RESEARCH

Diagnostic accuracy on fat-saturated T_2 weighted MRI for diagnosis of intra-articular adhesions of the temporomandibular joint

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Objective: The purpose of this study is to compare intra-articular adhesions of the temporomandibular joint (TMJ) between fat-saturated T_2 weighted MR images and arthroscopic findings.

Methods: 50 patients (50 joints) with closed locking of the TMJ who were examined with MRI and then underwent arthroscopic surgery participated in this study. The concordance rate of intra-articular adhesions between fat-saturated T_2 weighted MR images and arthroscopic findings was studied using the kappa coefficient.

Results: Intra-articular adhesions were seen on MRI in 21 joints (42%) and in arthroscopic findings in 26 joints (52%). Thus, five joints had false-negative results and mild adhesions were arthroscopically observed in these five joints. There was significant concordance between these two findings ($p < 0.001$). The kappa coefficient was 0.801, which was considered to be complete concordance.

Conclusions: On fat-saturated MRI, a low signal intensity area and narrowing image in the joint space of the TMJ may indicate the presence of intra-articular adhesions or fibrosis.

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Keywords: intra-articular adhesion; fat-saturated T_2 weighted magnetic resonance image; arthroscopic finding; temporomandibular joint

Introduction

Intra-articular adhesions are important pathological signs in intra-articular disease of the temporomandibular joint (TMJ). Murakami et al¹ reported that adhesion in the upper joint space led to limited mouth opening in patients with chronic locking of the TMJ. We reported that improvement of maximum mouth opening immediately after the removal of adhesions ranged from 2 mm to 6 mm with an average of 3.7 mm.² Sakamoto et al³ reported that the efficiency of arthrocentesis under low hydraulic pressure was insufficient in closed lock cases with adhesion in the upper joint space. Thus, evaluation for the presence of adhesions is useful for treatment planning and predicting the prognosis. MRI is a non-invasive imaging technique with superior soft tissue

resolution and has been widely used as the gold standard for examination of the TMJ; however, its diagnostic value for assessing the presence of intra-articular adhesions is limited.^{4,5}

Recently, on fat-saturated T_2 weighted MR images, we reported that a high signal intensity area is usually found in the joint space between the articular disc and the cartilage surface of the glenoid fossa in joints with disc displacement.⁶ When there is no synovial fluid in the joint space caused by severe intra-articular adhesions or fibrosis, MRI does not demonstrate high signal intensity areas. A low signal intensity area and a narrowing image in the joint space may demonstrate the presence of intra-articular adhesions or fibrosis on fat-saturated T_2 weighted MRI. Arthroscopy is the gold standard for the diagnosis of adhesions and the purpose of this study was to investigate the diagnostic accuracy of fat-saturated T_2 weighted MR images for the diagnosis of intra-articular adhesions of the TMJ using the kappa coefficient.

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Materials and methods

Patients

50 joints from 50 patients (5 males and 45 females) with closed lock of the TMJ who underwent MRI examination at Tonami General Hospital, Tonami, Japan, from 2004 to 2008 were included in this study. To improve joint pain and trismus, the patients were treated with arthroscopic surgery. Patient ages ranged from 12 to 71 years, with a median age of 44 years. Locking duration ranged from 3 to 48 months.

Fat-saturated T_2 weighted MRI

An MRI scan was obtained using a 1.5 T imager (Signa, General Electric, Hino, Japan) with a dual 3 inch surface coil. In the closed-mouth position, fat-saturated T_2 weighted images were obtained in both the sagittal and the coronal planes [time of repetition (TR) 3000 ms/time of echo (TE) 85 ms]. In this sequence, the fat signal is decreased and the water content signal is increased. The transaction plane was scanned to find the long axis of the condyle, the sagittal plane was calculated to be perpendicular to this long axis with 3 mm section thickness and the coronal plane was parallel to the long axis with 3 mm section thickness.

Evaluation of MR images

An MRI specialist who was not given any information about the patients evaluated the MR images for the presence of adhesions in the upper joint space. MR images of the TMJ with and without adhesions are shown in Figures 1–3. On fat-saturated T_2 weighted images, a low signal intensity area (Figure 1b) and narrowing image without hyperintensity signal (Figure 2b) in the upper joint space were classified as images of intra-articular adhesions.

Arthroscopic examination

Arthroscopy was performed by the same specialist and assistant within a 2 week period after the MRI according

to the technique of Yura *et al.*^{2,7} A 1.2 mm diameter ultra-thin arthroscope (DRK-21, Shinko Optical Co., Ltd., Tokyo, Japan) was used in the surgery. Saline solution was injected to widen the upper joint space and then an 18 gauge needle and a trocar for the arthroscope were inserted into the anterior and posterior recesses of the space, respectively. In the upper joint compartment, structures including the posterior attachment of the disc, the disc itself, the fibrocartilage of the glenoid fossa and eminence and the synovium were examined. Adhesions were classified as no adhesions (Figure 3c), mild adhesions (localized band-like or membrane-type adhesions) or severe adhesions (extensive wall-like adhesions).⁷ When intra-articular adhesions were detected, treatment was given simultaneously.^{7,8}

Data collection and statistical analysis

The presence and degree of adhesions in the upper joint space were investigated by fat-saturated T_2 weighted MRI and arthroscopic findings. To clarify the agreement between MRI and arthroscopic findings, the kappa value was calculated for concordance of these two findings. A kappa coefficient of 0.41–0.60 was considered to be fair concordance, 0.61–0.80 good concordance and 0.81–1.00 complete concordance.

