The biological concept of “internal derangement and osteoarthrosis”: A diagnostic approach in patients with temporomandibular joint pain?

Rüdiger Emshoff, MD, DMD, a Katharina Innerhofer, MD, b Ansgar Rudisch, MD, c and Stefan Bertram, MD, d Innsbruck, Austria

UNIVERSITY OF INNSBRUCK

Objectives. We sought to investigate whether the finding of temporomandibular joint (TMJ)-related pain may be linked to magnetic resonance (MR) imaging findings of TMJ internal derangement and TMJ osteoarthrosis.

Study design. The study consisted of 194 consecutive TMJ patients. Criteria for including a patient with a painful TMJ were as follow: report of orofacial pain in the TMJ, with the presence of unilateral or bilateral TMJ pain during palpation, function, and unassisted or assisted mandibular opening. Criteria for including a patient with a nonpainful TMJ were as follow: absence of a TMJ with pain during palpation, function, and unassisted or assisted mandibular opening. Application of the criteria resulted in a study group of 150 patients with unilateral TMJ pain, 10 with bilateral TMJ pain, and 34 without TMJ pain. Bilateral sagittal and coronal MR images were obtained to establish the presence or absence of TMJ internal derangement or osteoarthrosis, or both.

Results. A comparison of the TMJ-related data showed a significant relationship between the clinical finding of TMJ pain and the MR imaging diagnoses of TMJ internal derangement (P = .002) and TMJ osteoarthrosis (P = .004). Significant increases in risk of pain occurred with “disk displacement without reduction and osteoarthrosis” (P = .000), “disk displacement without reduction and absence of osteoarthrosis” (P = .000), and “disk displacement with reduction and osteoarthrosis” (P = .036).

Conclusions. The results suggest that TMJ-related pain is correlated with TMJ-related MR imaging diagnoses of internal derangement and osteoarthrosis. The data confirm the biological concept of “internal derangement and osteoarthrosis,” yet re-emphasize that internal derangement and osteoarthrosis may not be regarded as the unique and dominant factors in the definition of TMJ pain.


Temporomandibular joint (TMJ) internal derangement is one of the most common forms of temporomandibular disorders (TMD). The term refers to clinical criteria used in the classification of TMJ disorders but is generally used to denote an abnormal positional relationship of the articular disk to the mandibular condyle and the articular eminence. These disorders have been associated with characteristic clinical findings such as pain, joint sounds, and irregular or deviating jaw function.1,2 With the rapid progress in TMJ imaging techniques, the biological concept of “internal derangement and osteoarthrosis” was developed to emphasize that these conditions are the underlying mechanisms in the pathogenesis of TMJ-related pain and dysfunction.3,4 Mechanical disturbances were regarded as etiologic in the production of an imbalance between anabolic and catabolic processes, progressive cartilage degradation, and secondary inflammatory components,5 whereas therapeutic procedures such as splint therapy,6,7 arthrocentesis,8,9 arthroscopic lysis and lavage,10,11 and arthrotoomy12,13 were described primarily to address the reduction of TMJ loading and the restoration of normal TMJ function and structure. However, the question of whether the diagnostic variables of internal derangement and osteoarthrosis are making a significant biological contribution to the risk for pain and dysfunction remains a point of controversy.14,15

Magnetic resonance (MR) imaging is currently the most accurate imaging modality for identification of disk positions of the TMJ and may be regarded as the gold standard for disk position identification purposes.16 A study on observer variation that used the classification system proposed by Tasaki et al17 has shown a low level of intraobserver and interobserver variability.18 Osteoarthrotic changes were diagnosed with MR imaging according to the previously described criteria.16,19

The purpose of the present study was to investigate whether TMJ-related pain may be correlated with the
MR imaging diagnoses of TMJ internal derangement and TMJ osteoarthrosis.

MATERIAL AND METHODS

From January 1998 to May 2000, 578 patients were referred from medical practitioners and dentists in the community to the Orofacial Pain and TMD Clinic in the Department of Oral and Maxillofacial Surgery at the University of Innsbruck. This clinic is the primary referral center for TMD at the institution in that both conservative and surgical treatments are offered. Patients were referred to the center for treatment. They reported pain and dysfunction of the temporomandibular region as the primary problem. Of these patients, 275 underwent MR imaging of the TMJ.

