
Association between magnetic resonance signs of temporomandibular joint effusion and disk displacement

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Objective. The aim of the present study was to evaluate the association between temporomandibular joint (TMJ) effusion and disk displacement by means of magnetic resonance (MR) imaging.

Methods. One hundred and ninety-four patients were included in the study and underwent a bilateral MR of the TMJ at both closed mouth and maximum mouth opening positions. The association between TMJ effusion and disk displacement with or without reduction was assessed by means of 2×2 contingency tables and a permutation test for a categorical variable.

Results. The results showed a statistically significant association between joint effusion and disk displacement without reduction (DDNR) ($P = .008$). There was no statistically significant association between TMJ effusion and normal disk position ($P = .99$) or disk displacement with reduction (DDR) ($P = .43$).

Conclusions. Although these results show a significant association between joint effusion and disk displacement without reduction, there remains uncertainty as to if the nonreducing displacement causes the effusion or vice versa. The present investigation also pointed out the absence of association between reducing disk displacement and effusion. These findings have to be put into relation with clinical and histological findings. (*Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009;107:266-271)

Magnetic resonance imaging (MRI) of the temporomandibular joint (TMJ) has resulted in better understanding of the TMJ and a better comprehension of its disorders.¹ MR can provide positional information about the disk location,² quantitative data about the synovial fluid,³ and qualitative information about the status of the retrodiscal tissues⁴ and the condition of the bone marrow.⁵

Most literature works on MRI studies have focused on signal alteration in the joint compartments indicating the presence of fluid derived from the exudation of inflamed retrodiscal tissues and other inflammatory changes in the synovial membrane, resulting in joint effusion.⁶

TMJ effusion, which typically appears as an area of high signal intensity on T2-weighted images,⁷ can represent a local problem related to traumatic injuries or

can be related to systemic diseases such as rheumatoid and psoriatic arthritis.

The clinical significance of the presence of MR-diagnosed TMJ effusion lies in its association with clinically assessed pain in the TMJ area.⁸ Moreover, the presence of morphological and positional abnormalities of the disk has also been associated with TMJ effusion,⁹ leading to the hypothesis that effusion may represent an inflammatory response to a dysfunctional disk-condyle relationship.¹⁰ Some authors suggested that the effusion-disk displacement association may become evident at more advanced stages of disk displacement, thus representing an indicator of the progression of the disease to a more chronic condition.¹¹

The purpose of this study was to evaluate the association between TMJ effusion and disk displacement with and without reduction by means of MRI to test the hypothesis of a different association of the 2 disk displacement stages with effusion.

MATERIALS AND METHODS

Study sample and design

Participants were recruited from patients attending the TMD Clinic, Department of Maxillofacial Surgery, University of Padova, Italy, from September 2005 to May 2007 and seeking treatment for temporomandibular disorders. All subjects who underwent a bilateral MRI of the TMJs during the diagnostic process ($n = 240$) were asked to give their consent to use their MR

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findings from scientific purposes and all of them accepted. MR from 46 patients were excluded from statistical analysis because of the presence of systemic diseases affecting joint or masticatory muscles, such as fibromyalgia or other rheumatic diseases diagnosed according to the American College of Rheumatology criteria.¹²

Therefore, a total of 194 patients (153 females, 47 males; mean age 55.3; range 18-72) were included in the statistical analysis for an evaluation of the association between joint effusion and disk displacement.

Magnetic resonance

MR was carried out with a 1.5-Tesla (GE Signa Contour; GE Medical Systems, Buc, France) with a bilateral dedicated circular (8-cm diameter) surface coil for the right and left TMJ study. Sequential Gradient Echo T1- (TR = 340 ms, TE = 16 ms, FOV = 15 cm, slice thickness = 3 mm, matrix 256 × 192, interslice gap = 0.5 mm) and Fast Stir T2-weighted (TR = 3500 ms, TE = 27 ms, FOV = 15 cm, slice thickness = 3.5 mm, matrix 256 × 160, interslice gap = 0.5mm) bilateral images with the subjects at both closed mouth and maximum opening mouth positions were made. The latter position was obtained by means of a wooden intermaxillary device at the same opening as measured clinically.

The articular disk was directly identified, in sagittal oblique images, as an area of hypointensity with a biconcave shape above the condylar structure and its position has been categorized according to literature data¹³⁻¹⁶ as follows:

- Superior (normal) disk position (N): Posterior band of articular disk located above the apex of the condylar head (“at 12 o’clock position”) in the intercuspal position and thin intermediate zone between the condyle and the eminence in maximum opening mouth position.
- Disk displacement with reduction (DDR): Posterior band of the disk located anteriorly to the condylar head at the closed mouth position, but normal disk condyle relationship established in maximal opening position.
- Disk displacement without reduction (DDNR): Posterior band positioned anteriorly to the condyle either at closed or maximal opening mouth positions.
- Joint effusion has been identified as a large area of high signal intensity inside the joint space, so that the presence/absence of effusion was defined as follows, in accordance with the hypothesis that mild to moderate amount of fluid can be detected in normal joints as well⁸:
- No effusion: No area or thin lines of hyperintensity.



