Prediction of TMJ Arthralgia According to Clinical Diagnosis and MRI Findings

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Purpose: The aim of this study was to investigate the ability of clinical and magnetic resonance imaging (MRI) diagnoses to predict pain in the temporomandibular joint (TMJ). ***Materials and Methods:*** One hundred forty-nine patients were examined by 2 calibrated examiners in strict accordance with the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD). All patients who presented with a defined clinical RDC/TMD diagnosis were included and underwent bilateral coronal and sagittal MRI of the TMJ. Two raters blinded to the clinical diagnosis interpreted the MRI scans for TMJ pathology. The results were tested against the clinical diagnosis according to the RDC/TMD, including pain-related disability and psychosocial status, for associations to TMJ arthralgia using logistic regression analysis (GENMOD procedure, $P < .05$). ***Results:*** MRI-depicted anatomic changes, such as joint effusions, disc displacement, and osteoarthrosis, were not significantly correlated with the presence of pain in the TMJ. However, a significant relationship between pain on palpation of the masseter muscle origin ($P = .0050$) and psychosocial factors ($P = .0452$) and pain in the TMJ was demonstrated. ***Conclusions:*** Pain in the TMJ caused by the anatomic proximity of the muscle masseter origin and the lateral TMJ pole and the possible existence of trigger points in the musculature may lead to a false-positive or a false-negative diagnosis of arthralgia. Additionally, clinicians must consider the psychosocial aspects of pain in ideal treatment planning. *Int J Prosthodont 2006;19:333–338.*

Temporomandibular disorders (TMD) are widespread in the general population,[1] even though the absolute prevalence of symptomatic individuals varies.

The main reason that TMD patients seek treatment is the presence of pain,[2] including pain in the temporomandibular joint (TMJ). Although the clinician wishes to provide an optimal treatment for TMJ-related pain, treatment strategies are controversial and the cause of TMJ pain is not yet fully understood.

Since the introduction of magnetic resonance imaging (MRI) for imaging of the hard and soft tissues of the TMJ,[3] several studies have explored the relationship between TMJ pain and MRI-depicted TMJ anatomic findings, although no consensus has been reached.[4–13] While some researchers have demonstrated a correlation between the presence of TMJ pain and MRI findings, such as disc displacement (DD), osteoarthrosis (OA), and joint effusions (JE),[4,5,8,9,11–13] other reports have failed to find a correlation.[6,7,10]

One reason for these discrepancies may be the use of many different diagnostic systems, meaning that the patients are not consistently studied in the same way. Apart from the problem of the use of different methods of examination, some studies totally dispensed with a clinical examination.[5,9] These studies used only a questionnaire, raising doubts as to whether the pain was of another origin and was perhaps muscular.[14] Even if a clinical examination was performed,

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the question arises whether the reported pain was located in the TMJ or in the muscle area surrounding the TMJ, because of the anatomic proximity of the masseter muscle origin and the lateral TMJ pole. As a result, it remains unclear whether apparent TMJ pain might actually be muscular or arthritic.

It should not be forgotten that pain itself is always subjective, and its perception is the result of a combination of factors.[15] For TMD-related pain, it has been shown that the subjective reporting of pain is also influenced by psychosocial factors.[16] Although no differences could be demonstrated in pain severity and duration between patients with masticatory muscle pain and patients with intracapsular pain,[17] patients with chronic masticatory muscle pain demonstrated more dysfunctional behavioral profiles and significantly higher psychologic distress than patients with intracapsular pain.[17] Thus, psychosocial factors should be part of diagnostic TMD protocols, but are often not included.

In an attempt to overcome these difficulties, the standardized Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) was introduced to define the clinical subtypes of TMD and to differentiate between muscle and joint pain.[2] Pain intensity, pain-related impairment, and psychosocial aspects are also included in the RDC/TMD, via validated questionnaires.

The purpose of this study was to evaluate the relationship between the presence of pain in the TMJ (according to the RDC/TMD) and the presence of DD, OA, and JE as predicted by MRI. Additionally, the hypothesis that clinical diagnoses of arthralgia can lead to false positives or false negatives was tested, as was as the association between joint pain and psychosocial factors.

