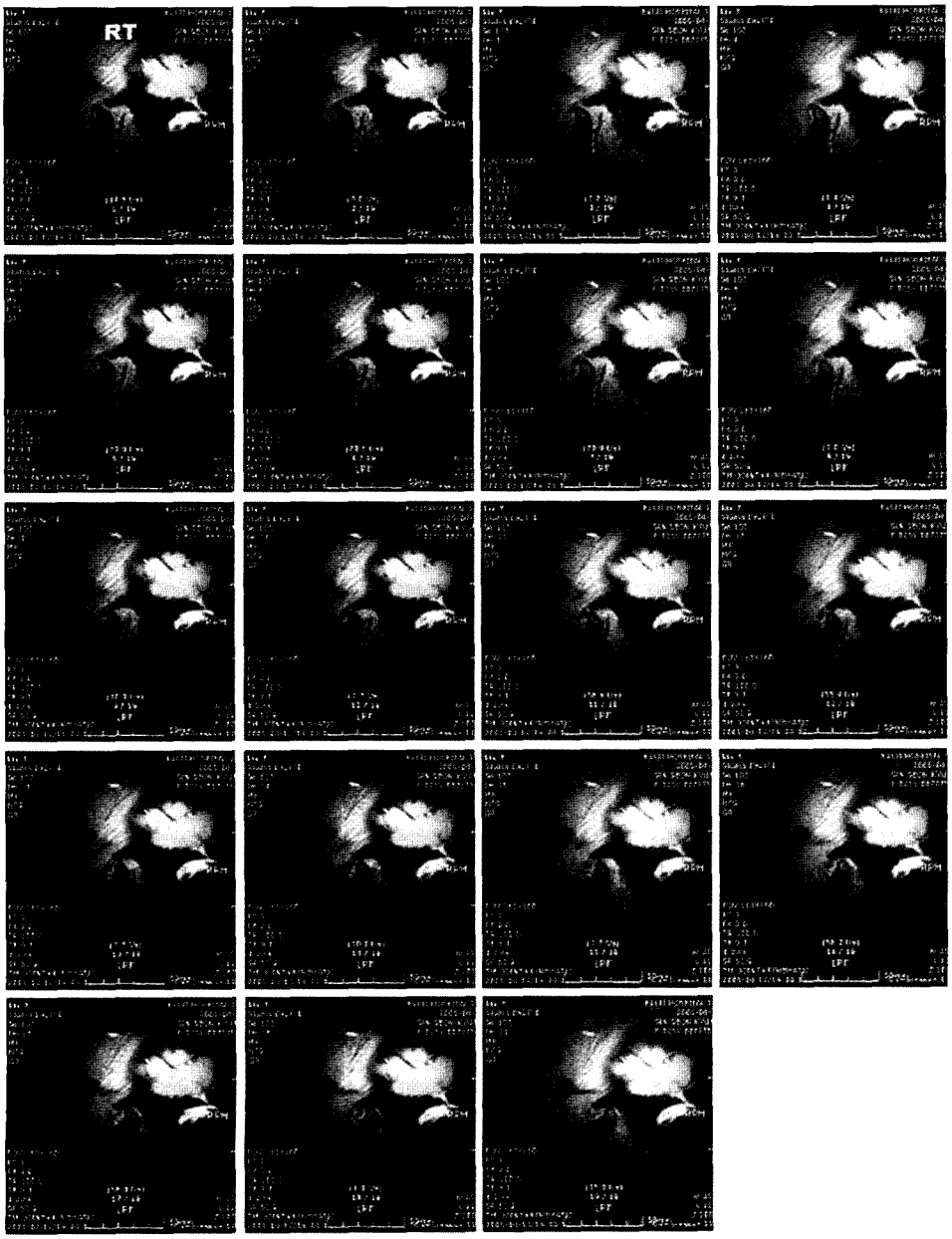

Fig. 7. The pseudo-dynamic MRI without reduction.

Table 1. Comparison of articular disk position observed in static MRI and pseudo-dynamic MRI (P=.157)

	Static MRI	Pseudo-dynamic MRI
Normal	13	13
ADDR	41	27
ADDNR	12	16

ADDR : anterior disk displacement with reduction
ADDNR : anterior disk displacement without reduction

Table 2. Comparison of condylar movement observed in static MRI and pseudo-dynamic MRI (P=.180)

	Static MRI	Psedu-dynamic MRI
Normal	55	58
Limited	11	8

Table 3. Comparison of condylar bony changes in static MRI and pseudo-dynamic MRI (P=.003)

	Static MRI	Psedu-dynamic MRI
Normal	57	48
Bony change	9	1

Table 4. Observations of posterior boundary of articular disk in static MRI and pseudo-dynamic MRI (P=.083)

	Static MRI	Psedu-dynamic MRI
Observed	64	61
Not observed	2	5

From pseudo-dynamic MRI, there were 13 cases where the location of articular disk was diagnosed normal, 37 cases where anterior disk displacement with reduction occurred, and 16 cases where anterior disk displacement without reduction occurred (Table 1).

Contrast and resolution of the static MRI were found to be better than in the case of pseudo-dynamic MRI. In terms of the location of articular disk, there wasn't a statistical significant difference between static MRI and pseudo-dynamic MRI (P=0.157) (Table 1).

From static MRI, there were 55 cases where movements of condyle were diagnosed normal, 11 cases where there was limitation in movements. From pseudo-dynamic MRI, there were 58 cases where movements of condyle were diagnosed normal, 8 cases where there was limitation in movements. In terms of movements of condyle, there wasn't a statistical significant difference between static MRI and pseudo-dynamic MRI (P=0.180) (Table 2).

