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Association between clinical TMJ Pathology and magnetic resonance imaging findings on disc displacement, function, position and condylar excursion

Abstract

Objective: The purpose of this study was to evaluate the association of clinical temporomandibular joint (TMJ) pathology with disc displacement, function and position, as well with the degree of condylar excursion identified through magnetic resonance imaging (MRI).

Material and methods: Disc displacement, function and position as well as the degree of condylar excursion were identified in TMJ MRIs taken from 70 patients. The association of these variables with signs and symptoms such as pain, TMJ clicking and crepitus, and irregular or limited mouth opening was assessed through bivariate and multivariate logistic regression.

Results: Positive associations were found between

1.Disc displacement with reduction and hypoexcursion with pain ($p \leq 0.05$).

2.Disc displacement with reduction and clicking ($p=0.05$).

3.Retrusive disc position (before 10o'clock), disc displacement without reduction and hypoexcursion with irregular and limited mouth opening ($p<0.05$).

Conclusion: This study suggests that normal disc positioning ranges from 10 to 1o'clock and that disc displacement with and without reduction and hypoexcursion are risk factors for clinical TMJ signs and symptoms when the disc is in a retrusive position. Clinical TMJ pathology appears to be associated with some MRI findings related to disc function, position and degree of condylar excursion.

Keywords: magnetic resonance imaging, orofacial pain, temporomandibular joint dysfunction syndrome, temporomandibular joint

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Introduction

The temporomandibular joint (TMJ) may be affected by musculoskeletal disorders related to structural, neuromuscular, occlusal and psychological factors, as by parafunctional habits, such as bruxism, postural abnormalities, trauma or degenerative processes of TMJ, resulting in temporomandibular dysfunction (TMD). This problem is characterized by the presence of orofacial pain, difficulty in performing mandibular movements during opening movements of the mouth, and by the advent of clicking and popping sounds in the joint.[1,2] With its increasing availability and lower costs, magnetic resonance imaging (MRI) is establishing itself as the gold standard for the diagnosis of internal derangements of the temporomandibular joint (TMJ).[3] This imaging modality is invaluable especially when clinical examination is unable to determine disc position.[4] Moreover, significant correlation between clinical symptoms and MRI findings has been demonstrated when evaluating patients with internal derangement of the TMJ.[5] There is a strong association between disc displacement and TMJ pain or dysfunction.[6] Some studies have shown that symptoms are more severe in cases of disc displacement without reduction than in cases of disc displacement with reduction.[6,7] Furthermore, there is a statistically relevant association between anterior disc displacement with reduction and reciprocal clicking, and between anterior disc displacement without reduction and limited mouth opening. Alternatively, others have reported on the absence of a relation between pain severity and variations of mandibular movement,[9] or between disc displacement with and without reduction and pain.[8,9] The purpose of this study was to evaluate the association of clinical temporomandibular joint (TMJ) pathology with disc displacement, function and position, as well with the degree of condylar excursion identified through magnetic resonance imaging (MRI), in an effort to deliver information that may contribute for better diagnosis and treatment planning of temporomandibular joint disorders (TMDs).

Material and methods

Design of study and characteristic of sample

A cross-sectional, observational and analytical study was performed. The sample of this study comprised 140 magnetic resonance images of 70 patients who was attended a private radiology service.

Image acquisition

All images were acquired with a SignaHDxt MRI unit (General Electric, Milwaukee, WIS, U.S.A.) operating at 1.5 TESLA with 6cm x 6cm bilateral coils. For image acquisition, patients were placed in the supine position. A 256x256 matrix was used with a field of view (FOV) of 145mm and 0.60mmx0.57mm pixel. Sagittal, axial and coronal images were evaluated in T1 and stored as Digital Imaging and Communication in Medicine (DICOM) files.

Initial image assessment

The exclusion criteria applied to the initial image set were:

1. Difficult visualization of the articular disc.
2. Images from patients who underwent TMJ surgery.
3. History of systemic inflammatory disease in the joints, facial trauma/fractures.
4. Patients with TMJ hypoplasia, hyperplasia, tumors and syndromes.
5. The 140 images comprising the study sample were drawn from the images that passed the exclusion criteria.

