Disc and condyle translation in patients with temporomandibular disorder

Shigeyuki Takatsuka, DDS, PhD, Kan Yoshida, DDS, Koichiro Ueki, DDS, PhD, Kohei Marukawa, DDS, PhD, Kiyomasa Nakagawa, DDS, PhD, and Etsuhide Yamamoto, DDS, PhD, Kanazawa, Japan

KANAZAWA UNIVERSITY GRADUATE SCHOOL OF MEDICINE

Objective. The purpose of this study was to elucidate causal relationship between disc and condyle range of movement and clinical signs and symptoms in patients with temporomandibular disorders (TMD), using magnetic resonance imaging (MRI).

Study design. The subjects comprised of a study group of 191 patients with TMD and a control group of 43 asymptomatic patients. The clinical assessment consisted of range of maximum mouth opening (MMO) and preauricular pain during mandibular function. After clinical and radiographic findings assessment, disc and condyle condition were examined by MRI and the range of movement was accordingly classified.

Results. Disc displacement was observed in 156/191 (81.7%) of the study group and 9/43 (20.9%) of the control group. When disc and condyle mobility was presented around the eminence, wider MMO range was maintained, P < .05. Presence of osteoarthrosis (OA) was not correlated with preauricular pain, because OA variables were mild in the study group.

Conclusion. Maintenance of disc/condyle translation is an important factor in TMJ function, irrespective of disc displacement or arthritis.


Internal derangement (ID) of the temporomandibular joint (TMJ) is accepted as the most common form of temporomandibular disorder (TMD). Advanced studies with magnetic resonance imaging (MRI) have shown the direction of displaced disc position variously. In patients with ID of the TMJ, anterolateral and anterior disc displacements were the most frequent type of disc displacement. Accompanied clinical findings of ID are generally characterized by pain, joint sounds, and limited jaw motion. Osteoarthrosis (OA) of the TMJ is frequently encountered in accord with progression of ID. Advanced research with arthroscopy has suggested that ID progresses as friction between the articulating surfaces increases. An increase of friction on the articulating surfaces causes rupture and breakdown of translation system by the load, resulting in fibrous adhesion, disc displacement, and subsequently disc perforation and arthritic changes of the condyle.

Alternatively, dislocation of the articular disc is encountered in the TMJ of the healthy volunteers. According to Katzberg et al, almost 33% of the TMJ of asymptomatic volunteers showed anterior disc displacement under MRI evaluation. Similarly, spontaneous resolution of the clinical signs and symptoms of chewing and mouth opening disturbances may take place in affected ID patients with disc displacement. If disc displacement was not always linked to clinical disturbances, then what was the other factor affecting the patients with ID? Interestingly, recovery of disc and/or condyle mobility is presented in such cases with spontaneous resolution of the clinical signs and symptoms or in patients who underwent arthroscopic lysis and lavage. Therefore, the causal relationship between disc/condyle mobility and symptom severity was hypothesized, irrespective of the degree or direction of disc displacement or the presence of OA. Consequently, in cases with condylar translation being maintained, least functional impairment of the TMJ may be expected.

In the present study, the causal relationship between disc and condyle range of movement and the clinical signs and symptoms were examined in patients with ID, and the presence of OA affecting the findings have been evaluated.

MATERIAL AND METHODS

The subjects comprised a study group of 191 ID patients with painful TMJs and a control group of 43 nonpainful TMJ patients. The study group consisted of 31 male and 162 female patients, ages 13 to 84 years (mean 37.8 ± 15.6), at the outpatient clinic in the Department of Oral and Maxillofacial Surgery at
Kanazawa University for conservative therapy or surgical treatment. All the patients in the study group complained of pain and dysfunction in the TMJ at the time of first examination. Immediately after the physical and radiographic diagnosis, the disc of TMJ and condyle were examined by MRI. The control group had no history of TMJ pain or dysfunction and were also asymptomatic at the time of MRI assessment. The study program was explained to both study and control groups, and informed consent was given. Inclusion criteria for the enrollment of the study group were the presence of current preauricular pain during palpation, function, and unassisted and assisted mandibular opening, a report of postauricular and/or ramus and temporal area pain referred to the TMJ, and limited jaw motion. After the subjects underwent clinical and MRI investigation, the clinical evaluation was performed by 2 oral surgeons.

