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Evaluation of temporomandibular joint disk displacement and its correlation with pain and osseous abnormalities in symptomatic young patients with magnetic resonance imaging

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Objective. To evaluate the occurrence of temporomandibular joint disk displacement and its correlation with pain and osseous abnormalities using magnetic resonance imaging (MRI) in patients under 21 years of age.
Study Design. MRI images in open- and closed-mouth positions from 102 patients, under 21 years of age (mean age 17 years), were studied retrospectively. Patients were divided into six groups according to the disk−condyle relationship. Chi-square, Marascuilo procedure, and Cochran-Mantel-Haenszel tests were used to evaluate the relationships among pain, abnormalities, and the groups.
Results. There was a statistically significant correlation between bilateral disk displacement without reduction and pain ($P = .011$), and osseous changes ($P < .0001$). There was no proven link between pain and osseous abnormality ($P = .414$).
Conclusion. Young patients are susceptible to all stages of disk displacement. There was a strong correlation only between each variable (osseous abnormalities and pain) and the most severe stage of disk displacement (bilateral disk displacement without reduction). (Oral Surg Oral Med Oral Pathol Oral Radiol 2015;119:107-112)

Temporomandibular disorders (TMDs) are defined as a subgroup of abnormal conditions involving masticatory muscles, osseous and ligamentous components of the temporomandibular joints (TMJs), and associated neurologic structures.[1-3] Common among adults, TMD does not appear to be a usual finding in children but tends to increase in frequency with age during adolescence.[4]

Despite better knowledge of the structure and function of the TMJ, the specific pathophysiology of TMDs is not completely understood.[1] It is well known that morphologic changes may be observed in the TMJ bone structures (mandibular condyle and articular eminence of the temporal bone) of patients with TMDs, including osteophytes, erosion, avascular necrosis, and subchondral cysts with intra-articular loose bodies and/or flattening.[3] Furthermore, the most common symptoms are pain, muscle tenderness, a "clicking" or "popping" sensation within the joint, headache, earache, and restricted mouth opening.[5]

Disk displacement (DD) is a common disorder of the TMJ, usually reported in young to middle-aged female adults (20 to 50 years of age).[1,6] In adolescents, it has also been shown that females have a greater incidence of DD and associated pain compared with males.[2,4] Moreover, there appears to be a high incidence of DD in young preorthodontic patients (ages 6-15 years), with no gender predilection, and a tendency to more advanced stages of DD with increasing age.[7]

Magnetic resonance imaging (MRI) is considered the best method of evaluating DD, since it provides excellent soft tissue contrast without radiation or surgical invasion.[8,9] MRI scans taken with the patient in open- and closed-mouth positions are widely used to evaluate the position, configuration, and posterior attachment of the disk, as well as the mandibular marrow status, presence of joint effusion, and anatomic details of the TMJ.[1,2,8,9] Its accuracy for assessment of the position and form of the disk has been reported to

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Statement of Clinical Relevance

This retrospective magnetic resonance imaging study of patients under 21 years of age found that these young patients are susceptible to all stages of disk displacement and that there is a strong correlation between osseous abnormalities or pain and the most severe stage of disk displacement.

be up to 95%.[10,11] On the other hand, it has demonstrated variable sensitivity (30%-82%) for the detection of osseous abnormalities, depending on the type and severity of such abnormality.[12,13] However, this uneven sensitivity should not restrict the evaluation of bone abnormalities when a MRI scan has been acquired to investigate DD.

The majority of the literature to date has related gender, anatomic or clinical findings, and imaging features with TMJ characteristics. Only a few studies have specifically correlated disk displacement findings from young patients. For this reason, the aim of this study was to evaluate the occurrence of TMJ disk displacement and its possible correlation with pain and osseous abnormalities using MRI in patients under 21 years of age.

MATERIALS AND METHODS

This retrospective cross-sectional study protocol was approved by the last author's Institutional Review Board and is in compliance with the Helsinki Declaration. All patients provided written informed consent.

MRI scans of 102 patients (22 males and 80 females), aged between 10 and 20 years (mean age 17 years), were studied retrospectively. The patients had been referred to the same radiology practice for MRI to investigate possible TMD-related findings. Before MRI, a professional with 15 years of experience in TMJ evaluation performed a clinical examination on all patients. To be included in the study, the subject had to present at least one of the following signs and symptoms: pain in joints and/or muscles, joint sounds, limitation of movement, history of headaches, and otologic complaints. Gender and the presence of joint pain, as reported by the subject, were registered for statistical purpose.

