Correlation between temporomandibular joint morphometric measurements and gender, disk position, and condylar position

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Objective. The aim of this study was to correlate the morphometric measurements of the temporomandibular joint, including condylar size, joint space, and articular eminence size, with gender, disk position, and condylar position by using magnetic resonance imaging.

Study Design. Overall, 93 patients were evaluated (31.2% males and 68.8% females; age 18−81 years; mean age 41 years). Condylar size (D1), joint space (D2), and eminence size (D3) were measured. Correlations with gender, disk position, and condylar position were calculated.

Results. A statistically significant correlation was found between D2 and gender, with the joint space being significantly larger in the male group ($P = .05$). There were correlations between D2 and the position of the disk and the position of the condyle ($P \leq .05$).

Conclusions. The results indicate a correlation between male gender and larger joint space. In addition, we found that the joint space size influences the articular disk and condyle position, which can cause disk displacement. (Oral Surg Oral Med Oral Pathol Oral Radiol 2019;128:538−542)

Temporomandibular disorders (TMDs) represent the major cause of nondental pain in the orofacial region and are defined as a subgroup of abnormal conditions that involve the masticatory muscles, osseous structures, ligamentous components, and neurologic structures of the temporomandibular joint (TMJ). Disk displacement (DD) is one of the most prevalent TMDs. A disk is in its normal position when its posterior band lies on the uppermost portion of the condyle (i.e., between the 11 o'clock and 1 o'clock positions).[1-6]

Magnetic resonance imaging (MRI) is the modality of choice for the assessment of internal TMJ disorders in patients with TMDs because this imaging modality allows for visualization of both osseous and soft tissue abnormalities.[7] MRI is currently the best technique for assessing the TMJ disk and is considered the gold standard for the study and diagnosis of soft tissue disorders in the TMJ.[5,6,8]

Patients with TMDs may have various signs, such as clicking and disturbance in mandibular movements, and symptoms, such as facial pain and TMJ pain.[9] Disk position, when observed on MRI images, correlates well with clinical symptoms when there is a significant displacement of the posterior band in relation to the mandibular condyle and in cases without reduction of the anteriorly displaced articular disk in the open-mouth position.[10] However, when other TMD diagnostic methods were used in one study to correlate TMDs and the symptoms, no association between TMJ intra-articular status and pain, mandibular function, or disability was reported.[11]

Evidence indicates substantial differences between men and women in clinical and experimental pain responses.[11] Compared with men, women present a higher prevalence of painful states, including orofacial pain and TMD symptoms, with the estimated male-to-female ratio ranging from 1:2 to 1:6, usually in the age group of 20 to 45 years.[12-14]

The aim of this study was to identify correlations between TMJ anatomic measurements and gender, disk position, and condylar position in the glenoid fossa by using MRI. The null hypothesis stated that there were no correlations between the morphometric data and gender, disk position, or condyle position.

Statement of Clinical Relevance

The articular eminence is exposed to functional load arising from chewing forces and other forces within the temporomandibular joint, and these loads influence its morphologic shape.

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MATERIALS AND METHODS

Ethical considerations

This was a retrospective cross-sectional investigation. This study followed the tenets of the Helsinki Declaration on medical protocol and ethics and was approved by the institutional review board. All patients provided written informed consent.

Sample selection

All patients in the study were referred from a private clinic for bilateral TMJ MRI examinations during the period January 2010 to December 2013.

To be included in the study, patients had to have at least 1 TMD sign and/or symptom, such as pain in joints and/or muscles, joint sounds, movement limitation, history of headaches, and otologic complaints. All symptoms were registered as reported by patients. Exclusion criteria included the presence of degenerative changes, such as osteophytes, surface erosion, or bone marrow changes in one or both TMJs, growth abnormalities, history of facial trauma or systemic arthritis (rheumatoid or psoriatic arthritis and gout), and age less than 18 years.

After applying the inclusion and exclusion criteria, 93 patients were included in the sample: 29 (31.2%) males and 64 (68.8%) females (age 18−81 years; mean age 41 years). The total number of evaluated TMJs was 186.