The clinical assessment consisted of a standardized evaluation of interincisal mandibular range of motion and TMJ pain during function. Range (mm) of motion was measured in maximum mouth opening (MMO) and lateral movement by a ruler. MMO was measured from the central maxillary incisor to the opposing mandibular incisor, and then lateral movements were measured relative to the maxillary midline with the teeth slightly separated. TMJ pain during mandibular function was evaluated by means of bilateral manual palpation of the lateral aspect of the condyle. Subjective visual analog scale of pain (VAS), with 0 for no pain and 100 for intolerable pain, was assessed during unassisted mandibular opening by asking the patient to perform maximum voluntary jaw opening. This scoring was also applied during assisted opening that was performed by the application of force to the lower and upper incisors with the middle finger and thumb.
TMJ sounds during movement were auscultated with a stethoscope during opening, lateral, and protrusive movements.

MRI

MRI assessment of each pair of TMJs in all subjects was carried out with a 1.5-tesla MRI system (Signa Scanner, General Electric Medical Systems; Milwaukee, Wis), using bilateral 3-inch dual surface coils with the jaw first in the closed resting position and then at the maximally open position. An initial axial localizer was introduced in order to obtain exact midcondylar sections of the mandibular condyles. For the protocol the images of bilateral orthogonal sagittal planes of both TMJs in the closed jaw position were acquired first, using a repetition time (TR) of 2000 msec, echo times (TEs) of 20 msec, 3 mm image slice thickness, and a field of view of 10 cm. This was followed by the acquisition of bilateral sagittal plane images in the open mouth position with a TR of 1000 msec and TEs of 20 msec.

In order to assess disc displacement and mobility, the following criteria were established. Normal disc position was defined as the posterior band of the disc being located at the superior or 12 o’clock position relative to the condyle. Primary categories of the status of the joint that were tabulated were (1) normal disc position, (2) disc displacement with reduction, and (3) disc displacement without reduction. Disc displacement was defined as the posterior band of the disc being in an anterior, anteromedial, anterolateral, medial, or lateral position relative to the superior part of the condyle as the reference point.1-4

Mobility of the disc and the mandibular condyle was classified as positive, limited, or negative. Positive translation was defined as forward and downward movement of the superior point of condyle along the posterior slope of the articular eminence more than two-thirds from the deepest point of the fossa to the greatest height of the articular eminence. Limited translation of the condyle was defined as being less than two-thirds of the movement, and negative was defined as no translation. Mobility of the disc was defined in accordance with translation range of the condyle. Positive movement of the disc was found to correlate with either positive or limited condylar translation. Limited movement of the disc was found to correlate with reduced movement of the disc during either positive or limited condylar

Fig 2. Disc displacement without reduction, showing positive condylar translation and limited disc movement. A, Closed position; folded disc is positioned anteriorly, minimal flattening of condyle. B, Open position; condyle moved to eminence, and the disc showed some movement, 34 mm of MMO noticed.
translation. Negative was defined as having no disc movement. Condylar shape with normal and minimal flattening was defined as absence of OA. Conversely, those with flattening, erosion, subchondral sclerosis, surface irregularity, and osteophyte were defined as presence of OA (Figs 1-5). Distribution of these OA patients in subgroups has appeared as OA index.

Data analysis
Chi-squared analysis was carried out to examine for the relationship of OA between disc displaced and normal positioned disc subgroups based on MRI findings. Difference of vertical MMO and VAS of preauricular pain during unassisted maximum mouth opening among subgroups of the study group was evaluated using the Mann-Whitney U test. Significance was set at \( P < .05 \). Stat View (Abacus Concepts; Berkeley, Calif) was used for all statistical analyses.