The MRI studies were conducted on a 1.5-T GE Signa scanner (General Electric, Milwaukee, WI). A bilateral TMJ dual-phased array coil (Signa; GE Medical System, Milwaukee, WI) was used, and the patients were placed in the supine position, with the sagittal plane perpendicular to the horizontal plane, and the Frankfort plane parallel to the scanner gantry. The protocol used a 256×256 matrix, 145-mm field of view, and a pixel size of 0.60×0.57 mm. Ten slices, 2-mm thick, were obtained for each TMJ in each sequence. Oblique parasagittal slices were obtained and corrected for the horizontal angulation of the condyle in all the following sequences: closed-mouth axial T1-weighted, coronal T1-weighted, and axial T2-weighted, as well as open-mouth axial T1-weighted. For the acquisition of images in the open-mouth position, a Burnett TMJ device (TMJ-200 s/n 0650; Medrad Inc., Pittsburgh, PA) was used to stabilize the maximal open-mouth position and to minimize motion artifacts.

Two experienced radiologists performed the MRI image evaluation, in a consensus approach, of all images without any clinical information. The position of the disk in closed-mouth images was evaluated and classified according to Ahmad et al.[11] as "normal" or "displaced." The patients with disk displacement were subclassified according to the disk−condyle relationship in open-mouth images into (1) disk displacement with reduction (DDwR), when the normal relationship between the disk and condyle was restored on mouth opening; and (2) disk displacement without reduction (DDwoR), when the disk was still displaced on mouth opening. Exclusion criteria included cases in which the position of the disk was indeterminate or the disk itself was not visible.[11]

Patients were then divided into six groups, on the basis of a previous study.[14] These groups were determined by the results of TMJ MRI according to both TMJ disks status, in the following order: bilateral normal TMJs (Normal/Normal); unilateral DDwR and normal contralateral TMJ (DDwR/Normal); bilateral DDwR (DDwR/DDwR); unilateral DDwoR and normal contralateral TMJ (DDwoR/Normal); unilateral DDwR and DDwoR in the contralateral TMJ (DDwR/DDwoR); and bilateral DDwoR (DDwoR/DDwoR).

The assessment of osseous abnormalities was adapted from Ahmad et al.[11] and included osteophytes, flattening, erosion, sclerosis, edema, thickness of cortical eminence and/or condyle, focal or diffuse necrosis, bifid condyle, condylar hypoplasia or hyperplasia, and the presence of free bodies.

The prevalence of the morphologic changes of bone structures of the TMJ and the prevalence of the position of the disk in the closed-mouth position were summarized as percentages. Chi-square test followed by the Marascuilo procedure for comparison of the K proportion was performed to evaluate the association of disk displacement with pain and with osseous abnormalities. The correlation between both variables (pain and osseous abnormalities) was assessed by creating six contingency tables (each corresponding to a TMJ group). Cramer's V, Chi-square test, and P values were calculated for each sub-table. These statistics were calculable only if the marginal sums were nonzero in each sub-table. Cramer's V shows the strength of the links between the variables. It is close to zero when there is no link. The general correlation coefficient method of the Cochran-Mantel-Haenszel test was used to evaluate the relationship between pain and abnormalities, considering all disk displacement status. Data analysis was performed using XLStat (version 2014.2.1, Addinsoft Inc., Brooklyn, NY). The *a priori* level of significance was set at $P < .05$.

Table I. The gender distribution [n (%)] of patients with pain and osseous abnormality among temporomandibular joint disk displacement groups