Image capture and evaluation

Oblique parasagittal magnetic resonance images—sagittal images corrected by the horizontal angle of the condyle—were obtained in the closed-mouth position (CMP) and open-mouth position (OMP). Images were acquired by using a Signa MR system (General Electric, Milwaukee, WI), operating at 1.5 T with 6 × 8 cm bilateral surface coils and the patient in the supine position. The parameters for MRI acquisition were 256 × 256 matrix, 145 mm field of view, and pixel size of 0.60 × 0.57 mm. Ten 2-mm-thick sections were obtained for each TMJ by using T1-, T2-, and proton density (PD)−weighted imaging, as chosen by the examiners for specific diagnostic purposes. For the acquisition of OMP images, a device (Burnett TMJ device, TMJ-200 s/n 0650; Medrad, Pittsburgh, PA) was used for stabilization at maximum mouth opening.

A specialist in dentomaxillofacial radiology assessed the images under optimal environmental conditions—in a quiet, windowless room with dimmed lighting and comfortable temperature (20°C)—in 3 different sessions with dual HP LP2475 W monitors (Hewlett-Packard Company, Palo Alto, CA) with a 1920 × 1200 resolution. The mean values obtained for all measurements were used for data analyses. Measurements were performed by using the Create Annotation − Distance of Centricity tools DICOM Viewer, version 2.2 (GE Healthcare, Chicago, IL).

The evaluated measurements were D1: anterior-to-posterior condylar width (distance between the most anterior point and the posterior-most point of the condyle), referred to as *condylar size*; D2: space between condyle and glenoid fossa (distance between the superior-most portion of the glenoid fossa and the superior-most point of the condyle), referred to as *joint space*; and D3: eminence height (distance between the most inferior point of the articular eminence and the superior-most point of the glenoid fossa), referred to as *eminence size* (Figure 1).

The disk position in CMP images was classified as normal (N) or anterior disk displacement (ADD). Patients with ADD on the OMP images were classified into disk displacement with reduction (DDwR), when the normal relationship between disk and condyle was restored on mouth opening; and disk displacement without reduction (DDwoR), when the disk was still displaced in OMP.[14]

The condylar position in CMP images was classified as central (normal position), anterior, or posterior.[14] It was measured by a vertical line that passed through the superior-most aspect of the condyle. The area of each space was then computed, and a ratio of anterior-to-posterior space was calculated. Concentric positioning

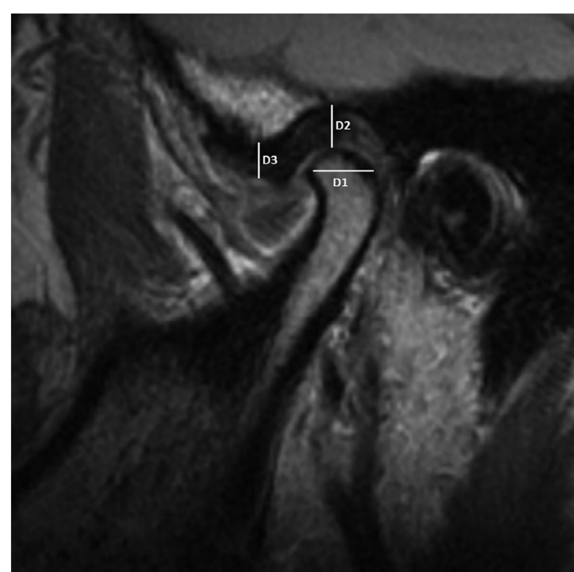

Fig. 1. D1, D2, and D3 measurements of the temporomandibular joint (TMJ). D1 represents the condylar size, defined as the anterior-to-posterior measurement of the condyle. D2 represents the joint space, defined as the distance between the superior-most portion of the glenoid fossa and the superior-most point of the condyle. D3 represents the eminence size, defined as distance between the inferior-most point of the articular eminence and the superior-most point of the glenoid fossa.

of the condyle in the articular fossa was indicated as central. Increase of the posterior articular space indicated the anterior condylar position. Increase of the anterior articular space indicated the posterior condylar position.

Statistical analysis

Data were analyzed by using the Statistical Package for Social Sciences version 15 (SPSS; SPSS Inc., Chicago, IL). During the evaluation of study data, along with descriptive statistical methods, parameters with normal distribution for the comparison of quantitative data were evaluated by using a 1-way analysis of variance (ANOVA) test. Student *t* test was also used for parameters with normal distribution. Significance was set at $P \leq .05$.