Results

Presence and degree of adhesions in the joint space

The presence and degree of adhesions evident on MRI and arthroscopic findings are shown in Table 1. Intra-articular adhesion images were found on MRI in 21 joints (42%) and in arthroscopic findings in 26 joints (52%). Thus, five joints had false-negative results (Table 2) and mild adhesions were observed in these five joints arthroscopically.

Figure 1 MRI and arthroscopic findings in a joint with adhesion. (a) T_1 weighted MR image. (b) Fat-saturated T_2 weighted MR image. Low signal intensity area (arrow) in the anterior recess of the upper joint space was seen. (c) Arthroscopic finding. An extensive wall-like adhesion was observed in the anterior recess of the upper joint space

Figure 2 MR images and arthroscopic findings in a joint with adhesion. (a) T_1 weighted MR image. (b) Fat-saturated T_2 weighted MR image. High signal intensity area in the joint space was not seen. (c) Arthroscopic finding. Extensive fibrosis was observed in the anterior recess of the upper joint space. Adhesions were cut using an 18-gauge needle (arrow)

Agreement between MRI and arthroscopic findings

The agreement between MRI and arthroscopic findings is shown in Table 2. The apparent concordance rate between these 2 findings was 90% $((21+24)/50 = 0.9)$. The kappa coefficient was 0.801 (95% confidence interval: 0.636–0.966, $p < 0.001$), which was considered to be complete concordance.

Discussion

On conventional MRI, it is difficult to distinguish the presence of intra-articular adhesions of the TMJ. The articular disc, cartilage, cortical bone and any adhesion show the same low signal. Adhesions are thus obscured by their same low signals.⁴ On a T_2 sequence of conventional MRI, when a joint effusion is observed in the joint space, the lower signal intensity area in the synovial fluid may be detected as an adhesion image. Zhang *et al*⁵ reported that intracapsular adhesions could

be detected on T_2 weighted images with existing synovial fluid. However, the diagnostic accuracy of MRI for intra-articular adhesions was poor. On a T_2 sequence of conventional MRI, synovial fluid is not always detected when it is a small amount. In a classic MRI, a technique of MR arthrography is needed for detection of adhesions in the joint space. On the other hand, on fat-saturated T_2 weighted MR images, we reported that a high signal intensity area is usually found in the joint space between the articular disc and cartilage surface in joints with disc displacement.⁶ In this sequence, synovial fluid is detected with high accuracy even if it is a small amount because the fat signal is decreased and the water content signal is increased. A low signal intensity area and narrowing image without a hyperintensity signal in the joint space may demonstrate the presence of intra-articular adhesions or fibrosis on fat-saturated T_2 weighted MRI. In this study, the diagnostic accuracy of MRI for intra-articular adhesions was high ($\kappa = 0.801$); most of the adhesions were diagnosed by MRI. However, 5 of the 26

Figure 3 MR images and arthroscopic findings in a joint without adhesion. (a) T_1 weighted MR image. (b) Fat-saturated T_2 weighted MR image. No compromise of the high signal intensity area in the joint space was seen. (c) Arthroscopic finding. No adhesions in the joint space were observed

Table 1 Presence and degree of adhesions in joint space

Examination	Adhesion	Number of joints (%)
MR images	Negative	29 (58)
	Positive	21 (42)
	Low signal	10
	Narrowing	11
	No adhesion	24 (48)
Arthroscopic findings	Mild adhesion	9 (18)
	Severe adhesion	17 (34)

Note: low signal indicates low signal intensity area in the upper joint space. Narrowing indicates narrowing image without hyperintensity signal in the upper joint space.

joints had false-negative results and mild adhesions were observed in these 5 joints arthroscopically. Small adhesions in joints may not be detected by MRI.

TMJ effusion on fat-saturated T_2 weighted MRI is useful in detecting the extent of synovial fluid in the joint space with disc displacement. Low signal intensity images of the disc can be distinguished easily from high signal intensity in the upper and lower joint spaces. Not only adhesions but also position, disc shape and disc perforation may be detected accurately.⁶ The use of MRI can reduce arthroscopic interventions for diagnostic

Table 2 Agreement between MR images and arthroscopic findings

	Adhesion	Arthroscopic findings		Total
		Positive	Negative	
MR images	Positive	21	0	21
	Negative	5	24	29
	Total	26	24	50

Apparent concordance rate: 90%; kappa coefficient: 0.801; 95% confidence interval: 0.636–0.966, $p < 0.001$.

purposes only and can help the clinician choose the best treatment. Because of these diagnostic characteristics on fat-saturated T_2 weighted MRI, this imaging method should widely be used for diagnoses of the TMJ.

In conclusion, a low signal intensity area and narrowing image without a hyperintensity signal in the joint space may demonstrate the presence of intra-articular adhesions or fibrosis on fat-saturated T_2 weighted MRI. In this study, the diagnostic accuracy of MRI for intra-articular adhesions was high ($\kappa = 0.801$); most of the adhesions were diagnosed by MRI. This imaging method should be widely used for diagnoses of intra-articular adhesions of the TMJ.

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