Group	Gender	Total	Pain*		Osseous abnormality*	
			Yes	No	Yes	No
Normal/Normal	Male	1 (0.98)	1 (0.98)	0 (0)	0 (0)	1 (0.98)
	Female	22 (21.57)	8 (7.84)	14 (13.73)	3 (2.94)	19 (18.63)
	Total	23 (22.55)	9 (8.82)	14 (13.73)	3 (2.94)	20 (19.61)
DDwR/Normal	Male	6 (5.88)	0 (0)	6 (5.88)	1 (0.98)	5 (4.90)
	Female	11 (10.78)	4 (3.92)	7 (6.86)	2 (1.96)	9 (8.82)
	Total	17 (16.66)	4 (3.92)	13 (12.74)	3 (2.94)	14 (13.72)
DDwR/DDwR	Male	8 (7.84)	1 (0.98)	7 (6.86)	0 (0)	8 (7.84)
	Female	14 (13.73)	5 (4.90)	9 (8.83)	7 (6.86)	7 (6.86)
	Total	22 (21.57)	6 (5.88)	16 (15.69)	7 (6.86)	15 (14.7)
DDwoR/Normal	Male	1 (0.98)	1 (0.98)	0 (0)	1 (0.98)	0 (0)
	Female	4 (3.92)	4 (3.92)	0 (0)	2 (1.96)	2 (1.96)
	Total	5 (4.9)	5 (4.9)	0 (0)	3 (2.94)	2 (1.96)
DDwR/DDwoR	Male	2 (1.96)	1 (0.98)	1 (0.98)	2 (1.96)	0 (0)
	Female	17 (16.67)	10 (9.81)	7 (6.86)	14 (13.73)	3 (2.94)
	Total	19 (18.63)	11 (10.79)	8 (7.84)	16 (15.69)	3 (2.94)
DDwoR/DDwoR	Male	4 (3.92)	2 (1.96)	2 (1.96)	2 (1.96)	2 (1.96)
	Female	12 (11.76)	7 (6.86)	5 (4.90)	12 (11.76)	0 (0)
	Total	16 (15.68)	9 (8.82)	7 (6.86)	14 (13.73)	2 (1.96)
Overall		102 (100)	44 (43.14)	58 (56.86)	46 (45.1)	56 (54.9)

*The distribution of pain and osseous abnormalities were made independently.

Table II. The distribution [n (%)] of the abnormalities according to the number of temporomandibular joints involved

Alteration	Unilateral	Bilateral	Total	
			Patients*	TMJs
Condylar hypoplasia	13 (12.74)	11 (10.78)	24 (23.52)	35 (17.16)
Condylar erosion	15 (14.70)	2 (1.96)	17 (16.66)	19 (9.31)
Osteophyte	9 (8.82)	0 (0)	9 (8.82)	9 (4.41)
Bone necrosis	2 (1.96)	2 (1.96)	4 (3.92)	6 (2.94)
Flattened condyle	2 (1.96)	1 (0.98)	3 (2.94)	4 (1.96)
Articular eminence erosion	3 (2.94)	0 (0)	3 (2.94)	3 (1.47)
Effusion	1 (0.98)	1 (0.98)	2 (1.96)	3 (1.47)
Bone sclerosis	1 (0.98)	1 (0.98)	2 (1.96)	3 (1.47)
Thickening of condyle cortex	2 (1.96)	0 (0)	2 (1.96)	2 (0.98)
Thickening of temporal eminence	1 (0.98)	0 (0)	1 (0.98)	1 (0.49)
Bifid condyle	1 (0.98)	0 (0)	1 (0.98)	1 (0.49)
Condylar hyperplasia	1 (0.98)	0 (0)	1 (0.98)	1 (0.49)

*Some patients presented with more than one entity.

RESULTS

Two hundred and four TMJs were analyzed. Table I shows the distribution of patients among the TMJ disk displacement groups. Overall, young females represented 78.43% of the sample (80 F/22 M). However, there was no statistically significant difference in the distribution of disk displacement according to gender ($P > .05$). For this reason, the following statistical tests were made considering the whole sample (both genders combined).

With respect to osseous abnormalities, 45.1% of the sample (46 patients) presented with at least one altered TMJ, that is, 31.86% (65 of 204) of all joints. Table II summarizes the distribution of the abnormalities according to the number of TMJs involved. Some patients presented with more than one entity.

The K proportions of pain and osseous abnormality among TMJ disk displacement groups are presented in Table III. Results indicated that there was a statistically significant correlation between DDwoR/DDwoR and pain. Of 16 patients presenting with bilateral disk displacement without reduction, pain was reported in 56.25% of the cases ($P = .011$). There was also a statistically significant association between osseous changes and disk displacement without reduction ($P < .0001$). The DDwR/DDwoR and DDwoR/DDwoR groups were more likely to present osseous abnormality compared with the other groups.

Table III. *K* proportion of pain and osseous abnormality among temporomandibular joint disk displacement groups*

Group	Pain	Osseous abnormality
Normal/Normal	0.235 [A]	0.13 [x]
DDwR/Normal	0.273 [A]	0.176 [x]
DDwR/DDwR	0.391 [A]	0.318 [x]
DDwoR/Normal	0.563 [A]	0.6 [x,Z]
DDwR/DDwoR	0.579 [A]	0.842 [Z]
DDwoR/DDwoR	1 [B]	0.875 [Z]

*Proportions in the same column with different letter mean differences statistically significant (A/B, $P = .011$; X/Z, $P < .0001$). Chi-square, Marascuilo procedure.