RESULTS

Mean D1, D2, and D3 values were 6.74 mm, 4.54 mm, and 7.69 mm, respectively, for all 186 TMJs. Mean D1 values for male patients (6.83 mm) did not differ significantly from those of female patients (6.72 mm) ($P = .672$), Mean D3 values were also not significantly different (males: 7.43 mm, females: 7.76 mm; $P = .391$). Mean D2 values differed statistically between male (4.73 mm) and female (4.34 mm) patients ($P = .050$), for all 186 evaluated TMJs (Table I).

The majority of disk positions were anterior, with the posterior band of the disk located 30 degrees anterior to the condyle in the CMP. Therefore, cases of partial ADD in the lateral part of the joint, partial ADD in the medial part of the joint, rotational anterolateral DD, and rotational anteromedial DD were grouped together with those of ADD for purposes of statistical analysis.[15] The final sample was composed of patients with normal disk position (N) and patients with ADD.

Of the 93 evaluated patients, 27 presented with normal disk position for both right and left TMJs (29.0%), and 66 patients presented with ADD in at least 1 TMJ (71.0%). A total of 114 of 186 TMJs had ADD: 94 with DDwR (82.5%) and 20 with DDwoR (17.5%).

The correlations between D1, D2, and D3 and the position of the articular disk and the mandibular condyle were assessed. The anterior-to-posterior condylar size (D1) and eminence size (D3) showed no differences in mean values between joints with normal disks and displaced disks (Table II). However, the difference in D2 (the joint space size between the condyle and the glenoid fossa) was significant between joints with normal versus displaced disks ($P = .001$; see Table II).

D1, D2, and D3 were analyzed in the OMP and compared with DDwR or DDwoR. No statistically significant differences were observed between these values and the status of reduction ($P \geq .079$; Table III).

Only 1 condyle was classified as anteriorly positioned; therefore, for statistical purposes, only central (32.1%) and posterior (67.9%) positions were taken into consideration. When comparing D1, D2, and D3 measurements in joints with central versus posterior position of the condyle, no significant differences were found for D1 and D3. However, joint space size (D2) exhibited a significant difference ($P = .001$) between joints with centrally positioned condyles compared with joints in which the condyle was posteriorly positioned (Table IV).

Table I. Mean values and standard deviations (mm) of condylar size (D1), joint space (D2), and eminence size (D3) in relation to gender

	Male *Mean ± standard deviation (SD)*	*Female* *Mean ± SD*	*P*
D1	6.83 ± 1.17	6.72 ± 1.12	.672
D2	4.73 ± 0.08	4.34 ± 0.07	.050*
D3	7.43 ± 1.32	7.76 ± 1.29	.391

*Student *t* test; $P \leq .05$.

DISCUSSION

The results of this investigation revealed that the joint space (D2) is significantly larger in men than in women (see Table I). In the study by Peroz et al.,[12] male patients presented higher results for superior joint spaces, which is in agreement with our findings. Some studies found a difference in the articular eminence according to gender.[16,17] Eminence inclination and height values in males were higher compared with those in females. In contrast to previous studies, no relation was found between the articular eminence and gender in the present study (see Table I).

When evaluating the anterior-to-posterior condyle width in axial MRI views, Vieira-Queiroz et al.[6] found higher values for patients without DD. The study measured the anterior-to-posterior condyle length at 2 points: lateral and medial poles. Smaller anterior-to-posterior length measurements at the lateral pole of the condyle were associated with DDwoR. In the present investigation, measurement was performed only in the central-most sagittal section (D1), which may be the reason for the lack of association between the anterior-to-posterior condyle width and DD on OMP images (see Table II). Pullinger and Seligman[14] measured the anterior-to-posterior condyle width by using cone beam computed tomography sagittal images and, in agreement with our study, found no significant correlation between condyle width and disk reduction.

With regard to the joint space, according to Peroz et al.,[12] patients with TMDs present smaller superior articular spaces, corroborating the results of the present

Table II. Mean values and standard deviations (mm) of condylar size (D1), joint space (D2), and eminence size (D3) in relation to disk position

	Articular disk position		*P*
	Normal disk *Mean ± Standard deviation (SD)*	*Disk displacement* *Mean ± SD*	
D1	6.828 ± 1.07	6.525 ± 1.02	.135
D2	5.536 ± 0.80	4.273 ± 0.79	.001*
D3	7.869 ± 1.98	7.691 ± 1.45	.169

*One-way analysis of variance (ANOVA) test; $P \leq .05$.

study, which found positive correlation between the joint space (distance between the condyle and the roof of the glenoid fossa) and the disk position on CMP images. The joint space in the glenoid fossa has been evaluated by Matsumoto et al. and Gedrange et al.[18,19] Both those studies agreed that the joint space is influenced by the presence of joint effusion but is unaffected by disk position and configuration.

