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Risk of temporomandibular joint effusion related to magnetic resonance imaging signs of disc displacement

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Abstract

Background: It has been suggested that TMJ effusion may represent an inflammatory response to a dysfunctional disc-condyle relationship. The purpose of the present study was to evaluate whether the status of the disc in the temporomandibular joint, as depicted in magnetic resonance (MR) images, is predictive of the presence of temporomandibular joint (TMJ) effusion.

Methods: The relationship between disc displacement and TMJ effusion was analyzed in MR images of 154 TMJs in 77 patients complaining for pain and/or dysfunction in the TMJ area and referred from medical practitioners to specialist consultation. Logistic regression analysis was used to identify the significant correlation between presence/absence of joint effusion and disc displacement.

Results: Significant correlation ($P<0.01$) between disc displacement and joint effusion was found. OR for all type of disc displacement was 3.1, and the odds that a joint had magnetic resonance imaging findings of effusion was greater for anterior disc displacement without reduction.

Conclusions: The status of the disc could represent a factor involved in the development of temporomandibular joint oedema. However, these findings suggest that disc displacement may not be regarded as the dominant factor in defining the occurrence of TMJ effusion. Certain local or systemic conditions other than the disc-condyle relationship must be considered.

Key words: *Temporomandibular disorder, disc displacement, magnetic resonance imaging, joint effusion.*

Introduction

The label temporomandibular disorders (TMD) is used to indicate a cluster of various clinical conditions involving temporomandibular joints (TMJs), masticatory muscles and their related structures.(1) These disorders have been associated with characteristic clinical findings such as muscle tenderness to palpation, joint pain at rest or during motion, joint sounds, and restricted or deviating jaw function.(2) The most common type of these diseases is considered to be temporomandibular joint disc displacement, that refers to an abnormal positional relationship of the articular disc to the condyle and the articular eminence.

The diagnosis of TMJ disc displacement is based on the clinical examination, with the contribution of a wide range of imaging techniques. With the rapid progress made in TMJ imaging methods, the comprehension of temporomandibular disorders has markedly improved. Magnetic resonance imaging of the TMJ can provide many information about the position of the disc,(3) the quantity of the synovial fluid(4), the status of the retrodiscal tissues(5), and the condition of the bone.(5,6)

The most part of magnetic resonance imaging (MRI) studies have focused on signal alteration in the joint compartments indicating the presence of fluid derived from the exudation of inflamed retrodiscal tissue and other inflammatory changes in the synovial membrane, resulting in joint effusion.(8) TMJ effusion describes the magnetic resonance imaging finding of a hyperintensity signal inside the joint compartments, which typically appears as a brightness area on T2-weighted magnetic resonance images. TMJ effusion can represent a local problem related traumatic injures as well as correlated to systemic diseases such rheumatoid and psoriatic arthritis. Also the status of the disc in TMJ could be one of these causal factors since disc displacement has been associated with TMJ effusion.(4) This led some authors to suggest that TMJ effusion may represent an inflammatory response to a dysfunctional disc-condyle relationship.(9)

Considering these premises, the aim of the present study was to evaluate the presence of TMJ effusion in a consecutive series of patients referred for MRI imaging and to asses its correlation with MR diagnosis of disc displacement.

Materials and Methods

Study design

One hundred fifty-four TMJ magnetic resonance images from 77 patients who were referred from medical practitioners to the Section of Prosthetic Dentistry, Department of Neuroscience, University of Pisa, Italy, were reviewed. Detection of joint fluid and determination of disc position were accomplished in order to asses the relationship between findings of effusion and type of disc displacement.

Magnetic resonance imaging was performed with a 1.5 T MRI scanner (GE Signa Contour; GE Medical Systems, Buc, France) and a dedicated, circular polarized transmit and receive TMJ coil. The MRI protocol included bilateral oblique sagittal and oblique coronal T1 weighted (repetition time, 500 ms; echo time, 16 ms) and T2 weighted images (repetition time, 2300 ms; echo time, 30-80 ms) with 3 mm slice thickness, 256X160 matrix, 15 cm field of view, in both closed and maximum open mouth position. MR images were corrected to the horizontal angulation of the long axis of the condyle. A wooden intermaxillary device was used for the open mouth views.