RESULTS
Disc displacement was observed in 156/191 (81.7%) of the study group and 9/43 (20.9%) of the control group. Positive condylar translation was noticed in 84 cases, limited condylar translation was noticed in 90 cases, and there were 17 cases of negative translation in the study group (Table I). Displaced-disc patients in the study group were categorized according to translation of the condyle and mobility of the disc. Then the mean value of vertical maximum mouth opening MMO (mm) was calculated (Table II). The presence of OA, indicated as OA index, shown in the present findings was restricted to flattening, erosion, and osteophyte. Almost all symptoms of OA were mild; distribution of OA (OA index) and VAS of preauricular pain during unassisted maximum mouth opening in accordance with presence or absence of OA are summarized in Table III. Clinical findings of the patients with normal disc position in the study group are summarized in Table IV.
There was no significant statistical difference of clinical findings between disc displacement without reduction and normal disc position subgroups, except for the incidence of OA (OA index), \( P < .05 \). Among displaced-disc patients, the condyle and disc translation—positive subgroup was compared to other subgroups, and significant difference was noticed on limited and negative disc mobility patients of the positive and limited condyle translation subgroup (Table V). However, there was no significant difference in VAS scores between presence or absence of OA in disc displacement without reduction subgroups.

**DISCUSSION**

The results of the present MRI study showed presence of wider range of maximum mouth opening in ID patients when positive (normal) disc and condylar translation were presented. Generally, TMJ pain is associated with MRI diagnoses of ID and OA; however, the factor of OA is not necessarily linked to progressive functional disturbance in affected TMJs, including pain and limited jaw movement. For comparatively mild OA variables restricted to flattening, mild erosion, and osteophyte, no significant difference might be found in the current study between OA presence and VAS scores.

Disc displacement is a commonly accepted condition in ID of the TMJ, and which is realized by increased friction of the articulating surfaces, causing reduced disc/condyle mobility and frequently resulting in OA of the condyle and eminence.\(^{12,13}\) Emshoff et al showed strong causal relationship between TMJ pain and ID of the TMJ, especially in patients with disc displacement without reduction.\(^{1,2}\) However, an interrelationship among ID, disc displacement, and disc/condyle translation is not fully proven yet. As reported variously, disc displacement is frequently found in healthy volunteers under MRI studies.\(^{9-11}\) Katzberg et al found disc displacement in 33% of asymptomatic subjects and
77% of symptomatic subjects. Although the incidence of disc displacement in asymptomatic subjects is low compared to those in symptomatic subjects, existence of disc displacement in asymptomatic subjects is an established finding among MRI studies.\(^8\)

Although an increase of VAS score was noticed as translation range declined, presence or absence of OA did not statistically correlate to VAS score in the present study. Brooks et al found osseous changes of the condyle and/or eminence in approximately 35% of younger asymptomatic subjects without ID.\(^14\) However, these condyles did not typically include such advanced changes as erosion, osteophyte, or sclerosis, or osseous alterations in asymptomatic subjects without ID were confined to minimal flattening. This result might be consistent with the present findings that for mild OA

**Fig 5. Disc displacement without reduction, showing negative condylar translation and negative disc movement.**

- **A.** Closed position; folded disc and osteophyte on the condyle.
- **B.** Open position; no movement showing both disc and condyle, 20mm of MMO noticed.

**Table I.** The incidence of disc-condyle relationship between study and control group

<table>
<thead>
<tr>
<th>Condylar translation</th>
<th>Study group (n = 191)</th>
<th>Control group (n = 43)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal disc position</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>Disc displacement with reduction</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Disc displacement without reduction</td>
<td>60</td>
<td>77</td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>90</td>
</tr>
</tbody>
</table>

*Pos.*, positive; *Limit.*, limited; *Neg.*, negative.
confined to flattening, erosion, and osteophyte, there is no significant statistical difference between OA presence and VAS scores.

Patients with disc displacement without reduction frequently show reduced translation of disc and condyle. In the study group 14 patients with ID and 3 without ID presented with no disc and condyle mobility. Their limited MMO range suggests occurrence of anchored disc phenomenon or fibrous adhesion. According to Nitzan’s hypothesis, anchored disc phenomenon occurs when uncontrolled reactive oxygen species mediate breakdown of the joint lubrication system, thus initiating this adhesion of the disc to the fossa. Advancement in the biochemical analysis of synovial fluid will assist in classifying degenerative stages of ID of the TMJ.

