Temporomandibular Joint Structural Derangement and General Joint Hypermobility

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Aim: *To explore the relationship between general joint hypermobility (GJH) and displacement of the temporomandibular joint (TMJ) disc as evident from magnetic resonance imaging (MRI).* ***Methods:*** *Fifth finger extension, thumb apposition, elbow extension, knee extension, trunk flexion, and ankle dorsiflexion were measured in 66 young female patients with MRI-evident TMJ internal derangement (ID) and in 30 age-matched female controls. The Beighton score of each subject was measured quantitatively. The possible association between TMJ ID and mobility of a single joint or index of GJH, ie, the Beighton score, were assessed with one-way ANOVA with post-hoc Bonferroni and chi-square test, respectively. Correlations of the mobility of every measured joint were also explored.* ***Results:*** *Very few of the TMJ ID patients and control subjects were diagnosed with GJH according to the Beighton score. The Beighton score did not differentiate between subjects with and without TMJ ID. Subjects with TMJ ID, especially patients with MRI-evident disc displacement without reduction, seemed to have a stiffer trunk than controls, but this may not be of clinical relevance. The mobilities of paired joints were significantly correlated; however, the mobilities of different anatomical joints seemed to be independent.* ***Conclusion:*** *Based on the Beighton score, GJH does not seem to be a reliable indicator of the presence of TMJ ID.* J OROFAC PAIN 2012;26:33–38

Key words: Beighton score, general joint hypermobility, internal derangement, temporomandibular joint

Magnetic resonance imaging (MRI) has improved our knowledge of temporomandibular joint (TMJ) internal derangement (ID). Nevertheless, it is still unclear why the TMJ disc becomes anteriorly displaced. It has been suggested that the altered disc position can be related to elongation, tear, or rupture of the capsule or ligaments.[1] Tissue alterations have been shown not only within the displaced disc proper but also in its peripheral attachments.[2] These tissue alterations might be a consequence of unfavorable ectopic loading following disc displacement; however, the possibility that impairment of the peripheral disc attachment had already existed prior to disc displacement could not be excluded. Such a hypothesis can be partly supported by the observation that in patients with connective tissue defects, such as Marfan syndrome and Ehlers-Danlos syndrome, there is a higher risk of developing TMJ ID.[3,4]

Dijkstra et al critically reviewed 14 studies related to general joint hypermobility (GJH) and temporomandibular disorders (TMD).[5]

After critical assessment of the quality of study design, only four studies were selected for further analyses. Logistic regression analysis using raw data from three of them yielded an approximately five-times higher chance to develop TMD in the presence of GJH (odds ratio 5.4). The subsequent sensitivity analysis indicated that including or excluding studies from the meta-analysis had considerable consequence for the results. Furthermore, to test the influence of the methodologic quality of the reviewed papers, the authors excluded from the analysis the one with the lowest methodologic score. The calculated Fisher-exact test yielded no association between GJH and TMD. Therefore, the authors concluded that the review could not be conclusive as to whether a relationship between TMJ disorders and GJH exists. In addition, the study suggested that the hypermobility assessment technique might influence the association between GJH and TMJ disorders.

A further problem with most of the studies analyzed by Dijkstra et al[5] is that they assessed the presence of TMJ ID not by means of magnetic resonance imaging (MRI) but by clinical examination. As demonstrated by Huddleston Slater et al,[6] TMJ ID cannot be reliably diagnosed with a clinical examination. Therefore, the lack of a gold standard to indicate the presence of ID might also account for the different study results.

Assessment of the range of motion (ROM) of normal TMJs and those with an ID should be the best strategy to test whether the ID is associated with GJH. However, because of the displaced disc, mandibular mobility is often limited in TMJ ID, especially in the acute phase but also in the chronic phase. One possibility to overcome this problem is to use the ROM of other joints, provided that the degrees of mobility of different peripheral joints are correlated.

The aim of this study was to explore the relationship between GJH and displacement of the TMJ disc as evident from MRI.

Materials and Methods

Patients

The MRI database of the authors' TMD clinic was reviewed to find female patients with at least one TMJ with ID and who were still under active treatment or follow-up within the study period. These patients were invited to participate in this study. Exclusion criteria were the intake of steroids or hormones during the last 6 months. From this list, 56 young female patients (18 to 30 years of age) agreed to take part in the study. Forty age-matched asymptomatic female subjects (18 to 29 years of age) were recruited to serve as controls. However, 10 of these asymptomatic subjects had at least one TMJ with ID as diagnosed by MRI. These 10 subjects were thus recruited as TMJ ID patients. Therefore, the final sample consisted of 66 patients and 30 controls. The subjects recruited in this study were the same as those who had participated in the authors' previous study on the relationship between bone mineral density and TMJ ID.[7] The study protocol was approved by the local medical ethics committee and the informed consents of patients were obtained.