Fig. 1. Disk displacement with reduction. Closed mouth position.

- Effusion: Presence of areas of high signal intensity greater than 2 mm of superior-inferior height or anterior-posterior length inside the articular space.
- Magnetic resonance images were interpreted by 2 radiologists, who recorded the presence/absence of effusion and disk position abnormalities by consensus (Figs. 1-6).

Statistical analysis

The relationship between MR-diagnosed disk displacement and effusion was assessed through 2 × 2 contingency tables as suggested by Finos and Salmasso.¹⁷ This method provides for pairwise comparisons between the category of interest and combining the other categories using an appropriate adjustment for multiple comparisons, such as the Bonferroni correction, as suggested by Pesarin.¹⁸

RESULTS

Of the 388 joints examined, 165 (42.5%) showed normal disk position, 133 (34.3%) showed disk displacement with reduction, and 90 (23.2%) showed disk displacement without reduction.

Of the normal disk position joints, 20 (12.1%) showed joint effusion. This compares to 18 (20.0%) joints with disk displacement with reduction and 35 (26.3%) joints with disk displacement without reduction (Table I).

Among the joints with TMJ effusion, 47.9% had a DDNR, 24.7% had a DDR, and the remaining 27.4% had a normal disk position. Among the joints with no TMJ effusion, the proportion of MR-diagnosed DDR is unchanged (22.9%), whereas the proportion of joints

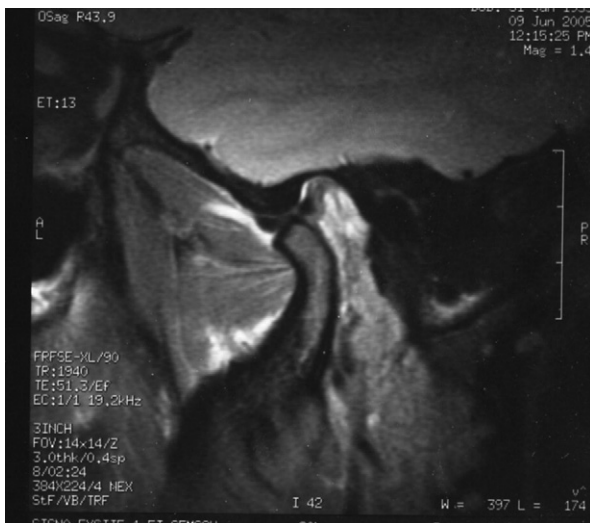


Fig. 2. Disk displacement with reduction. Open mouth position.

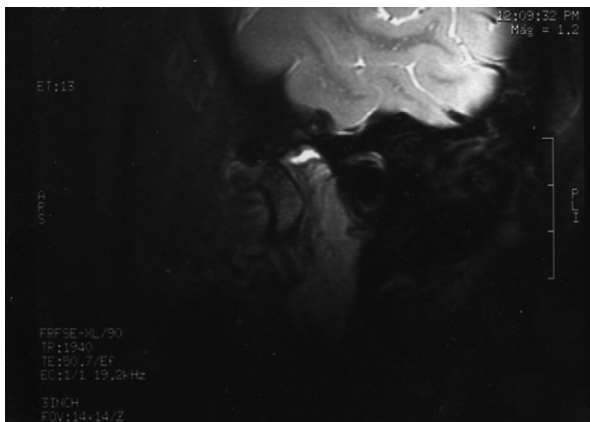


Fig. 3. Intra-articular effusion.

with a normal disk position raises up to 46.0% and that of those with DDNR decreases to 31.1%.

Chi-square analysis comparing all 3 groups demonstrated a significant statistical association between the presence of joint effusion and disk position ($P = .007$). Pairwise comparisons showed a statistically significant association between joint effusion and disk displacement without reduction ($P = .008$) but not for the other 2 groups (Table II).

DISCUSSION

The existence of a relationship between an abnormal disk position within the TMJ and the presence of intra-articular fluid that can be detected as areas of increased signal with MRI is a debated issue.

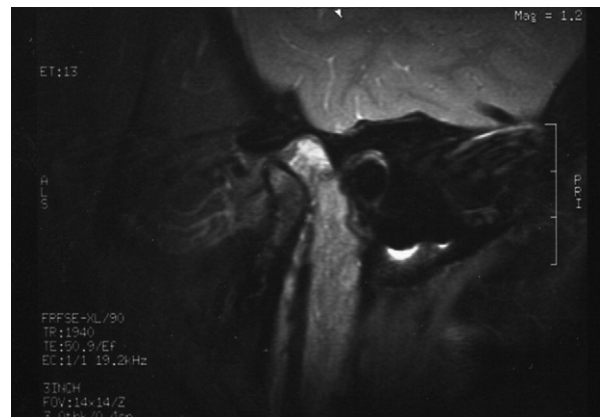


Fig. 4. Normal disk-condyle relationship in presence of joint effusion.