The study group finally consisted of 194 consecutive TMJ patients. There were 152 females and 42 males, aged between 17 and 79 years (mean age, 36.0 years). The subjects were informed about the study procedure, and consent was received. Criteria for including a patient with TMJ pain were report of orofacial pain in the TMJ, with the presence of unilateral or bilateral TMJ pain during palpation, function, and unassisted or assisted mandibular opening. Criteria for including a patient with a nonpainful TMJ were absence of a TMJ pain during palpation, function, and unassisted or assisted mandibular opening. Patients assigned a TMD diagnosis of myalgia, degenerative joint disease, or collagen vascular disease and patients with a history of trauma were not included in this study. Application of the criteria resulted in a study group of 150 patients with TMJ pain during palpation, function, and unassisted or assisted mandibular opening. Patients assigned a TMD diagnosis of myalgia were referred to the Orofacial Pain and TMD Clinic in the institution in that both conservative and surgical treatments are offered.

To determine whether findings of TMJ pain may be linked to MR imaging findings of TMJ internal derangement and TMJ osteoarthrosis, the subjects underwent clinical and MR imaging investigation. One clinician (R.E.) performed the clinical evaluation on the subject, and, every time the patient underwent clinical investigation, MR imaging was performed immediately afterward. Because the study was double-blinded, the clinical records and images were interpreted by the clinician and radiologist independently, without knowledge of the results of the other investigator.

The clinical assessment consisted of a standardized evaluation of the signs and symptoms of TMD, including mandibular range of motion, joint sounds, muscle and joint pain on palpation, and pain on mandibular function.20

Mandibular range of motion was evaluated for maximum opening and lateral movements. Maximum opening was measured from the central maxillary incisor to the opposing mandibular incisor on a millimeter ruler. Lateral movements were measured relative to the maxillary midline with the teeth slightly separated. The TMJs were auscultated with a stethoscope, with the subject performing 3 openings and 3 lateral and protrusive movements. These were described as single clicks and reciprocal clicks.

TMJ pain on palpation was assessed by means of bilateral manual palpation of the lateral aspect of the condyle. The parameter of TMJ pain during unassisted mandibular opening was assessed by asking the patient to perform maximum voluntary jaw opening. Assisted opening was performed by the application of force to the lower and upper incisors with the middle finger and thumb. A positive pain score was recorded by the examiner if a patient experienced a distinctly painful sensation in the TMJ during the procedure.

Pain of the muscles was assessed as positive or negative by a bilateral manual palpation technique. The following sites were palpated: the anterior, posterior, and middle temporalis; the tendon of temporalis; the superficial and deep masseters; the lateral pterygoid; and the anterior and posterior digastric muscle. A diagnosis of myalgia was assigned if palpation produced a clear reaction from the patient (ie, if the patient experienced a distinctly tender or painful sensation in 2 or more muscle sites, with muscle palpation pain of 2 or more on a 0 to 3 severity scale).21

Clinical decision criteria for a TMJ diagnosis of degenerative joint disease included presence of hard grating or crepitus during mandibular range of motion.21 There was no access to tomographic films for the evaluation of the osseous structure of the TMJ.

MR IMAGING

MR imaging was carried out with a 1.5T MR scanner (Vision; Siemens AG, Erlangen, Germany) and a dedicated circular-polarized transmit-and-receive TMJ coil. The data were collected on a 252 × 256 matrix with a field of view of 145 mm, giving a pixel size of 0.60 × 0.57 mm. With the patient in a supine position, 15 coronal slices and 8 parasagittal slices were obtained of each TMJ using a TSE-PD sequence (TR, 2800 ms; TE, 15 ms), with thin slices of 3 mm. MR images were corrected to the horizontal angulation of the long axis of the condyle. Each subject received an individual nonferromagnetic intermaxillary device to obtain the different mouth-opening positions. Sequential bilateral images were made at the closed-mouth and the respective maximum mouth-opening positions. Those images were selected for analysis of the disk-condyle relationship that depicted the disk, condyle, articular eminence, and glenoid fossa. Normal disk position was defined by the location of the posterior band of the disk at the superior or 12 o’clock position relative to the
condyle, whereas disk displacements were defined by the location of the posterior band relative to the superior part of the condyle. Diagnosis of TMJ disk-condyle relationship was categorized as normal and disk displacement with reduction and disk displacement without reduction; the relationship was defined according to the finding of a closed-mouth–related diagnosis of absence or presence of disk displacement associated with or not associated with an open-mouth–related interposition of the disk between the condyle and the articular eminence.3 MR imaging diagnosis of TMJ osteoarthrosis was defined by the presence of flattening, subchondral sclerosis, surface irregularities, and erosion of the condyle or presence of condylar deformities associated with flattening, subchondral sclerosis, surface irregularities, erosion, and osteophytes.4,16