MRI

Static and dynamic MRI scans of both TMJs were taken in all participants in the supine position using a 1.5 Tesla MR scanner with 8.2-cm diameter TMJ coils (Sonata, Siemens). A series of bilateral static angulated sagittal images (2-mm thick, nine images for each TMJ) were taken in maximum intercuspation with the following scanning parameters: a gradient echo pulse sequence (me2d), TR: 393 ms, TE: 23 ms, flip angle: 35 degrees.

Thereafter, 30 consecutive angulated sagittal dynamic images of 4.5-mm thickness were taken. The subjects were asked to perform slow mouth opening/closing movements. Continuous movement of the TMJ disc/condyle complex could thus be captured at a pace of 0.4 seconds/image by using the following scanning parameters: a true FISP pulse sequence, TR: 423.6 ms, TE: 1.87 ms, flip angle: 25 degrees.

Image Analysis

The condyle/disc relationship in maximum intercuspation was assessed using the modified clock-face criterion.[8] Briefly, a normal condyle/disc relationship was diagnosed when the anterior prominence of the condyle was opposed to the intermediate zone of the biconcave TMJ disc. Anterior disc displacement was diagnosed if, on at least one image of the series, the posterior band of the disc was located anterior to the vertex of the condyle.

Dynamic MRI images were used to diagnose whether the displaced disc reduced during mouth opening.

The evaluation of the static and dynamic images was performed by the last author, who was well experienced in reading MRI scans and blind to the assessments of GJH.

The diagnosis of the condyle/disc relationship for each subject was then determined as follows:

1. Disc displacement without reduction (DDw/oR), if at least one TMJ had a displaced but nonreducing disc.
2. Disc displacement with reduction (DDwR), if at least one TMJ had a reducible displaced disc, and the other did not have a DDw/oR.
3. Normal, if disc position of both TMJs was normal.

GJH

The ROM of the following joints was measured according to the measurement protocol of Dijkstra et al.[9] Beighton cutoff values defining hypermobility of different anatomical joints were used.[10]

1. Passive extension of the fifth finger was measured with an 8-inch plastic goniometer in degrees: the larger the value, the more flexible the fifth finger. A hypermobility was diagnosed when the extension was greater than 90 degrees.
2. Passive thumb apposition to the forearm was measured with a set square in mm: the smaller the value, the more flexible the wrist. A hypermobility was diagnosed when the thumb contacted the forearm.
3. Active extension of the elbow was measured with a 14-inch metal goniometer in degrees: the larger the value, the more flexible the elbow. Hypermobility corresponded to an angle larger than 190 degrees.
4. Active extension of the knee was measured with a 14-inch metal goniometer in degrees: the larger the value, the more flexible the knee. Hypermobility corresponded to an angle larger than 190 degrees.
5. To perform the active trunk flexion test, the subjects were standing on a foot stool 24 cm high from the ground. Active trunk flexion was measured from the tip of the index finger to the ground in cm with the knees straight; the smaller the value, the more flexible the trunk. When the palms of the hands rested easily on the stool, a hypermobility was diagnosed.
6. Active dorsal flexion of the ankle was measured with a 14-inch metal goniometer in degrees: the smaller the value, the more flexible the ankle.

This last measurement was not used to calculate the Beighton score. Except for the passive thumb apposition, all other tests were performed without help from the examiner. In the apposition test, the examiner applied as much force as the subject could tolerate. For the fifth finger extension test, the subject was instructed to apply as much force as she could tolerate.

All measurements were performed bilaterally by the same examiner (first author). The ROM of every joint was measured twice, and the mean value was used. If the difference between two measurements was larger than five measuring units, the measurement was repeated and the mean value calculated. The number of joints diagnosed as hypermobile was summed to build the Beighton score. A Beighton score of ≥ 4 represented GJH.[11]

To evaluate intraobserver reliability, 14 randomly selected participants performed the measurements twice within a 1-week interval. The intraclass correlation coefficient (ICC) with absolute agreement was then calculated.