Image assessment and data collection

Images were used to classify disc displacement and function. Determination of disc position and degree of condylar excursion was performed by two calibrated examiners blinded for the results of the patients' clinical examination.

Disc displacement was classified using MR images obtained with mouth closed and according to the system proposed by Tasaki et al.,[10] which offers the following options: superior disc position, anterior displacement, partial anterior displacement of the lateral segment, partial anterior displacement of the medial segment, anterolateral rotational displacement, anteromedial rotational displacement, lateral displacement, medial displacement and posterior displacement. In this study, one additional option wasadded: the partial *en bloc* anterior displacement. In addition, presence and absence of disc displacement was recorded for the sake of association analysis.

To determine whether the TMJ was functioning normally or had disc displacement with or without reduction, sagittal images obtained with the mouth closed and open were used (Figure 1). Function was considered normal when the disc was interposed between the lower part of the eminence and the uppermost portion of the condyle, both with the mouth closed and open. Disc displacement with reduction was identified and recorded when the disc was positioned between the uppermost portion of the condyle and the lowermost portion of the eminence during mouth opening. Disc displacement without reduction was identified and recorded when the disc remained anterior to the condyle and the eminence during mouth opening.[9–11] The main author and one calibrated radiologist assessed disc position and degree of condylar excursion in sagittal MR images obtained with the mouth closed and open. Examiners were blind toother MR images and to the symptoms recorded on the patients' medical records. The Kappa test that assessed interobserver agreement resulted in values of 0.89 for the right TMJ and 0.93 for the left TMJ, which were considered acceptable for the validation of this study.

To classify the position of the articular disc, a new categorization of the 12-hours technique - based on the distribution of hours in a clock (Drace, Enzmann, 1990) – was suggested. We employed the Centricity Dicom Viewer version 2.2 software (General Electric, Waukesha, WIS, U.S.A.). Positions were categorized into five groups: before 10 o'clock, between 10-11 o'clock, between 11-12 o'clock, between 12-1 o'clock and past 1 o'clock. The disc was considered in a normal position when the thickest portion of the posterior margin of the disc was on the most prominent portion of the condyle, i.e.,between 11-12o'clock.[9,10]

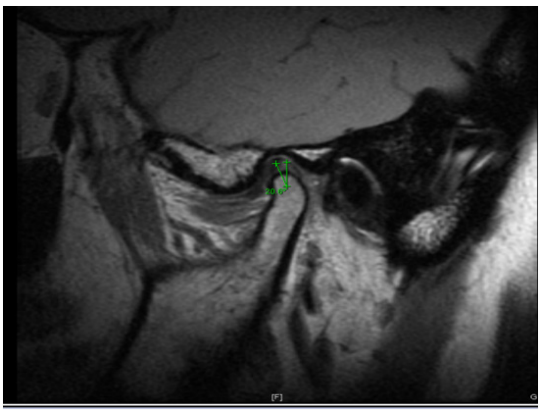

Figure 1 Examination of MR image by MR after measurement.

The disc-condyle relationship was first measured in degrees, and later the angles were converted into hours. The 0° position corresponded to the 12o'clock position. The conversion from degrees to hours is described in Table 1.

The degree of condylar excursion was classified according to the system proposed by Haiter-Netoet al.[11] and Senna et al.[9] Thus, condylar excursion was classified as: Ho - Hypoexcursion, when there was a limitation of the condylar excursion, i.e., the condyle was posterior to the apex of the articular eminence; Ne - Normoexcursion, when the condyle was at the level of the articular eminence;and He-Hyperexcursion, when the condyle was hypermobile and lied anterior to the apex of the articular eminence.

Clinical data on TMJ symptoms were collected from the charts of each patient, and the following signs and symptoms were recorded: presence of joint pain, joint crepitus, joint clicking, irregular mouth opening and limited mouth opening.

Ethical aspects

The study's project was approved without restrictions by the Research Ethics Committee-State University of Paraíba (protocol number: 39062914.0.0000.5187). All individuals willing to participate in the study were asked to sign an informed consent form. All rights of participants have been protected. A signed informed consent was obtained from each patient sampled in this study. The STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) checklist was used to assist in conducting the survey.