Materials and Methods

Patients participating in the study were recruited from patients seeking treatment for TMD at the Department of Prosthodontics at the University of Heidelberg, Germany. All patients were examined by 2 calibrated examiners in strict accordance with the RDC/TMD protocol. All patients with a defined RDC/TMD diagnosis were asked to participate the study. Exclusion criteria were a history of polyarthritis, acute traumatic injury, age below 18 years, inability to give informed consent, or factors impeding MRI acquisition. All patients in the study group gave informed consent. The university's review board approved the study.

The study group consisted of 149 patients (75% women and 25% men) between 18 and 79 years of age (mean, 38.5; SD, 15.3).

The RDC/TMD examination procedure includes the assessment of the presence or absence of joint sounds and pain, palpation of intraoral and extraoral mastcatory muscles using defined pressure, and measurement of the range of mandibular motion. Muscle and joint palpation for tenderness was done with standardized pressure as follows: 2 lbs of pressure for extraoral muscles and 1 lb of pressure on the joints and intraoral muscles.

For palpation of the lateral pole of the TMJ, the examiner's finger was placed anterior to the tragus of the ear and over the subject's TMJ, and subjects were asked to open slightly until the lateral pole of the condyle translated forward. For palpation of the masseter muscle origin, the examiner's finger was placed 1 cm immediately in front of the TMJ and immediately below the zygomatic arch. The detailed RDC/TMD examination protocol has been described elsewhere.[2]

The RDC/TMD protocol provides defined parameters for muscle and joint related diagnosis[2]:

- *Group 1:* muscle disorders (1a, myofascial pain; 1b, myofascial pain with limited opening)
- *Group 2:* DDs (2a, disc displacement with reduction [DDWR]; 2b, disc displacement without reduction [DDWoR] with limited opening; 2c, DDWoR without limited opening)
- *Group 3:* arthralgia, arthritis, and arthrosis (3a, arthralgia; 3b, osteoarthritis of the TMJ; 3c, OA of the TMJ)

In making diagnoses of the RDC/TMD subtype of arthralgia, defined criteria had to be met:

1. Pain and tenderness in the joint capsule and/or the synovial lining of the TMJ
2. Pain in one or both joint sites (lateral pole and/or posterior attachment) during palpation; *plus*
3. One or more of the following self-reports of pain: pain in the region of the joint, pain in the joint during maximum unassisted opening, pain in the joint during assisted opening, pain in the joint during lateral excursion
4. Absence of coarse crepitus (for a diagnosis of simple arthralgia)

Of the 298 TMJs examined, 282 could be statistically evaluated with respect to the analysis of arthralgia. Sixty-eight TMJs fulfilled the RDC/TMD criteria for arthralgia (arthralgia group). The 214 pain-free TMJs were used as the control group.

The statistical evaluation of the TMJs was without regard for which group the TMJs were from; thus, assignment of patients to the study or control group was not possible.

Furthermore, psychosocial assessment was performed as recommended by Türp et al[18] and included the Graded Chronic Pain Scale,[19] a depression scale (modification of the CES-D[20,21]), an assessment of somatization,[22] and the jaw disability index.[2]

MRI Examination

All patients in the study group underwent bilateral coronal and sagittal MRI of the TMJ after the clinical examination. No medication, splint therapy, or self-help advice was given during the time between the clinical examination and the MRI.

Two raters blinded to the clinical diagnosis interpreted the MRI scans: a dental practitioner and a head and neck radiologist with appropriate experience in interpreting MRI data. These 2 raters were previously calibrated in a 5-hour calibration session, during which 70 sets of MRI scans (not including any of the MRI scans from the present study) were provided. Each set consisted of 5 images of the TMJ, arranged in the same way as in the present study.

Twenty of these sets were judged by the 2 raters together, and the criteria to assess the status of the TMJ were determined. Afterward, each rater individually evaluated 50 sets of MRI scans, and a reliability assessment demonstrated acceptable agreement (mean $\kappa = 0.7$).