Table IV. Distribution of patients according to the presence/absence of pain in the presence or absence of osseous abnormality among temporomandibular joint disk displacement groups

Group	Pain	Osseous abnormality Yes	Osseous abnormality No	Cramer's V	Chi-square	P value
Normal/Normal	Yes	2	7	0.219	1.098	.538
	No	1	13			
DDwR/Normal	Yes	0	4	−0.257	1.121	.541
	No	3	10			
DDwR/DDwR	Yes	2	4	0.020	0.009	1.000
	No	5	11			
DDwoR/Normal	Yes	3	2	—	—	—
	No	0	0			
DDwR/DDwoR	Yes	9	2	−0.077	0.112	1.000
	No	7	1			
DDwoR/DDwoR	Yes	7	2	−0.333	1.778	.475
	No	7	0			

Cochran-Mantel-Haenszel test: Odds ratio = .737; confidence interval = .187 − 2.555); $P = .414$.

Table IV presents the contingency sub-tables of the correlation between pain and osseous abnormality. Cramer's V was close to zero in all groups, demonstrating no links between the variables. When taking the tables all together for a Cochran-Mantel-Haenszel test, there was a common odds ratio of 0.737 with a 95% confidence interval that included the value 1 (0.187-2.555). Generally, there was no proven link between pain and the presence of osseous abnormalities ($P = .414$).

DISCUSSION

Although the prevalence of TMD is higher in older adults, its presence among young patients should not be neglected. In fact, an early diagnosis must be pursued. It has been suggested that disk displacements occur frequently in preorthodontic adolescents and, independent of the age group, females are highly predisposed.[3,15-18] According to a longitudinal study that included female adolescents, a history of clicking or grating sounds in the joint was related to a subsequent development of symptoms.[16]

There appear to be few studies in the English literature on the assessment of MRI findings of TMJs of adolescents with suspicion of TMD, other than one study of normal MRI findings of juvenile TMJs in children without rheumatism (range 3-13 years)[19] and several cases of juvenile idiopathic arthritis.[9,20-22] In part, the use of MRI for the evaluation of the TMJ in patients is limited by its high cost.[14] Also, as already mentioned, there is a lack of early diagnoses of TMD in the young population, which makes this present study unique. The 102 patients recruited for this study were under 21 years of age (range 10-20 years; mean age 17 years) and had been referred for MRI examinations for assessment of TMDs. In other words, the referring dentists identified a sign and/or symptom that justified an investigation of the joints.

In order to correctly diagnose and treat TMDs, an accurate diagnostic method is necessary. Undoubtedly, MRI is the gold standard for diagnosis of internal derangement of the TMJ.[1,10,11,14,23] On the other hand, the diagnosis of osseous changes is still questionable. Some authors[11,12] have stated that MRI has fair reliability and marginal sensitivity in diagnosing osseous changes compared with computed tomography (CT) and cone-beam CT (CBCT). Therefore, MRI would not be an ideal imaging technique for detecting osseous changes, and CT or CBCT would remain the imaging modality of choice for that task.[11,12] However, in a comparison of the detection of erosion by T1-weighted, 1.5-T MRI and microCT sections of the metacarpophalangeal joints of patients with rheumatoid arthritis, a recent investigation[13] found that MRI demonstrated high sensitivity and specificity (0.79 and 1.00, respectively) in detecting bone erosions, and only very small lesions escaped detection. In fact, the few bone erosions that could not be depicted by MRI were very small lesions with volume of less than 10 mm.[3,13]

TMJs are unique paired joints that attach a single bone (the mandible) to the base of the skull. Although some authors consider them separate entities, the present study considered them a single functional unit. For this reason, our sample was divided into six groups according to the status of both articular disks when in function: Normal/Normal, DDwR/Normal, DDwR/DDwR, DDwoR/Normal, DDwR/DDwoR, and DDwoR/DDwoR. The disk was considered displaced when its posterior band was not positioned on top of the mandibular condyle (in the 11 to 12 o'clock position) in the closed-mouth position.

The establishment of a relationship among prevalence, disk displacement type, and disk function could be difficult, since TMDs can be progressive. Some authors have stated that DDwR is expected to be an initial phase of the disk displacement process, which evolves to DDwoR in a later phase.[17] Even though our sample consisted of young patients, which could suggest that those individuals would present an early stage of TMD, 39.21% already presented with DDwoR in at least one joint. This could suggest that in some patients, TMD progression seems to be faster than in others, independent of age.