TMJ effusion has been shown to be frequent in asymptomatic subjects,¹⁹ but it may also represent a radiological sign of osteoarthritis when accompanied by cortical bone erosion and/or productive bone changes.²⁰

The hypothesis that a mechanical impairment within the joint, such as a disk displacement, can cause inflammatory-degenerative changes within the synovial fluid and be responsible for intra-articular fluid accumulation is biologically plausible. Abnormal mechanical loads, as those exerted on the retrodiscal tissue in joints with a displaced disk, have been shown to be associated with a molecular events chain culminating in the storing of free radicals and nitric oxide, both contributing to joint degeneration and inflammation.^{21,22}

Nonetheless, it should be also plausible that in some cases a preexisting effusion in the posterior joint compartment may cause a mechanical displacement of the joint disk toward a more anterior position. This hypothesis provides a possible explanation for disk displacements in joints affected by primary articular diseases, as in the case of rheumatic disorders.²³⁻²⁵

These considerations suggest that TMJ disk displacement and inflammatory changes within the TMJ may be interconnected.^{26,27} However, despite both studies based on autopsy findings and imaging studies that have been conducted in different age groups, as well as clinical investigations,²⁸⁻³² the actual frequency of association of MR evidence of joint effusion and disk displacement is still a matter of debate.^{9,10,33,34}

A study by Larheim et al.⁹ reported an association between disk displacement and joint effusion, showing that 96% of the joints with large amount of fluid had internal derangement. The same study supported the hypothesis that a mild to moderate amount of fluid may be present in asymptomatic joints as well, thus suggest-

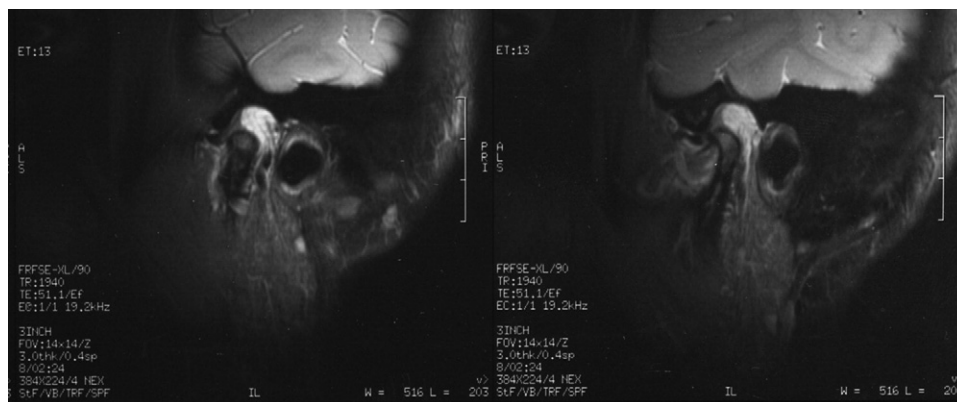


Fig. 5. Disk displacement with reduction in presence of joint effusion.

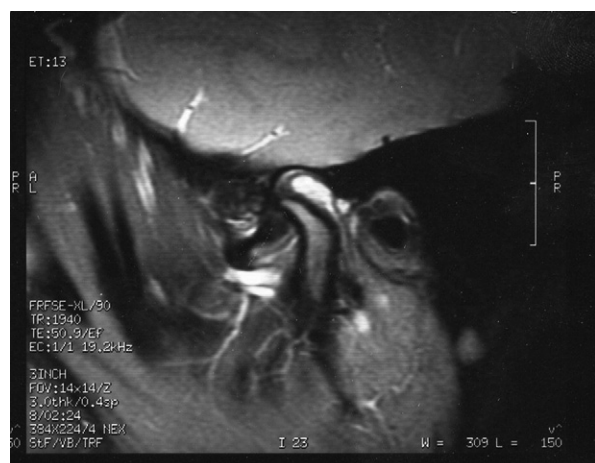


Fig. 6. Disk displacement without reduction in presence of joint effusion.

Table I. MR diagnoses of disk position and effusion

Frequencies	MR diagnosis			Total
	Normal	DDR	DDNR	
TMJ effusion				
0	145	72	98	315
1	20	18	35	73
Total	165	90	133	388

DDR, disk displacement with recution; DDNR, disk displacement without reduction; MR, magnetic resonance; TMJ, temporomandibular joint; 0, absence; 1, presence.

ing the need for a quantitative definition of joint fluid accumulation.