All the MR images were evaluated by two experienced radiologist who were blind to each other. Each radiologist assessed independently each MR image to evaluate both the status of the disc and the amount of fluid. Any disagreement in the diagnosis was resolved by consensus.

The T1 weighted images, that allowed to locate the disc, the condyle, the eminence and the glenoid fossa, were collected to asses the TMJ disc-condyle relationship. Based on the MR findings, the joints were categorized as follows (9). Normal: the disc was located superior to the condyle in which the posterior band of the TMJ disc was at the apex of the condylar head (12 o'clock position). Disc displacement with reduction (DDwR): the disc was displaced at the closed mouth position but was in the normal position when the mouth was in the open position. Disc displacement without reduction (DDwoR): the disc was displaced in both the closed and open mouth position.

On the T2 weighted images, the presence or absence of joint effusion was established by identifying the presence of thin lines or an area of high signal intensity inside the articular space: when more than a line of high signal was evident in at least 2 consecutive sections, it was considered positive for TMJ effusion (10). The severity or amount of effusion was ignored.

Statistical analysis

MRI findings of joint effusion versus no effusion were considered as dependent variable and a univariate logistic regression model was used to identify the significant correlation between presence/absence of joint effusion and disc displacement (independent variable).

The odds ratios (ORs) and their corresponding 95% confidence intervals (CIs) for joint effusion were calculated separately for all type of disc displacement (disc displacement with reduction and disc displacement without reduction). All test were two sided, and a P value <0.05 was considered statistically significant. The odds ratio is a measure without any etiologic implication, which describes the risk that TMJ with disc displacement will belong to the effusion group. For value of OR>2 the independent variable could be considered as risk factor

for the disease. Cox and Snell's R2 was obtained as an estimation of the total log likelihood explained by the presence of disc displacement. The log likelihood in a logistic regression is the analogue of the variance explained in a linear regression model and represents the amount that the independent variable can differentiate the dependent variable. R2 represents the numerical expression of the dependent variables accounted for by the model. If R2 is >0.75, the fitted model is considered able to predict the presence of disease at a very good level. The model ability to predict disease is considered good if R2 is between 0.50 and 0.75, fair if is 0.25 and 0.50, and poor for R2 of 0.25 or less (11) The accuracy of disc displacement to predict the presence or absence of joint effusion was determined from 2 x 2 classification table. For all statistical analysis the SPSS package was used (SPSS 14, SPSS Inc, Chicago, IL).

Results

The TMJs with disc displacement constituted 55.2% of the 154 TMJs (n=85). Among these, 58 TMJs had anterior disc displacement with reduction (37.7%), and 27 had anterior disc displacement without reduction (17.5%); the remaining TMJs showed no signs of disc displacement.

Of the 154 TMJs evaluated, 75 showed the presence of thin lines or areas of high signal intensity inside the articular space (48.6%). Magnetic resonance findings of effusion were seen in 23 of 69 joints with normal superior disc position, 34 of 58 joints with disc displacement with reduction, 18 of 27 joints with disc displacement without reduction.

Significant correlation (P<0.01) between disc displacement and joint effusion was found. OR for all type of disc displacement was 3.1, and the odds that a joint had magnetic resonance imaging findings of effusion was greater for anterior disc displacement without reduction (Fig.1).

The total amount of the log likelihood (Cox and Snell's R2) accounted for disc displacement to predict joint effusion was poor and was equivalent to 7.5% with 73.5% accuracy (sensitivity 82.6% and specificity 65.4%). DDwR accounted for less of the likelihood than DDwoR (6.3% Cox and Snell R^2 vs 8.8%) with a sensitivity of 65.7% versus 83.6%, and a specificity of 59.6% versus 43.9%. Both DDwR and DDwoR show a low sensitivity (59.6%; 43.9%); while DDwoR has good specificity 83.6%. Further details are presented in the table (Table 1).