Differences in the interpretation of the sagittal MRI scans were resolved by a consensus diagnosis.[23]

MRI was carried out with a 1.5-tesla magnetic resonance tomograph (Symphony, Siemens) using a TMJ surface coil (Siemens). Initial localizers were obtained in the closed-mouth and open-mouth positions, with the aim of detecting the condyles in various functional positions. Slices of the diagnostic sequences were obtained perpendicular to the condylar long axis, so that the first slice consisted of the lateral portion of the condyle and the fifth slice consisted of the medial portion of the condyle. When the open-mouth images were taken, a Burnett bidirectional TMJ device (Medrad) was used in an attempt to stabilize the maximal open-mouth position and to minimize motion artifacts.

The MRI protocol comprised coronal oblique T1-weighted images (proton-weighted fast low-angle shot, PD Flash 2D), time of echo (TE) 10.2 ms, time of repetition (TR) 208 ms, acquisition time (AT) 3.5 min, and T2-weighted images (TE 112 ms, TR 5290 ms, AT 3.8 min) with a slice thickness of 3 mm. Additionally, the MRI protocol included sagittal oblique T1-weighted images (TE 10.2 ms, TR 208 ms, AT 5.3 min) with 3-mm slices. Data were collected on a 256 × 256 matrix with a field of view of 120 × 120.

Structural diagnosis was made on T1-weighted images, while T2-weighted images were used for detecting JEs.

Normal sagittal disc positions were defined by the relative position of the posterior band of the TMJ disc compared to a 12 o'clock disc location superior to the condyle.[24] A line perpendicular to Frankfort horizontal and through the middle of the condyle was used to define the 12 o'clock position.[25] DDWR was defined as follows: the disc was displaced at the closed-mouth position but was in the normal position at the opened-mouth position. DDWoR was defined as follows: the disc was displaced in both the closed- and open-mouth positions.[4]

Degenerative bony changes were diagnosed in the presence of flattening, subchondral sclerosis, surface irregularities, and erosion of the condyle or presence of condyle deformities.[26] Areas in the articular space that showed low signal intensity on T1-weighted sagittal imaging and high signal intensity on T2-weighted coronal imaging were regarded as areas containing JEs.

Statistical Analysis

The following parameters were included in the statistical analysis to evaluate the risk factors for prediction of TMJ arthralgia:

1. *MRI-based variables:* DDWR, DDWoR, JE, and OA.
2. *Clinical variables:* Pain during palpation of the masseter muscle origin and pain during palpation of the masseter muscle insertion (each with arthralgia on the corresponding side), depression and somatization score, age, gender, and RDC/TMD diagnosis of myofacial pain.

All analyses, including descriptive statistics, were carried out using SAS (Version 8.2; SAS Institute).

To control for nonindependence of the left and right joints, a generalized estimation equation (GEE) model was used (GENMOD procedure).[27] Logistic regression analysis was used to identify the factors influencing whether a patient with a certain clinical or MRI finding or psychosocial status could belong to a TMJ arthralgia group.

Initially, a logistic regression model using all dependent variables was generated; subsequently, each single variable was analyzed separately. The final logistic regression model was developed to include the significant variables from the aforementioned analyses as well as clinically meaningful variables. The final logistic regression model was generated manually to allow for previous results and to avoid the exclusion of clinically meaningful variables by the computer.[28]

Results

Of the 298 TMJs examined, 282 TMJs could be statistically evaluated with respect to the analysis of arthralgia. Missing data (patients' self-reports of pain) prevented assignment of 16 TMJs to either the arthralgia or control groups. Of the 282 statistically evaluated TMJs, 68 TMJs fulfilled the RDC/TMD criteria for arthralgia. The remaining pain-free 214 TMJs were taken as the control group.

Table 1 Initial Analysis of GEE Parameter Estimates

Parameter	Estimate	SE	CI		*P*
Intercept	−2.3019	0.7302	−3.7331	−0.8706	.0016
DDWR	0.5338	0.4167	−0.2830	1.3506	.2002
DDWoR	0.8058	0.4336	−0.0441	1.6556	.0631
JE	0.4842	0.3511	−0.2038	1.1723	.1678
OA	−0.1998	0.4390	−1.0603	0.6607	.6490
Mass origin	1.2357	0.5096	0.2369	2.2345	.0153*
Mass insertion	−0.1369	0.4802	−1.0781	0.8044	.7757
Depression score	1.0476	0.4365	0.1920	1.9031	.0164*
Somatization score	−0.1787	0.3972	−0.9571	0.5997	.6528
Male	0.5311	0.4047	−0.2620	1.3242	.1894
Female	–	–	–	–	–
Myofascial pain	−0.1900	0.2132	−0.6078	0.2279	.3792
Age	0.0102	0.0101	−0.0095	0.0299	.3101

*Statistically significant.
Mass origin = pain during palpation of the masseter muscle origin;
Mass insertion = pain during palpation of the masseter muscle insertion.