Because of the controversial results on the ideal dimensions of the joint space, Matsumoto et al.[20] questioned the clinical relevance because the condyle can present a diversity of positions in both symptomatic and asymptomatic patients. To determine the influence of condylar position on the articular fossa and its resulting spaces as an etiologic factor of DD, a longitudinal study should be carried out, as proposed by Ren et al.[21] and Kinniburgh et al.[22]

Pullinger and Seligman[14] observed that patients with DDwoR had a slight tendency to present smaller distances between the superior point of the condyle and the glenoid fossa. In the present investigation, the presence of DD was associated with a smaller space between the condyle and the glenoid fossa (D2) in the sagittal plane (see Table II), but this dimension was not affected by the status of disk reduction (see Table III). These different results can be explained by the diagnostic method used to detect DD because Pullinger and Seligman[14] used Clinical Research Diagnostic Criteria

Table III. Mean values and standard deviations (mm) of condylar size (D1), joint space (D2), and eminence size (D3) in relation to articular disk displacement in the open-mouth position

	Articular disk position		*P*
	DDwR *Mean ± standard deviation (SD)*	*DDwoR* *Mean ± SD*	
D1	6.417 ± 1.07	6.708 ± 1.10	.130
D2	4.276 ± 0.90	4.057 ± 0.88	.079
D3	7.551 ± 1.21	7.959 ± 1.30	.098

One-way analysis of variance (ANOVA) test; $P \geq .079$.
DDwR, disk displacement with reduction; *DDwoR,* disk displacement without reduction.

and tomographic images. Ikeda and Kawamura[23] also reported that it is possible to estimate the direction and extent of DD on the basis of joint space changes.

The articular eminence is a transverse bony bar anterior to the glenoid fossa and medial to the posterior margin of the zygomatic process. The anterior slope of the articular eminence, known as the *preglenoid plane*, gently arises from the infratemporal surface of the squamous portion of the temporal bone.[1] The flatness or steepness of the articular eminence dictates the path of the condylar movement, as well as the degree of rotation of the disk over the condyle. The steeper the articular eminence, the more the condyle is forced to move inferiorly as it shifts anteriorly, leading to greater vertical condyle movement during mouth opening movements.[3] The articular eminence is exposed to functional loads arising from the effect of chewing forces on other structures within the TMJ and these loads influence its morphologic shape.[2,24]

In one investigation, larger eminences and deeper glenoid fossae were found to be more predominant in patients with DDwR, whereas shallower eminences were more predominant in patients with DDwoR.[4] Articular eminence flattening is associated with DD.[5,12,25] In the present study, there was no statistical correlation between eminence height (D3) and DD (see Tables II and III). A higher eminence may be related to its greater inclination; therefore, to make the study more reliable, the depth of the joint fossa should also be measured. A previous study reported that the anatomy of the articular eminence may predispose to DD,

Table IV. Mean values and standard deviations (mm) of condylar size (D1), joint space (D2), and eminence size (D3) in relation to mandibular condyle position

	Mandibular condylar position		*P*
	Central *Mean ± standard deviation (SD)*	*Posterior* *Mean ± SD*	
D1	6.877 ± 1.05	6.476 ± 1.09	.121
D2	4.570 ± 0.87	5.239 ± 0.76	.001*
D3	7.837 ± 1.35	7.724 ± 1.40	.130

*One-way analysis of variance (ANOVA) test; $P \leq .05$.

but at the same time, DD may also change the shape of the articular eminence.[20]

CONCLUSIONS

In this study, a correlation was found between male gender and a larger joint space size. In addition, we found significant differences in joint space size in relation to disk position. Joint spaces were significantly smaller in patients with DD, although the status of disk reduction had no significant effect on joint space size. Another relevant finding in this study was increase in the joint space in patients with posteriorly positioned condyles compared with those with centrally positioned condyles. In other words, it was observed that the joint space presented a correlation with the position of the articular disk and the condyle, which may be related to DD. Longitudinal studies assessing both TMJ morphometric dimensions and angles should be carried out to better evaluate the etiology of TMDs.

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