Data analysis

Statistical analysis consisted of bivariate and multivariate logistic regression to evaluate the association between the dependent and independent variables. The IBM SPSS Statistics software (SPSS for Windows, version 20.0; SPSS Inc, Chicago, IL, USA) was used for data analysis, considering a 95% confidence interval.

Results

Most of the patients were female (82.9%) with a mean age of 39.2 years. Regarding disc function, frequencies were similar for normal functioning discs and discs displaced with reduction (44.9% and 41.3%, respectively). On the other hand, displacement without reduction showed a lower frequency (13.8%). Regarding the degree of condylar excursion, normal excursion corresponded to 80% of the sample, followed by hypoexcursion (19.3%) and hyperexcursion (7%). The most frequent types were the anterolateral rotational displacement (ARD-lateral, 12.9%) and the medial displacement (MD, 8.6%) (Table 1).

Table 1 Sample characteristics based on the age and sex of patients as well disc function, condylar excursion and TMJ disc displacement types

Variables		n	%
Sex [70]	Female	58	82,9
	Male	12	17,1
Age group [70]	15-30 years	25	35,7
	31-45 years	21	30,0
	46-60 years	18	25,7
	> 60 years	6	8,6
Disc function [138]	Normal	62	44,9
	Desl. com redução	57	41,3
	Desl. sem redução	19	13,8
Condylar Excursion BA – TMJ [140]	Normo excursão	112	80,0
	Hipoexcursão	27	19,3
	Hiperexcursão	1	,7
Disc displacement type [140]	*N*	64	45,7
	AD	10	7,1
	PAD -enbloc	5	3,6
	PAD – medial	7	5,0
	PAD – lateral	9	6,4
	RAD – medial	9	6,4
	RAD -lateral	18	12,9
	MD	12	8,6
	LP	7	5,0
	PD	0	0,0

Note: Values between brackets indicate the total amount of patients that answered the question. N, normal position; AD, anterior displacement; PAD block, partial anterior displacement en bloc; PAD, medial, partial anterior displacement of the medial segment; PAD, lateral, partial anterior displacement of the lateral segment; RAD, medial, anteromedial rotational displacement, lateral RAD, anterolateral rotational displacement; MD, medial displacement; LD, lateral displacement; PD, posterior displacement.

Table 2 shows that patients with disc displacement with reduction were 2.03 times more likely to have TMJ pain when compared to those with normal excursion (p=0.05). Patients with hypoexcursion of the condyle were shown to have 4.59 times more chance of having pain than those with normal excursion (p=0.01). Moreover, there was no significant association between the independent variables and crepitus (Table 3). Only disc function showed a statistically significant association with joint clicking (p=0.05). TMJs showing disc displacement with reduction associated positively and had a 2.13-fold chance of clicking than did normal functioning TMJs (Table 4).

Table 2 Bivariate regression for the independent variables disc position, disc displacement, disc function and condylar excursion and the dependent variable pain

		Pain					
		Absent	Present	p	OR	95% CI	
		n(%)	*n*(%)			Low	High
Disc position, left TMJ closed mouth	From 11 to 12 o'clock	31(50%)	31(50%)				
	Before 10 o'clock	13 (46,4%)	15 (53,6%)	0,75	1,15	0,47	2,82
	From 10 to 11 o'clock	24 (50%)	24 (50%)	1,00	1,00	0,47	2,12
	From 12 to 1o'clock	2 (100%)	0 (0,0%)	0,99	0,00	0,00	.
Discdisplacement	Absent	33 (44%)	42 (56%)				
	Present	37 (57,8%)	27 (42,2%)	0,13	0,57	0,29	1,12
Discfunction, open mouth	Normal	37 (59,7%)	25 (40,3%)				
	DDWR	24 (42,1%)	33 (57,9%)	0,05	2,03	0,98	4,22
	DDWoR	9 (47,4%)	10 (52,6%)	0,34	1,64	0,58	4,62
Condylarexcursion, open mouth	Normal	63 (58,6%)	48 (43,2%)				
	Hipoexcursion	6 (22,2%)	21 (77,8%)	0,01	4,59	1,72	12,26
	Hiperexcursion	1 (100%)	0 (0,0%)	1,00	0,00	0,00	.