Discussion

In recent years, MR imaging has been confirmed as the imaging technique of choice in the study of TMJ dysfunction. MR imaging technique in this context includes the use of dual surface coils, sagittal oblique and coronal thin sections of 3 mm or less, and proton-density–weighted and T2-weighted sequences in both closed- and open-mouth positions (12).

The most frequent cause of TMJ disorder is internal derangement, which is defined as an abnormal relationship of the disc to the condyle (13). As a consequence, precise localization of the disc is very important in the diagnosis of TMJ internal derangement and can easily be achieved with MR imaging, if we consider that the diagnostic accuracy of this tool on fresh autopsy material using oblique sagittal and oblique coronal sections has been found to be 95% in determining the disc position (14,15).

Joint effusion is usually described as a large amount of articular fluid. The presence of joint effusion has been associated with TMJ disc displacement (9) and it is thought that it could represent an early change that can precede osteoarthritic changes (16). At MR imaging, joint effusion is best depicted with T2-weighted sequences, manifesting as areas of hyperintensity. Though the clinical relevance of joint effusion detected on magnetic resonance images in internal derangement of the temporomandibular joint is not yet clear, studies have shown that such effusion may reflect inflammatory changes that involve extravasation of some molecules into the joint space (17-19). There have been no reports on whether the stage of disc displacement is a predictive factor for the occurrence of joint effusion. Results of the present study showed a positive correlation (OR>2) between disc displacement and joint effusion, that was statistically significant at a level of P<0.01. OR for all type of disc displacement was 3.1, and the odds that a joint had magnetic resonance imaging findings of effusion was greater for anterior disc displacement without

Table 1. Accuracy, specificity, sensitivity of disc displacement to predict joint effusion.

Factor in regression model.	P	OR (CI 95%)	SENS (%)	SPEC (%)	ACC (%)	Total R^2
All Disc Displacement	.001	3.15 (1.62 – 6.12)	69.3	58.2	63.6	0.075
DDwR	.005	2.83 (1.37 – 5.84)	59.6	65.7	63.0	0.063
DDwoR	.004	4.00 (1.55 – 10.27)	43.9	83.6	66.7	0.088

OR: odds ratio; CI: confidence interval; SENS: sensitivity; SPEC: specificity; ACC: accuracy; Total R2 Cox and Snell; DDwR: Disc Displacement with Reduction; DDwoR: Disc Displacement without Reduction.

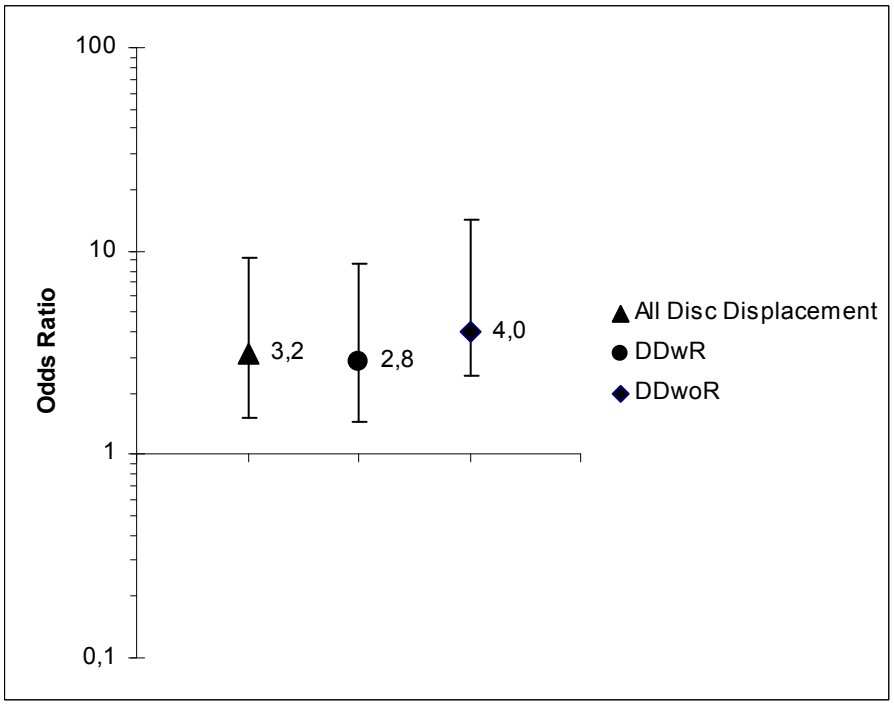

Fig. 1. Relative odds of TMJ effusion as a function of magnetic resonance imaging findings of disc displacement.