Fibrous adhesion of the upper joint compartment has been thoroughly investigated under arthroscopic studies. The cause of ID progress depends much on this adhesion derived from reduced lubrication and increased friction. Dijkgraaf et al diagnosed TMJ disorder in arthroscopic studies of articular cartilage degradation in the upper joint compartment corresponding to OA progress. Therefore, successful arthroscopic surgery is proposed to perform lysis and lavage of the upper joint compartment. This aspect is different from

### Table II. MRI diagnosis of disc-condyle relationship and vertical MMO range in patients presenting disc displacement without reduction

<table>
<thead>
<tr>
<th>Condylar translation</th>
<th>Pos. (n = 60)</th>
<th>Lmt. (n = 77)</th>
<th>Neg. (n = 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc mobility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>22</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>MMO (mm) mean ± SD</td>
<td>37.6 ± 7.4</td>
<td>30.2 ± 6.2</td>
<td>32.3 ± 8.5</td>
</tr>
</tbody>
</table>

Pos., positive; Lmt., limited; Neg., negative; MMO, maximum mouth opening.

### Table III. MRI diagnosis of disc-condyle relationship and pain in patients presenting disc displacement without reduction in accord with OA presence

<table>
<thead>
<tr>
<th>Condylar translation</th>
<th>Pos. (n = 60)</th>
<th>Lmt. (n = 77)</th>
<th>Neg. (n = 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc mobility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>22</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>OA index (%)</td>
<td>72.7</td>
<td>61.1</td>
<td>45.0</td>
</tr>
<tr>
<td>VAS (0-100) Presence of OA</td>
<td>55 ± 10</td>
<td>60 ± 12</td>
<td>60 ± 15</td>
</tr>
<tr>
<td>VAS (0-100) Absence of OA</td>
<td>45 ± 15</td>
<td>40 ± 10</td>
<td>50 ± 10</td>
</tr>
</tbody>
</table>

Pos., positive; Lmt., limited; Neg., negative; OA index, distribution of OA presence; VAS, visual analog scale of pain.

### Table IV. MRI diagnosis of disc-condyle relationship and clinical findings in patients with normal disc position

<table>
<thead>
<tr>
<th>Condylar translation</th>
<th>Pos. (n = 19)</th>
<th>Lmt. (n = 13)</th>
<th>Neg. (n = 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc mobility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>14</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>MMO (mm) mean ± SD</td>
<td>41.8 ± 13.3</td>
<td>22.5</td>
<td>42.3</td>
</tr>
<tr>
<td>VAS (0-100)</td>
<td>40</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>OA index (%)</td>
<td>42.9</td>
<td>50.0</td>
<td>33.3</td>
</tr>
</tbody>
</table>

Pos., positive; Lmt., limited; Neg., negative; MMO, maximum mouth opening; VAS, visual analog scale of pain; OA index, distribution of OA presence.

### Table V. Statistical analysis of the maximal open range between disc displacement without reduction presenting positive condyle and disc mobility and others

<table>
<thead>
<tr>
<th>Condylar translation</th>
<th>Positive</th>
<th>Limited</th>
<th>Negative</th>
<th>Positive</th>
<th>Limited</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc mobility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P value</td>
<td>*.0053</td>
<td>*.0462</td>
<td>.0523</td>
<td>*.0001</td>
<td>*.0003</td>
<td></td>
</tr>
</tbody>
</table>

*Significant difference, $P < .05$, Mann-Whitney U test.
conventional treatment strategy for anatomic reduction of the displaced disc. After smoothing of fibrillated cartilaginous surfaces, the adaptive capacities of the joint tissues have the opportunity to balance the increased tissue degradation in OA. Final recovery of the translation of the disc and condyle will be the treatment goal of ID or OA of the TMJ. This concept supports the results of the present study that ID and OA patients with normal disc and condyle translation presented almost normal range of MMO, more than 35 mm.

The results of the present study suggest that disc and condyle translation is an important factor of function of the TMJ, irrespective of disc displacement without reduction. Although ID and OA correspond to pain at mandibular movement, this pathologic change can be managed with arthrocentesis or arthroscopic surgery. Owing to the finding, the concept of lysis and lavage of the fibrous adhesion in the joint compartment takes a primary important role for treatment of ID and OA of the TMJ.

REFERENCES


Reprint requests:
Shigeyuki Takatsuka, DDS, PhD
Oral & Maxillofacial Surgery, Graduate School of Medicine
Kanazawa University
13-1, Takaramachi, Kanazawa, Ishikawa, 920-8640, Japan
takataka@oral.m.kanazawa-u.ac.jp

Volume 99, Number 5 Takatsuka et al 621