Note: p, level of significance; OR, odds ratio; n, frequency; TMJ, temporomandibular joint; DDWR, disc displacement with reduction; DDWoR, disc displacement without reduction.

Table 3 Bivariate regression for the independent variables disc position, disc displacement, disc function and condylar excursion and the dependent variable crepitus

		Crepitus				95% CI	
		Absent	Present	p	OR		
		n(%)	n(%)			Inferior	Superior
Disc position, left TMJ closed mouth	From 11 to 12 o'clock	58 (93,5%)	4 (6,5%)				
	Before 10 o'clock	27 (96,4%)	1 (3,6%)	0,58	0,53	0,05	5,03
	From 10 to 11 o'clock	43 (89,6%)	5 (10,4%)	0,45	1,68	0,42	6,65
	From 12 to 1o'clock	2 (100%)	0 (0,0%)	0,99	0,00	0,00	.
Discdisplacement	Absent	67 (89,3%)	8 (10,7%)				
	Present	62 (96,9%)	2 (3,1%)	0,10	0,27	0,05	1,32
Discfunction, open mouth	Normal	60 (96,8%)	2 (3,2%)				
	DDWR	51 (89,5%)	6 (10,5%)	0,13	3,52	0,68	18,25
	DDWoR	17 (89,5%)	2 (10,5%)	0,22	3,52	0,46	26,94
Condylarexcursion, open mouth	Normal	102 (91,9%)	9 (8,1%)				
	Hipoexcursion	26 (96,3%)	1 (3,7%)	0,44	0,43	0,05	3,59

***Note*:** p, level of significance; OR, odds ratio; n, frequency; TMJ, temporomandibular joint; DDWR, disc displacement with reduction; DDWoR, disc displacement without reduction.

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Table 4 Bivariate regression for the independent variables disc position, disc displacement, disc function and condylar excursion and the dependent variable clicking

		Clicking		p	OR	95% CI	
		Absent	Present				
		n(%)	n(%)			Inferior	Superior
Disc position, left TMJ closed mouth	From 11 to 12 o'clock	21 (33,9%)	41 (66,1%)				
	Before 10 o'clock	12 (42,9%)	16 (57,1%)	0,41	0,68	0,27	1,70
	From 10 to 11 o'clock	15 (31,3%)	33 (68,8%)	0,77	1,12	0,50	2,52
	From 12 to 1o'clock	0 (0,0%)	2 (100%)	0,99	8,27	0,00	.
Discdisplacement	Absent	24 (32%)	51 (68%)				
	Present	24 (37,5%)	40 (62,5%)	0,49	0,78	0,38	1,58
Discfunction, open mouth	Normal	24 (38,7%)	38 (61,3%)				
	DDWR	13 (22,8%)	44 (77,2%)	**0,05**	**2,13**	**1,00**	**4,76**
	DDWoR	11 (57,9%)	8 (42,1%)	0,14	0,45	0,16	1,30
Condylarexcursion, open mouth	Normal	37 (33,3%)	74 (66,7%)				
	Hipoexcursion	10 (37%)	17 (63%)	0,40	0,71	0,31	1,58
	Hiperexcursion	1 (100%)	0 (0,0%)	0,00	0,00	0,00	

Note: p, level of significance; OR, odds ratio; n, frequency; TMJ, temporomandibular joint; DDWR, disc displacement with reduction; DDWoR, disc displacement without reduction.

As for the association between the independent variables and irregular mouth opening, some risks factors were identified. For instance, disc position before 10 o'clock (OR=2.88, p=0.04), disc displacement without reduction (OR=3.43, p=0.03) and condylar hypoexcursion (OR=11.36, p<0.01) showed statistically significant, positive association with irregular mouth opening (Table 5). Three variables showed statistically significant ($p \leq 0.05$) positive associations with limited mouth opening. TMJs with disc position before 10 o'clock were 9.10 times more likely to show mouth opening limitation, while joints with non-reducible disc displacement were 10.09 times more likely to present limited mouth opening. Interestingly, hypoexcursion was identified as a strong risk factor with a striking OR of 40 (Table 6). The remaining variables in the multivariate model were disc position and condylar excursion. TMJs with disc position before 10 o'clock were five times more likely to show mouth opening limitation (p=0.01), while hypoexcursive joints were 25.32 times more likely to present limited mouth opening (p=0.01, Table 7).