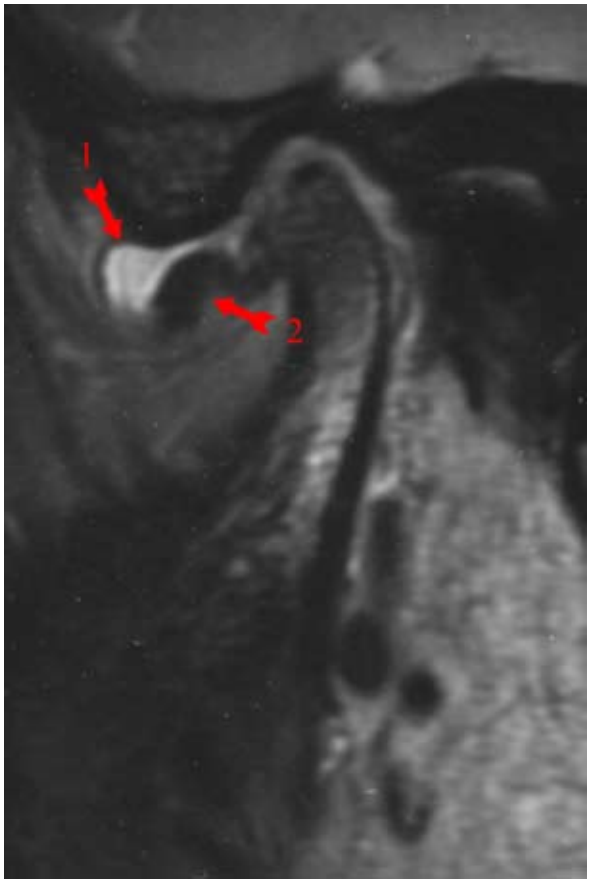

Fig. 2. Close mouth, effusion in the anterior compartment of the upper joint space. Disc displacement without reduction.
Arrow 1: points disc position. Arrow 2: points effusion.

Fig. 3. Open mouth, effusion in the posterior compartment. Disc displacement without reduction.
Arrow 1: points disc position. Arrow 2: points effusion.

reduction. However the value of sensitivity, specificity and accuracy were low, thus suggesting that disc displacement was not able to detect the presence or absence of joint effusion. Furthermore a small part of the variance of temporomandibular joint effusion (Cox and Snell R^2<0.25) could be explained only by the presence of disc displacement, so other factors must play a role.

Our findings of a significant relationship between the presence of disc displacement and the presence MR imaging findings of TMJ effusion are in agreement with those of some authors who supported the hypothesis that TMJ effusion could represent an inflammatory response to a dysfunctional disc-condyle relationship. In the study of Westesson and Brooks (4), the percentage of joints with effusion was greater in patients with the more advanced stage of disc displacement (disc displacement without reduction) than in those with the earlier stage (disc displacement with reduction). In a sample of the 76 joints with effusion, 83% showed two specific categories of disc displacement in a study conducted by Larheim et al. (4). Among these, more than two-thirds were classified as disc displacement without reduction. Conversely, in a study of Adame et al.(20), even if the incidence of disc displacement on MRI was greater in the effusion group than in controls, there were no differences in DDwR or DDwoR on MRI between both groups. Sano et al. (8) did not identify any statistically significant association between signal intensity from the retrodiscal tissue and the diagnosis of the joint with respect to disc position. In a study of Yano et al.(21) in which even a minimal amount of fluid was regarded as being positive for effusion, no statistically significant relationship between disc displacement and the presence of joint fluid was found. However, all patients with moderate to extensive fluid had disc displacement. These results suggest that a large quantity of fluid is related to disc displacement while a small quantity of fluid is probably not. According to our findings, it is conceivable that a non-reducible disc represents a risk factor for the occurrence of joint oedema more than a reducible one since the odds that a joint had magnetic resonance imaging findings of effusion was greater for anterior disc displacement without reduction. It may be that DDwoR produces more abnormal mechanical stresses or inflammatory chemical mediators than does DDwR and, therefore, results in effusions in some TMJs. On the other hand, the displaced disc in patients with DDwoR is less mobile and more deformed than it is in patients who have DDwR: due to these more advanced anatomical changes, the normal synovial fluid circulation may be impaired, causing localized collection of fluid. According to this reasoning an effusion is simply a pooling of synovial fluid with no direct relationship to inflammation. All of the above described explanations may be appropriate in different cases. To try to solve the above concern, the clinician needs to conduct TMJ fluid analysis (22).