DATA ANALYSIS

Univariate analysis of variance and chi-square analysis were used to control for possible differences in age and sex between the clinical TMJ pain–related variables. The TMJ-related MR imaging findings of internal derangement and osteoarthrosis were statistically assessed by chi-square analysis. A logistic regression analysis was used for assessment of the relative odds of each MR imaging diagnosis. Significance was set as $P < .05$. For all statistical analysis, the SPSSx package (SPSS Inc, Chicago, Ill, 1997) was used.

RESULTS

The distribution of the age and sex of the subjects is presented in Table I. There was no significant difference in age ($P = .920$) or sex ($P = .297$) between the clinical variables of absence and presence of TMJ pain.

An MR imaging diagnosis of TMJ internal derangement was established in 252 of 388 TMJs (64.9%; Table II): 107 TMJs were found to have a TMJ internal derangement type of disk displacement with reduction (27.6%) and 145 had disk displacement without reduction (37.4%). Analysis of side-related data showed a significant relationship between the clinical finding of TMJ pain and the MR imaging diagnoses of TMJ internal derangement ($P = .002$; Table II).

With respect to the distribution of TMJ osteoarthrosis established in 176 of 388 TMJs (45.4%; Table III), 49 (27.8%) were associated with an MR imaging diagnosis of absence of TMJ internal derangement and 36 (20.5%) and 91 (51.7%) with those of disk displacement with reduction and disk displacement without reduction, respectively. There was a significant relationship between the clinical finding of TMJ pain and the MR imaging diagnoses of TMJ internal derangement ($P = .002$; Table II).

The odds ratio that an individual TMJ with an MR imaging diagnosis of “disk displacement without reduction and osteoarthrosis” or “disk displacement without reduction and absence of osteoarthrosis,” or both, might belong to the TMJ pain group was very strong (3.7:1 and 3.5:1) and highly significant ($P = .000$). In addition, there was an increased probability that instances of an MR imaging diagnosis of “disk displacement with reduction and osteoarthrosis” might be associated with TMJ pain (2.4:1 odds ratio; $P = .036$). There was no significant increase in the odds ratio to indicate that a TMJ with an MR imaging diag-

### Table I. Age and sex distribution (n = 388)

<table>
<thead>
<tr>
<th>Clinical diagnosis</th>
<th>Male</th>
<th>Female</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of TMJ pain</td>
<td>41</td>
<td>129</td>
<td>170</td>
</tr>
<tr>
<td>Absence of TMJ pain</td>
<td>43</td>
<td>175</td>
<td>218</td>
</tr>
<tr>
<td>Sum</td>
<td>84</td>
<td>304</td>
<td>388</td>
</tr>
</tbody>
</table>

*TMJ, Temporomandibular joint; N, number of TMJs.

### Table II. Relationship between MRI diagnosis of internal derangement and TMJ pain (n = 388)

<table>
<thead>
<tr>
<th>MRI diagnosis</th>
<th>Painful side (%)</th>
<th>Nonpainful side (%)</th>
<th>Sum (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence of internal derangement</td>
<td>45 (26.5)</td>
<td>91 (41.7)</td>
<td>136 (35.1)</td>
</tr>
<tr>
<td>Presence of internal derangement</td>
<td>125 (73.5)</td>
<td>127 (58.3)</td>
<td>252 (64.9)</td>
</tr>
<tr>
<td>Sum</td>
<td>170 (100)</td>
<td>218 (100)</td>
<td>388 (100)</td>
</tr>
</tbody>
</table>

*MRI, Magnetic resonance imaging.