Table 5 Bivariate regression for the independent variables disc position, disc displacement, disc function and condylar excursion and the dependent variable irregular mouth opening

		IMO		p	OR	95% CI	
		Absent	Present				
		n(%)	n(%)			Inferior	Superior
Disc position, left TMJ closed mouth	From 11 to 12 o'clock	52 (83,9%)	10 (16,1%)				
	Before 10 o'clock	18 (64,3%)	10 (35,7%)	0,04	2,88	1,03	8,07
	From 10 to 11 o'clock	40 (83,3%)	8 (16,7%)	0,94	1,04	0,37	2,87
	From 12 to 1o'clock	2 (100%)	0 (0,0%)	0,99	0,00	0,00	.
Discdisplacement	Absent	59 (78,7%)	16 (21,3%)				
	Present	53 (82,8%)	11 (17,2%)	0,53	0,76	0,32	1,79
Discfunction, open mouth	Normal	53 (85,5%)	9 (14,5%)				
	DDWR	47 (82,5%)	10 (17,5%)	0,65	1,25	0,46	3,34
	DDWoR	12 (63,2%)	7 (36,8%)	**0,03**	**3,43**	**1,06**	**11,06**
Condylarexcursion, open mouth	Normal	100 (90,1%)	11 (9,9%)				
	Hipoexcursion	12 (44,4%)	15 (55,6%)	**<0,01**	**11,36**	**4,25**	**30,33**
	Hiperexcursion	0 (0,0%)	1 (100%)	1,00	1,46	0,00	.

Note: IMO, irregular mouth opening; p, level of significance; OR, odds ratio; n, frequency; TMJ, temporomandibular joint; DDWR, disc displacement with reduction; DDWoR, disc displacement without reduction.

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Table 6 Bivariate regression for the independent variables disc position, disc displacement, disc function and condylar excursion and the dependent variable limited mouth opening

		LMO				95% CI	
		Absent	Present	p	OR		
		n(%)	n(%)			Inferior	Superior
Disc position, left TMJ closed mouth	From 11 to 12 o'clock	53 (85,5%)	9 (14,5%)				
	Before 10 o'clock	11 (39,3%)	17 (60,7%)	**0,01**	**9,10**	**3,22**	**25,66**
	From 10 to 11 o'clock	40 (83,3%)	8 (16,7%)	0,75	1,17	0,41	3,32
	From 12 to 1o'clock	2 (100%)	0 (0,0%)	0,99	0,00	0,00	
Discdisplacement	Absent	53 (70,7%)	22 (29,3%)				
	Present	53 (82,8%)	11 (17,2%)	0,09	0,50	0,22	1,13
Discfunction, open mouth	Normal	53 (85,5%)	9 (14,5%)				
	DDWR	46 (80,7%)	11 (19,3%)	0,48	1,40	0,53	3,69
	DDWoR	7 (36,8%)	12 (63,2%)	**0,01**	**10,09**	**3,13**	**32,51**
Condylarexcursion, open mouth	Normal	100 (90,1%)	11 (9,9%)				
	Hipoexcursion	5 (18,5%)	22 (81,5%)	**0,01**	**40,00**	**12,62**	**126,77**
	Hiperexcursion	1 (100%)	0 (0,0)	1,00	0,00	0,00	

Note: LMO, limited mouth opening; p, level of significance; OR, odds ratio; n, frequency; TMJ, temporomandibular joint; DDWR, disc displacement with reduction; DDWoR, disc displacement without reduction.