One limitation of the present study was the lack of a grading system for categorizing the amount of TMJ fluid on MR images. Joint effusion is generally defined as the pathological collection of TMJ fluid in the joint spaces manifesting as an increased signal on T2-weighted MR images. Regarding TMJ, the joint spaces are too small and the signal of the effusion is quite similar to that of the synovial fluid. Therefore, it is not easy to distinguish joint effusion from normal synovial fluid in the TMJ on MR images. We did not quantify the amount of joint effusion. Instead, we subjectively quantify the presence or absence of joint effusion. Criteria to differentiate between joint effusion and normal synovial fluid on MR image is needed because there is no firm consensus on what amount of fluid constitutes joint effusion (4,23).

It wasn't considered the association between TMJ effusion and MRI findings of other pathological conditions such as bone marrow abnormalities and cortical bone integrity. The combination of oedema and sclerosis of the bone marrow are considered reliable signs of avascular necrosis of the mandibular condyle (24). Some authors reported joint effusion to be significantly more frequently observed in joints with bone marrow abnormalities than in joints without such changes (16,25). However, it is thought that bone marrow abnormalities represent a response to an increased intra-articular pressure in conditions such as synovitis and effusion (24,25) more than a risk factor for the extravasation of fluid in the articular space. As regard cortical bone changes, it was reported that the presence of flattening, subchondral sclerosis, surface irregularities, and erosion of the condyle define the MRI diagnosis of osteoarthrosis (14). In the study of Adame et al.(20), bone degenerative alterations were related to effusion on MRI. However, it is conceivable that the above mentioned degenerative changes represent a consequence of the collection of a large amount of fluid more than a predisposing condition for the occurrence of synovitis. In fact, it is known that articular cartilage nutrition is provided mainly by the synovial membrane. The presence of joint effusion may affect chondrocyte nutrition by increasing the diffusion path through the synovial fluid and this could be involved in early metabolic changes. The metabolism of the condylar articular surface could be altered, resulting in osteochondritis, subchondral degeneration, and osteoarthrosis (26).

However, it has to be considered that effusion may be associated with not only disc displacement or bone abnormalities, but also with several systemic diseases (such as psoriatic rheumatoid arthritis). Thus, to clarify this concern further, it is necessary to perform magnetic resonance imaging studies in patients with rheumatic diseases and temporomandibular disorders.

Within all the limitations of the present investigation,

the findings obtained suggest the purpose of new research in such direction. For example, to our knowledge, there have been no longitudinal studies on the correlation between the excessive accumulation of joint fluid and internal derangement. Yano et al.(21) evaluated the relationship between changes in joint fluid in the joint space and the state of the disc before, during, or after orthodontic treatment: their findings indicated variations of TMJ effusion and pain during the observation period. However, more longitudinal studies in this field are necessary to reinforce the assumption of a possible correlation between temporomandibular joint effusion and disc displacement.

In conclusion, on the base of the findings obtained, it seems that the incidence of TMJ effusion does correlate with the status of the disc in the TMJ. In detail, joint effusion occurs more often in joints with more advanced stages of disc displacements than in normal joints or in joints with earlier stages of disc displacement. However, disc displacement may not be regarded as the dominant factor in defining the occurrence of TMJ effusion.

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