From static MRI, there were 57 cases where the bony change of condyle was shown normal, 9 cases where there was bony change. From pseudo-dynamic MRI, there were 48 cases where the bony change of condyle was shown normal, 18 cases where there was bony change. In terms of movements of condyle, there was a statistical significant difference between static MRI and pseudo-dynamic MRI (P=0.003) (Table 3).

From static MRI, there were 64 cases where it was possible to observe boundary of articular disk, and 2 cases where it wasn't. From pseudo-dynamic MRI, there were 61 cases where it was possible to observe boundary of articular disk, and 5 cases where it wasn't (P=0.083) (Table 4). From static MRI and pseudo-dynamic MRI, it wasn't relatively difficult to diagnose kinds of disk displacement. But it was difficult to diagnose bony change of condyle due to low contrast and resolution in pseudo-dynamic MRI compared to static MRI.

There was not statistically significant difference in the observation of articular disk position, mandibular condylar movement and posterior boundary of articular disk using static MRI and pseudo-dynamic MRI (Table 1, 2, 4). Statistically significant difference existed in bony changes of condyle using static MRI and pseudo-dynamic MRI (Table 3).

Discussion

It is important to maintain the location of the articular disk that inferior portion of the retrodiscal tissue is normal.[22] MRI of the TMJ is useful to identify the articular disk and retrodiscal tissue. MRI is indicated on the case of history of limited mouth opening and pathologic changes of the condyle on plane films. Prevalence of TMJ ID is increased on unilateral TMJ ID. MRI of both TMJ is necessary to identify the pathologic states of TMJ because TMJ cannot act independently.[23]

Conventional spin-echo images in closed and open mouth positions form the basis of diagnosis of internal derangements of the disk. Generally, spin-echo sequences have stronger signal-to-noise ratio and high contrast. Disadvantages of spin-echo technique are limitation to shortening of TE and long imaging times. Kinematics of the condyle and disk of TMJs has been evaluated by using gradient-echo sequences. Gradient-echo technique have been known as fast scan technique because of short imaging times.[24]

Mouth opening movements were composed of rotational movement and translational movement of the condyle-disk complex. The relationships between rotational movement and translational movement were various to individuals.[25]

Pseudo-dynamic MRI shows the pathways of mandibular condylar movements and difference from the rotation and translation. And it identifies the factor of inhibition of translation. More information on disk and condyle are obtained from pseudo-dynamic MRI. Pseudo-dynamic MRI is useful to know the morphological changes of disk, overextension of articular capsule on maximum mouth opening, position of condyle during translation and adhesion.[26] Disadvantages of pseudo-dynamic MRI are semi-dynamic images (no true dynamic images) and low contrast. It is limited to diagnose the medio-lateral displacement of disk because of mid-sagittal images of condyle. And it is different from the real movement of condyle and disk because of synthetic image from multiple static images.[27] Some authors reported the dynamic images of MRI on mouth opening.[28,29] Burnette et al obtained the serial images with specific device.[29] Later turbo-fast low angle shot or EPI-sequence have been used to obtained the dynamic images of TMJs.[29-31] But, those images had not higher contrast than static MRI. Ren et al. reported that pseudo-dynamic MRI had relatively low sensitivity (60%) and medial specificity (80%) on diagnosis of TMJ ID.[27] Chen et al suggested that inadequate signal-to-noise ratio and low resonance of space result to poor images of the articular disk.[30] In this study, location of the articular disk were not differ from static MRI and pseudo-dynamic MRI. This finding may be resulted from the technical improvement of MRI machine (inhibition of artifact during imaging).

Eberhard et al. reported that the condyles rotate to 0.5-2 cm and translate beyond 2 cm and relationships between condyle and disk change abruptly during translation on TMJ ID with reduction.[32] Generally, the serial images on mouth opening were obtained from closed mouth position to open position. But, in this study the serial images were obtained from open mouth position to closed position for technician's convenience and patient's compliance. There was not statistically significant difference in the observation of mandibular condylar movement using static MRI and pseudo-dynamic MRI in this study. But, it was founded in pseudo-dynamic MRI that relationships between condyle and disk change abruptly during translation on TMJ ID with reduction. This finding suggested that pseudo-dynamic MRI may be useful to diagnose TMJ ID with reduction and identify the location of the articular disk.

Masui et al. reported that static MRI might be more useful to observe cortical bone of the condyle and size of articular disk.[33] In this study, statistically significant difference existed in bony changes of the condyle using static MRI and pseudo-dynamic MRI. It is impossible to make discriminations between static MRI and pseudo-dynamic MRI because of no gold standard on bony changes of the condyle. But, diagnostic validity of pseudo-dynamic MRI may be not satisfied as much as static MRI according to previous studies.[33]

Abolmaali et al. reported that there was not statistically significant difference in the observation of the posterior boundary of articular disk using static MRI and pseudo-dynamic MRI.[34] In this study, same result was obtained. The posterior boundary of articular disk was not found in cases of TMJ ID without reduction. Abolmaali et al. suggested the cause of those findings; the first, articular disk may be difficult to be discriminated from other anatomical structures because of thinning of the disk due to degenerative changes. The second, articular disk may be difficult to be found in cases of rotation or lateral displacement during mouth opening.

Pseudo-dynamic MRI has been used to adjunctive diagnostic method because it has been difficult to obtain high contrast images. But, pseudo-dynamic MRI may be used as another diagnostic method of TMJ ID if the imaging technique has been developed.

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