Citation: Queiroz JC, Melo NBD, Martins SKLD, et al. Association between clinical TMJ Pathology and magnetic resonance imaging findings on disc displacement, function, position and condylar excursion. *J Dent Health Oral Disord Ther.* 2019;10(4):226–234. DOI: 10.15406/jdhodt.2019.10.00489

Table 7 Multivariate regression for the independent variables disc position and condylar excursion and the dependent variable limited mouth opening

		p	OR	95% CI	
				Inferior	Superior
Disc position, left TMJ closed mouth	From 11 to 12 o'clock				
	Before 10 o'clock	0,01	5,00	1,30	19,18
	From 10 to 11 o'clock	0,55	1,48	0,40	5,41
	From 12 to 1o'clock	0,99	0,00	0,00	
Condylarexcursion, open mouth	Normal				
	Hipoexcursion	0,01	25,32	7,46	85,96
	Hiperexcursion	1,00	0,00	0,00	

Note: p, level of significance; OR, odds ratio; TMJ, temporomandibular joint.

Discussion

Since only disc position before 10 o'clock showed association with irregular opening and with limited mouth limitation of buccal opening, it seems that positions between 10 o'clock and 1 o'clock are compatible with the absence of such clinical findings. There was no significant association between disc position and pain, which goes in line with the reports by Emshoffet al.[12] and Senna et al.[9] In this study, we observed an association between disc displacement with reduction and pain, unlike other studies[6,13,14] which showed that pain had a stronger association with non-reducible disc displacement. In our sample, disc displacement without reduction showed a relatively low frequency (13,8%). Pain is the main symptom leading patients to seek treatment, since it compromises the patient's quality of life and affects overall oral health.[15]

However, the association between reducible disc displacement and clicking and non-reducible disc displacement and limited mouth opening corroborate what had already been demonstrated by Mariz et al [8]. In addition to mouth opening limitation, disc displacement without reduction was associated with irregular mouth opening. Of notice, Moncada et al.[16] showed that non-reducible discs are significantly associated with degenerative bone changes. Hypoexcursion showed strong association with signs and symptoms such as pain ($p<0.05$, OR=4.59), irregular opening ($p<0.01$, OR=11.36), and limited mouth opening ($p<0.05$, OR=40.00) in the bivariate regression model, findings that differ from those by Senna et al.[9] who reported that pain was associated with hypermobility (hyperexcursion). However, it should be emphasized that only one case of hyperexcursion was identified in our sample, which could void any attempts to determine the presence of an association with that variable.Concerning irregular and limited mouth opening, three variables were associated with these signs: disc position before 10 o'clock, disc displacement without reduction and condylar hypoexcursion. It has been reported elsehwere that the most severe morphological disc alterations[17] are identified in patients with non-reducible disc displacement. A multivariate logistic regression model was possible for limited mouth opening, in which disc position before 10 o'clock ($p <0, 05$, OR = 5.00) and hypoexcursion ($p <0.05$; OR = 25.32) were identified as risk factors. It is important to emphasize that during the natural course of the disease, the disc shortens and becomesanteriorly displaced, which is accompanied by reductions in condyle height and changes in the clinical picture.[18] Surprisingly, associations between crepitus and the independent variables was not observed here, probably due to the small number of patients accusing the presence of this signal (n=10). There was also no association between disc displacement with the mouth closed and clinical symptomatology, a result similar to that of studies by Emshoffet al.,[12] Mariz et al.[8] and Senna et al.[9]

According to Badelet al.,[19] there is no significant difference with regards to disc and condyle position in patients with disc displacement; however, in patients without disc displacement, asymptomatic and symptomatic cases show differences in these variables. Thus, it appears that associations exist between disc position before 10 o'clock and disc function (i.e.,disc displacement with and without reduction), and between condylar hypoexcursion and TMJ symptomatology. Disc position before 10 o'clock, disc displacement and condylar hyporexcursion showed significant association with TMJ symptomatology. According to the categorization of disc position proposed here and assessed by means sagittal MR images obtained with the mouth closed mouth, only disc positioned before 10 o'clock showed an association with TMJ symptoms, which points to disc positions ranging from 10 o'clock to 1 o'clock as being compatible with the absence of symptomatology. Regarding disc function, disc displacement with and without reduction showed associations with some signs and symptoms. Only condylar hypoexcursion was associated with TMJ symptoms.

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Conflict of interest

The author declares that there is no conflict of interest.

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