An early investigation by Westesson and Brooks¹⁰ showed that 40% of the study joints with disk displacement with reduction and 50% of those with disk displacement without reduction presented signs of effu-

Table II. Results of partial test performed for each MR diagnostic category

Partial tests	MR diagnosis		
Category	Normal	DDR	DDNR
P value	.99800	.42957	.00799

DDR, disk displacement with recution; DDNR, disk displacement without reduction; MR, magnetic resonance.

sion, in comparison with 7% of the joints with normal superior disk position. Those results suggested that TMJ effusions may primarily occur in joints with disk displacement, but they have been only partly confirmed by successive studies.

Rudisch et al.,³³ in a sample of 41 consecutive patients with TMJ pain, found a significant relationship between the MRI diagnosis of internal derangement and effusion. In their study sample, 59.6% of the joints with disk displacement showed presence of effusion, in comparison with 13.3% of the joints with a normal disk-condyle relationship.

In contrast with the early report by Westesson and Brooks,¹⁰ these findings did not support a difference in the frequency of the presence of joint effusion between joints with disk displacement with or without reduction (58.8% versus 60.0%).

A successive large sample study by Huh et al.¹¹ showed that joint effusion is more frequent in joints at more advanced stages of disk displacement (without reduction) than in those at the earlier stage (with reduction). Results from the present investigation described an association of joint effusion with disk displacement without reduction but not with disk displacement with reduction, thus supporting the findings by Huh et al.¹¹ Indeed, the prevalence of nonreducing disk displacement in joints with effusion is

significantly higher than that of reducing disk displacement (35/73, 47.9% versus 18/73, 24.7%).

These results are open to several interpretations, one being that the chronic degenerative process associated with disk displacement without reduction is responsible for changes within the TMJ space resulting in fluid accumulation.

So, findings from the present study lend support to the hypothesis that disk displacement leads to effusion and not the converse, in line with the early suggestions by Westesson and Brooks.¹⁰

Moreover, Huh et al.¹¹ observed that synovial fluid collection was more frequent in the acute phase of disk displacement without reduction than in the chronic stage, explaining their findings with the hypothesis that in the acute and subacute phases of disk displacement without reduction the disk is less deformed than in the chronic stage, thus being flexible enough to open a space within the joint in which accumulation of fluid may happen.

This hypothesis has never been verified, and it is also possible that a chronically nonreducing displaced disk with a fibrous posterior attachment would be less flexible and less able to adapt to the changing articular contours related to the changing spatial relationship between the condyle and fossa or eminence during translation, thus opening a space to be filled with fluid.

Unfortunately, the difficulty in establishing reliable temporal and/or clinical cut-off criteria to discriminate between acute and chronic displacements without reduction made such hypotheses difficult to test. In the present investigation, attention was focused on the effusion-displacement association and on the different reducing/nonreducing displacement relation with effusion.

The lack of association between disk displacement with reduction and joint effusion supported the hypothesis that an abnormal disk position with respect to the physiological 12 o'clock may be considered a normal variation in a discrete percentage of cases.

The present findings support other studies that found an imperfect agreement between the magnetic resonance and clinical signs of disk displacement.^{15,26,35-37} The fact that studies have shown that about 30% of asymptomatic volunteers will not have a disk position in the 12 o'clock position leads to question the definition of the "normal" disk position.^{14,19}

Generalization of results from the present investigation is tempered by the characteristics of the study sample, which was constituted by patients under treatment for temporomandibular disorders. Future studies on this issue should include a control sample of asymptomatic subjects within the study group, in order to define the prevalence of effusion in normal joints of

asymptomatic subjects. This suggestion is important if one considers that joints with a normal disk-condyle relationship may be mechanically stressed by the presence of contralateral pathologies and may present effusion due to such an abnormal mechanical load, thus possibly leading to overestimation of the prevalence of effusion in joints with normal disk position. This concern has not influenced the study's results, since a strong difference in the prevalence of effusion between joints with disk displacement and those with a normal disk-condyle relation has been detected anyway.

CONCLUSIONS

Taken together, findings from this investigation have raised considerations that suggest the direction for future researches. Technological progress clearly has led to the development of imaging techniques that provide for better understanding of the TMJ,¹ but it is also true that the actual significance of some radiological signs (disk-condyle relationship, joint fluid accumulation) and their relation with clinical signs (joint sounds) and symptoms (pain) have yet to be clarified.³⁸

In the present investigation an association with effusion was found only in disk displacement without reduction. This supports the hypothesis that disk displacement causes intra-articular fluid accumulation and not the converse. Nonetheless, further study is necessary to confirm this hypothesis. Also, similar studies conducted on populations of healthy subjects will help providing information about the prevalence of effusion in normal joints and clarifying the role of effusion and disk displacement in determining disorders of the contralateral joint.

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