Statistical Analysis

One-way analysis of variance (ANOVA) with the post-hoc Bonferroni was used to assess differences in the ROM of every measured joint of the TMJ ID patients and controls. To test whether the intraindividual ROM degrees of different anatomical joints were correlated, the correlation matrix among ROM of different joints after Bonferroni correction was also calculated. Chi-square (χ^2) test was used to test the association between the Beighton score and TMJ ID. The significance level was set at $P = .05$, and all statistics, including the ICC, were calculated using SPSS version 16.0 for Windows (SPSS, IBM).

Results

Condyle/Disc Relationship

Of the 66 patients with TMJ ID, 50 had a DDw/oR (mean age ± SD, 22.6 ± 2.7 years), and 16 had a DDwR (mean age ± SD, 22.3 ± 2.7 years). The mean age of the 30 control subjects was 23.2 ± 2.6 years.

Intraobserver Reliability of ROM Measurements

The ICC of the ROM measurements is summarized in Table 1. The P value of all the ICC values was < .05.

ROM of Individual Joints

The ROM of all the measured joints is given in Table 2. Only left knee extension and trunk flexion were significantly different between the control subjects and patients with DDw/oR ($P < .05$, ANOVA). However, after Bonferroni correction, only the difference in trunk flexion remained statistically significant ($P = .055$ left knee; $P = .001$ trunk flexion).

Table 1 ICCs Measuring the ROM of Body Joints										
Fifth finger extension		Thumb apposition		Elbow extension		Knee extension		Trunk flexion	Ankle dorsal flexion	
R	L	R	L	R	L	R	L		R	L
0.962	0.911	0.987	0.979	0.859	0.893	0.925	0.836	0.973	0.984	0.969

The *P* value of all ICC values was < .05.

Table 2 ROM of Body Joints in Controls and in Patients with DDwR or DDw/oR

	Fifth finger extension (deg)		Thumb apposition (mm)		Elbow extension (deg)		Knee extension (deg)		Trunk flexion (cm)	Ankle flexion (deg)	
	R	L	R	L	R	L	R	L		R	L
Control											
Mean	63.4	68.9	15.0	13.0	2.4	–1.6	-6.1	–1.1*	23.0*	36.6	38.5
SD	10.0	8.5	14.7	13.7	7.5	6.8	4.4	4.0	7.8	5.9	6.3
DDwR											
Mean	61.4	70.2	8.3	5.2	5.1	0.2	–5.3	1.5	28.8	36.5	39.1
SD	16.3	15.0	9.5	7.8	5.8	4.2	4.6	4.3	12.8	6.0	7.5
DDw/oR											
Mean	57.8	63.3	14.7	13.5	1.7	–0.0	–4.0	2.3*	28.3*	37.8	38.7
SD	14.8	13.3	15.2	13.4	6.4	6.7	4.2	3.8	8.7	6.9	7.4

*Significant difference (*P* < .05, ANOVA) between control group and DDw/oR group, although Bonferroni corrections indicated *P* = .055 for left knee and *P* = .001 for the trunk.
The values shown are the measured values minus 180 degrees. Therefore, a positive value represents joint extension over 180 degrees. For hypermobile joints, these values should be greater than 10 degrees.

Table 3 Pearson Correlation Coefficients Between the ROM of Different Joints

	Fifth finger (R)	Fifth finger (L)	Thumb (R)	Thumb (L)	Elbow (R)	Elbow (L)	Knee (R)	Knee (L)	Trunk	Ankle (R)	Ankle (L)
Fifth finger (R)	1	0.807*	–0.357*	–0.269*							
Fifth finger (L)		1	–0.414*	–0.323*							
Thumb (R)			1	0.866*						0.323*	0.320*
Thumb (L)				1						0.372*	0.348*
Elbow (R)					1	0.723*					
Elbow (L)						1					
Knee (R)							1	0.520*			
Knee (L)								1			
Trunk									1		
Ankle (R)										1	0.889*
Ankle (L)											1

*Pearson correlation significant at the .01 level (two-tailed); blank space = Pearson correlation not significant at the .05 level.

Therefore, only the trunk was more flexible in controls than in patients with DDw/oR. Table 3 lists the correlation matrix of all measured joints. The ROM of paired joints was moderately to highly correlated (*r* value ranging from 0.52 to 0.889, *P* < .01); however, the ROM among different joints was mostly not correlated (*P* > .01). A slight correlation was present between the ROM of the ankle and thumb (*r* value ranging from 0.320 to 0.372, *P* < .01) and between the ROM of the thumb and fifth finger (*r* value ranging from –0.269 to –0.414, *P* < .01).