Table 2 Final Logistic Regression Model Analysis of GEE Parameter Estimates

Parameter	Estimate	SE	CI		*P*
Intercept	−1.6755	0.5422	−2.7383	−0.6128	.0020
DDWoR	0.5116	0.3068	−0.0896	1.1129	.0953
Mass origin	1.1768	0.4195	0.3546	1.9989	.0050*
Mass insertion	0.1837	0.4197	−0.6389	1.0063	.6616
Depression score	0.7770	0.3879	0.0168	1.5373	.0452*
Myofascial pain	−0.1084	0.1916	−0.4839	0.2670	.5714

*Statistically significant.
Mass origin = pain during palpation of the masseter muscle origin;
Mass insertion = pain during palpation of the masseter muscle insertion.

MRI demonstrated DDWR in 13 TMJs with arthralgia (39 without arthralgia), DDWoR in 23 TMJs with arthralgia (53 without arthralgia), OA in 23 TMJs with arthralgia (54 without arthralgia), and JE in 19 TMJs with arthralgia (57 without arthralgia).

Pain during palpation of the masseter muscle origin in combination with arthralgia on the corresponding side was seen in 35 TMJs with arthralgia (41 TMJs without arthralgia), while pain during palpation of the masseter muscle insertion in combination with arthralgia on the corresponding side was seen in 36 TMJs with arthralgia (57 TMJs without arthralgia).

Sixteen patients with clinically diagnosed arthralgia demonstrated myofascial pain (28 without arthralgia), 14 patients with arthralgia demonstrated an increased depression score (5 without arthralgia), and 14 patients with arthralgia demonstrated an increased somatization score (17 without arthralgia).

Initial Analysis of GEE Parameters Estimates

In the initial analysis of GEE parameter estimates (Table 1), a significant association was found between arthralgia and pain during palpation of the masseter muscle origin ($P = .0153$) and depression score ($P = .0164$).

No significant association was found between arthralgia and DDWR ($P = .2002$), DDWoR ($P = .0631$), JE ($P = .1678$), OA ($P = .6490$), pain during palpation of the masseter muscle insertion ($P = .7757$), somatization ($P = .6528$), gender ($P = .1894$), myofascial pain ($P = .3792$), or age ($P = .3101$).

Analysis of GEE Parameter Estimates in the Final Model

In the final logistic regression model (Table 2), pain during palpation of the masseter muscle origin ($P = .0050$) and depression score ($P = .0452$) remained significant predictors of arthralgia.

No significant association was found between arthralgia and DDWoR ($P = .0953$), pain during palpation of the masseter muscle insertion ($P = .6616$), or myofacial pain ($P = .5714$).

Discussion

In the present study, no association between arthralgia and OA, DD, or JE could be detected. Instead, significant correlations between arthralgia and pain during palpation of the masseter muscle origin and depression score were found.

The results of previous studies investigating an association between pain and structural alterations within the TMJ as diagnosed by MRI were inconsistent, with some reporting correlations[4,5,8,9,11–13] and others denying an association.[6,7,10]

Comparison of previous results is inherently difficult because a variety of different clinical examination methods have been used,[4,9,11–13] while other researchers dispensed with any clinical examination or did not differentiate between joint and muscle pain.[5,9,12] Thus, the question arises whether TMJ pain might actually have been muscular pain.

Any significant association between pain from palpation at the masseter muscle origin and arthralgia may be a result of the anatomic proximity of the masseter muscle origin to the lateral TMJ pole. In particular, it may be possible that fibers of the masseter muscle insert into the capsule,[29] which further calls into question whether pain during lateral joint palpation truly reflects joint pain or is in fact muscle pain.[30]

Travel and Simmon[31] also showed that pain during palpation of the masseter can manifest itself as pain in the TMJ (or conversely) due to trigger points, leading to

false-positive or false-negative diagnoses. Likewise, the present study showed a significant association between pain from the masseter muscle origin and TMJ pain.