A displaced disk may lead to TMJ clicking, pain, and restricted jaw movements.[14] According to a study from 1981, temporomandibular arthropathy (better known nowadays as TMD) may progress from an initial stage of clicking and locking to a terminal stage of crepitation and constriction.[24] However, the major reason for patients with TMDs seeking treatment seems to be persistent pain. In the present study, there was a statistically significant correlation only between the presence of bilateral DDwoR and pain ($P = .011$; see Table III). In a study conducted in a "stress free" population, there was no observed association between disk position and pain.[17] On the other hand, a study conducted in 72 patients reported a statistically significant difference in the occurrence of disk displacement between symptomatic and asymptomatic joints (54% vs 22%; $P < .001$).[6] When a sample of 144 patients with known TMJ dysfunction was selected, the group without reduction presented with significant increases in the risk of experiencing symptoms ($P = .002$).[25]

Overall, when bone changes were considered, 50% of the cases were not associated with pain. The correlation between pain and each bone abnormality separately was not possible due to the small sample size for each one, making the statistical tests less sensitive. Only a larger sample size for each abnormality could generate statistical evidence valid for the population sample. As shown in Table IV, the presence of bone abnormalities was not related to referred pain, even when the "disks in function" subgroups were considered independently (odds ratio = .737; confidence interval, 0.187-2.555; $P = .414$). A previous study with 131 symptomatic patients found a significant relationship between pain and the MRI diagnosis of osteoarthritis.[26] However, this study considered a large age range (14-79 years), which could be related to more severe presentations of bone changes.

Despite the known limitations of MRI, a statistically significant association was demonstrated between osseous changes and disk displacement without reduction ($P < .0001$). A previous study that investigated 74 symptomatic patients who underwent MRI found that erosion of the articular eminence and the combination of erosion of the condyle and osteophytes were more common in DDwoR.[27] An association between DDwoR and degenerative bone changes was also seen in a study of 180 patients (mean age 33.4 years) referred for MRI and CT.[3] Moreover, it has been suggested that the risk of degenerative changes and joint effusions increases with the severity of disk displacement.[26-28] For this reason, patients with TMD with confirmed DDwoR or disk deformity on MRI should undergo examination with CBCT.[29]

The occurrence of osseous abnormalities in a study based on CBCT images of 55 patients (mean age 41 years) ranged from 5% to 25%.[12] Our results demonstrated a distribution from 0.49% to 17% (see Table II). In some types of abnormalities, the difference between both results was up to 12 times higher. These results showed that MRI was better at detecting changes in the size of the TMJ, such as deformities, than in detecting changes in shape, for example, flattening, osteophyte formation, or erosion. According to those authors, this could be primarily due to the limited spatial resolution of MRI; the slice thickness of MRI (3 mm in their study) may be too thick to detect subtle osseous changes.[12] Our results do not corroborate those previous findings. The most common alterations observed in the present investigation were condylar hypoplasia (23.52% of patients − 17.16% of TMJs), condylar erosion (16.66% of patients − 9.31% of TMJs), and the presence of osteophytes (8.82% of patients − 4.41% of TMJs) (see Table II). This contradiction could be due to the difference in the mean age of the patients and/or to the protocol used (i.e., the present research acquired 10 slices, 2 mm thick, per sequence, and the previous authors had used 7 slices, 3 mm thick).

It is important to remember that TMD is a multifactorial disease. Psychosocial factors, such increased levels of stress, somatic complaints, and emotional problems, may play a more prominent role than anatomic factors in adolescents with TMD.[30] This could justify the presence of severe TMD in some of the young patients included in our study. However, those psychosocial factors were not taken into consideration in the present study. A future study would be necessary to investigate this possible association. Other interesting future studies would be (1) a longitudinal follow-up study to determine the MRI findings of the evolution of disk displacement from adolescence to adulthood, and (2) a transversal comparison of the most common findings in each age group (e.g., children, adults, and older adults) to try to establish a direct relationship between age and TMJ alterations.

CONCLUSIONS

On the basis of the data presented for a specific population of patients under 21 years of age, it is possible to conclude that (1) young patients are susceptible to all stages of disk displacement, and (2) there was a lack of a statistically significant association between osseous abnormalities, pain, and disk displacement, except for the most severe stage of disk displacement (bilateral disk displacement without reduction), which was strongly correlated with both variables.

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