GJH

Table 4 lists the Beighton scores of all subjects. Only four out of the 96 subjects (4.2%) were diagnosed as having GJH. The Beighton score was not associated with the presence or severity of TMJ ID (χ^2 test, $P > .05$).

Discussion

This study measured the ROM of 10 peripheral joints and of the trunk in 66 young female patients with at least one TMJ with ID and 30 age-matched female controls. Static and dynamic MRI scans were used to assess the presence of ID. Results indicated that the Beighton scores did not differ between controls and TMJ ID patients. Only the trunk flexion significantly differed between controls and subjects with TMJ ID, suggesting the latter may have a significantly stiffer trunk.

A possible explanation of a causal relationship between TMJ ID and GJH is that stretching or laxity of the collateral disc ligaments facilitates the disc displacement.[12] Partial support to this hypothesis comes from an autopsy study in which the author speculated that DDw/oR cannot occur without rupture of the collagenous fibers attaching the disc to the medial and lateral condylar poles.[13] Therefore, either trauma or a "defected" connective tissue attachment might predispose one to disc displacement.[14] However, previous studies have produced conflicting results between GJH and TMJ ID.[5,12,15–17] These differing results might have arisen from differences in the joint mobility measurement technique and/or from errors in the diagnosis of ID. For instance, the correlation between functional-based and anatomical-based (MRI) diagnoses of disc displacement is low.[6] According to MRI studies, about one third of clinically asymptomatic subjects have disc displacement,[18–24] as was the case also in the present study in which 10 out of the 40 asymptomatic subjects initially recruited as controls also had a displaced disc. The use of a clinical examination to diagnose a TMJ ID yields, therefore, about one-third false negatives. Moreover, most of the previous studies used only a clinical functional examination to evaluate the association between GJH and TMJ,[14,25,26] while the present study used MRI to diagnose a disc displacement, irrespective of the clinical manifestation. Nevertheless, studies using MRI to assess a TMJ ID also have provided conflicting results. Perrini et al used TMJ MRI to study the association between GJH and TMD for 62 symptomatic TMD patients and 38 asymptomatic controls.[17] They found that symptomatic TMD patients seemed to have a higher joint laxity score than asymptomatic controls. On the contrary, Sáez-Yuguero et al also used MRI as the gold standard but could not find such an association in 66 female TMD patients.[27] Differences in how the joint laxitiy was measured can also explain differences in the results.

Table 4 Distribution of Beighton Scores in Controls and in Patients with DDwR or DDw/oR

Beighton score	Control	DDwR	DDw/oR	Total
0	14	3	26	43
1	4	5	6	15
2	8	7	15	30
3	3	0	1	4
4	0	0	2	2
5	1	1	0	2
Total	30	16	50	96

To diagnose whether a joint is hypermobile, the measured ROM has to be compared with a given cutoff value. This evaluation can be made by visual inspection or quantitative measurement. Watkins et al demonstrated that the intertester reliability was higher with quantitative measurement than with visual inspection in assessing ROM.[28] Visual inspection was used in the study by Perrini et al,[17] while Sáez-Yuguero et al[27] did not describe how they assessed the ROM. As shown in Table 1, the ICCs of the measurements in the present study were good.

The ROMs of different anatomical joints were mostly not correlated in the present study. Dijkstra et al have demonstrated that only one fourth of the variance of the maximal mouth opening capacity can be explained by the regression models comprising ROM of multiple joints.[14] In subjects without connective tissue disorders, the ROM of an individual joint is likely determined by local factors; therefore, a high Beighton score does not necessarily reflect a hypermobile TMJ or a weakened disc attachment.

The present results showed that DDw/oR patients have significantly stiffer trunks. Other than an indicator of GJH, trunk flexion is more often used to evaluate health-related fitness. A recent study demonstrated that underweight subjects have poorer performance in a sit-and-reach test, which is comparable to the trunk flexion, than normal-weighted subjects.[29] As shown elsewhere,[7] the mean body mass index (BMI) of these DDw/oR patients was significantly lower than that of the controls.

Therefore, the stiffer trunk might be due to low BMI rather than laxity of the body.

Conclusions

Within the limits of this study, the Beighton score did not differentiate between control subjects and patients with TMJ ID, and there was a lack of association between GJH and TMJ ID.

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