Chi-square = 9.786; $P = .002$; df = 1.
nosis of “absence of internal derangement and presence of osteoarthrosis” (2.0:1; \(P = .069\)) or “disk displacement with reduction and absence of osteoarthrosis” (1.3:1; \(P = .398\)) would belong to the TMJ pain group (Table IV).

**DISCUSSION**

The results of MR imaging in the present study showed that TMJ pain was associated with a high rate of TMJ internal derangements (64.9%). This observation compares favorably with the results of other authors reporting prevalences ranging from 77% to 89%\(^\text{17,22}\) of TMJ internal derangement in TMD populations, although prevalence rates in symptom-free subjects have been described as ranging from 30% to 39%.\(^\text{17,22}\) Ongoing studies involving a large number of subjects with and without TMD, as well as more specified inclusion criteria, may be warranted to demonstrate any TMD-specific effect of internal derangement and internal derangement types.

This study revealed a significant relationship between the presence of TMJ pain and the MR imaging diagnoses of TMJ internal derangement, the results of which may be regarded as comparable with those of previous studies reporting that in patients with TMD pain and dysfunction, the affected TMJ side may be associated with high MR imaging–related prevalences of TMJ internal derangement, with reported figures ranging from 69.5% to 100%.\(^\text{17-27}\) These findings may support the concept that TMJ internal derangement is significantly involved in the production of TMJ pain and dysfunction. However, given the fact that TMJ internal derangement alone is not always associated with pain and dysfunction and that several imaging studies have also demonstrated the occurrence of bilateral TMJ internal derangement with frequencies ranging from 51% to 71%,\(^\text{17,22,27-30}\) more data may be necessary if TMJ internal derangement is to become generally accepted as a diagnostic guide in the management of patients with TMJ-related TMD, especially for patients for whom surgery is under consideration.

This study confirms MR imaging to be a valuable diagnostic method for measuring local TMJ-related signs of osteoarthrosis.\(^\text{16,19,26}\) With respect to the prevalence of TMJ osteoarthrosis (45.4%), the findings correspond with those in the reports of other authors who described frequencies of imaging signs of TMJ osteoarthrosis in patients with TMD as ranging from 11.4% to 58%.\(^\text{26,31,32}\) The finding of a significant relationship between structural TMJ osteoarthrosis changes and TMJ-related findings of pain may contrast with the results of several authors reporting high prevalences of radiographic signs of osteoarthrosis in asymptomatic TMJs ranging from 50% to 90%.\(^\text{31,33,34}\) However, the fact that prevalences of TMJ osteoarthrosis are reported with great variations in the literature and that multiple-factor studies using specific clinical and imaging criteria for diagnosing TMJ osteoarthrosis are still lacking indicates the necessity for further investigations to test the hypothesis that patients with TMJ-related TMD with specific clinical symptoms do not differ from control subjects with regard to the presence of specific imaging signs of TMJ osteoarthrosis.\(^\text{35}\)

### Table III. Relationship between MRI diagnosis of osteoarthrosis and TMJ pain (n = 388)

<table>
<thead>
<tr>
<th>MRI diagnosis</th>
<th>Painful side (%)</th>
<th>Nonpainful side (%)</th>
<th>Sum (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence of osteoarthrosis</td>
<td>79 (46.5)</td>
<td>133 (61.0)</td>
<td>212 (54.6)</td>
</tr>
<tr>
<td>Presence of osteoarthrosis</td>
<td>91 (53.5)</td>
<td>85 (39.0)</td>
<td>176 (45.4)</td>
</tr>
<tr>
<td>Sum</td>
<td>170 (100)</td>
<td>218 (100)</td>
<td>388 (100)</td>
</tr>
</tbody>
</table>

Chi-square = 8.146; \(P = .004\); df = 1.