Thus, neither the patient nor the examiner may be able to reliably differentiate between pain in the TMJ and muscle pain during palpation. Considering that the inclusion criteria for the diagnosis of arthralgia may be incorrect, it is likely that in previous studies subjects were not always correctly allocated to the experimental or control groups. Therefore, this may provide an explanation for the discrepancies in published results on arthralgia. The possibility cannot be excluded that in the present study patients with arthralgia were not classified as belonging to the arthralgia group or that patients without arthralgia were assigned to the arthralgia group.

Another limitation of the present study is that MRI is not the best technique to define bony changes, especially if the condyles are small. Apart from the obvious advantages, such as the precise imaging of both hard and soft tissues and less invasiveness,[3] the specificity of MRI is inferior to that of computerized tomography for diagnosing OA, although the sensitivity of MRI is superior.

Additionally, there was no differentiation between patients with acute or chronic pain conditions in the present study, which may influence the diagnosis of arthralgia, starting from the assumption of an inflammatory reaction that causes pain in the TMJ.[8]

However, if it is assumed that nociceptive afferents coming from muscle and the TMJ converge at the trigeminal nucleus[32] and that peripheral afferents or central neurons may be sensitized in chronic states,[33] it becomes very difficult to distinguish between muscle and joint pain.

Furthermore, it must be taken into consideration that psychosocial factors may also influence pain status. Psychosocial factors and psychologic factors have been proposed to play a major role in the etiology[34] and maintenance of TMD in the last decade, even if the influence is greater when the pain is of muscular origin.[35] However, studies examining the differences in depression scores between TMD subgroups have given inconsistent results. Some studies have found no TMD-related differences,[36] whereas others found major differences.[17]

In the present study, the depression score remained a significant predictor of arthralgia. Thus, it could be concluded that pain may include a subjective aspect.[15]

Conclusion

Pain in the TMJ caused by the anatomic proximity of the masseter muscle origin to the lateral TMJ pole or the possible existence of trigger points in the musculature may lead to a false-positive or a false-negative diagnosis of arthralgia.

Additionally, clinicians must consider the psychosocial aspects of pain in ideal treatment planning.

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Literature Abstract

Effect of the dentin cleansing techniques on dentin wetting and on the bond strength of a resin luting agent

This paper studied the effect of different dentin cleansing techniques on the bond strength of a resin luting agent and dentin wetting. Sixty human molars were prepared until the dentin was exposed and a eugenol-containing provisional cement was applied to the dentin surfaces. After removing the cement with a hand instrument, specimens were divided into 6 groups of 10 specimens each. The dentin surfaces of the specimens were treated with: group S, cleansing agent (Sikko Tim); group C, cleansing agent (Cavity Cleanser); group O, rotary instrument (OptiClean); group OS, rotary instrument preceding Sikko Tim; group OC, rotary instrument preceding Cavity Cleanser; and 10 specimens were untreated (controls, CT). An adhesive resin luting agent (Variolink II) was applied to all specimens. Shear bond strength was measured using a universal testing machine. An additional 6 groups (n = 5) were prepared using the same methods to measure the contact angle. The effect of the dentin cleansing techniques on removing the provisional cement from the dentin surface was examined with scanning electron microscope (SEM). The results indicated that: *(1)* specimens cleaned with any techniques showed higher shear bond strength values than control specimens, except group C; *(2)* the cleansing techniques tested affected the dentin wetting significantly in comparison with the control group, except for groups C and O; and *(3)* no significant difference in wetting were present between groups C and O. The SEM showed different dentin cleansing techniques left different amounts of provisional cement. Specimens treated only with Sikko Tim showed the highest bond strength. The lowest bond strength was obtained with the rotary instrument.

Sarac D, Sarac YS, Kulunk S. Kulunk T. *J Prosthet Dent* 2005;94:363–369. **References**: 18. **Reprints**: Dr Duygu Sarac, Ondokuz Mayis Universitesi, Dis Hekimligi Fakultesi, Protetik Dis Tedavisi AD, 55139 Kurupelit, Samsun, Turkey. Fax: +90 362 457 60 32—*Ansgar C Cheng, Singapore*