### Table IV. Risk and relative odds of TMJ pain as a function of MRI diagnoses of TMJ internal derangement and TMJ osteoarthrosis (n = 388)

<table>
<thead>
<tr>
<th>MRI diagnosis</th>
<th>Odds ratio</th>
<th>95% CI</th>
<th>Chi-square</th>
<th>(P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk displacement without reduction and presence of osteoarthrosis</td>
<td>3.661</td>
<td>1.94-6.86</td>
<td>17.029</td>
<td>.000</td>
</tr>
<tr>
<td>Disk displacement without reduction and absence of osteoarthrosis</td>
<td>3.538</td>
<td>1.73-7.24</td>
<td>12.454</td>
<td>.000</td>
</tr>
<tr>
<td>Disk displacement with reduction and presence of osteoarthrosis</td>
<td>2.349</td>
<td>1.05-5.26</td>
<td>4.418</td>
<td>.036</td>
</tr>
<tr>
<td>Disk displacement with reduction and absence of osteoarthrosis</td>
<td>1.340</td>
<td>0.68-2.65</td>
<td>0.714</td>
<td>.398</td>
</tr>
<tr>
<td>Absence of internal derangement and presence of osteoarthrosis</td>
<td>1.969</td>
<td>0.94-4.11</td>
<td>3.302</td>
<td>.069</td>
</tr>
</tbody>
</table>
The present study provides another perspective on the contribution of MR imaging variables to TMJ pain and may have an impact on the presumptive terms internal derangement and degenerative joint disease, which consider TMJ imaging variables of the disk-condyle relationship and osteoarthrosis to be diagnostic for disease. Although the MR imaging parameter of disk displacement with reduction and osteoarthrosis—traditionally believed to be influential—contributed in only a minor way to the change in risk, a clear definition of the TMJ pain group was only evident for the disk displacement without reduction variable and involved only a few TMJs. Therefore, on the basis of this study, internal derangement and osteoarthrosis may not be considered the unique and dominant factors in the definition of TMJ pain. Further investigations are necessary to answer the question 'which additional TMJ-related features may have to be defined as diagnostic for disorder or normal,' namely with or without significant elevated risk for pain and dysfunction.

In terms of clinical decision making, the findings raise the question of whether the use of clinical TMJ-related TMD diagnoses may need to be supplemented with MR imaging to distinguish among subtypes of TMD. From a methodologic point of view, the etiology, prognostic statements, and implications for treatment are considered to be the main indicators of the efficacy of diagnostic classifications. Further research may be warranted to assess the diagnostic validity of MR imaging-related variables of TMJ internal derangement and osteoarthrosis by determining how well these diagnoses may show decisive differences in the areas of pathogenesis, treatment, or prognosis.

With the rapid progress made in TMJ imaging techniques, many studies have focused on the importance of internal derangement and osteoarthrosis as the underlying mechanisms in the etiology of TMJ-related pain and dysfunction. The biological concept of TMJ internal derangement and TMJ osteoarthrosis as closely related entities in the production of TMJ pain and dysfunction has been emphasized by several authors and the conditions were regarded as requiring surgical correction when conservative treatment failed to improve severe TMJ-related signs and symptoms. However, the question of whether TMJ internal derangement and TMJ osteoarthrosis are the result, the cause, or an accompanying factor remains a point of controversy. With the introduction of TMJ arthroscopy and synovial fluid analysis the "synovitis and osteoarthritis" concept was developed, emphasizing these conditions as the underlying mechanisms in the pathogenesis of TMJ-related pain and dysfunction. Factors such as direct mechanical injury, hypoxic perfusion, and neurogenic inflammation were regarded as etiologic in the production of synovitis, cartilage degeneration, and osteoarthritis, whereas therapeutic procedures were described primarily to address the reduction of TMJ loading and the restoration of TMJ mobility.

CONCLUSION

The data confirm the biological concept of internal derangement and osteoarthrosis; however, they also re-emphasize that the prediction of pain is not a matter of simple linearity in which the presence of one risk factor may equate with predictive ability.

REFERENCES

16. Tasaki MM, Westesson PL. Temporomandibular joint: diag-

Reprint requests:
Rüdiger Emshoff, MD, DMD
Hohenstraße 5
A-6020 Innsbruck
Austria
Maxillofaziale-Chirurgie@uibk.ac.at