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TMJ

Correlation between joint effusion and morphology of the articular disc within the temporomandibular joint as viewed in the sagittal plane in patients with chronic disc displacement with reduction: A retrospective analytical study from magnetic resonance imaging

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ABSTRACT

Objective: To evaluate the presence of joint effusion and morphology of the articular disc (AD) viewed in the sagittal plane in patients with disc displacement with reduction (DDWR) and to correlate the results with clinical findings.

Methods: The sample consisted of 116 patients with DDWR who were evaluated clinically and with magnetic resonance imaging. The AD's morphology was assessed from the sagittal view with the mouth both open and closed. The statistical analysis demonstrated a significance level of 5%.

Results: With a mean age of 35 years, 79 patients (68.10%) showed joint effusion, and the female gender was most prevalent ($p < 0.05$). The results showed a relationship between joint effusion and DDWR in both sides ($p < 0.05$).

Conclusion: Clinically, the present study can infer that DDWR is associated with joint effusion, and females are the most affected. It can be suggested that the pain may be associated with joint effusion.

KEYWORDS
Temporomandibular joint; effusion; temporomandibular joint disorders; magnetic resonance imaging; articular disc

Introduction

Temporomandibular disorders (TMDs) are a set of changes involving the stomatognathic system, particularly the masticatory musculature and the temporomandibular joints (TMJs) or both [1–3].

Disc displacement with reduction (DDWR) is one of the most frequent of all internal derangements of the TMJ, associated with and without pain [4,5]. In this condition, the articular disc (AD) is in an anterior position relative to the mandibular head of the condyle when the mouth is closed, and when the mouth is open, the AD returns to normal position in the middle zone between the upper pole of the mandibular head and the articular tubercle [6,7].

Sometimes, DDWR can cause deformation of the AD, such as changes in its biconcave morphology, due to mechanical overload resulting in a release of inflammatory mediators, causing pain in the joint [8,9]. With magnetic resonance imaging (MRI), the presence of inflammatory changes in the retrodiscal tissue and synovial membrane of the TMJ is observed by an increase in the T2 signal, also known as joint effusion (JE) [10].

Beyond the connection between the presence of articular effusion and pain in the TMJ [11,12], there is evidence that abnormal relations of the AD morphology and position can lead to JE [13]. Clinically, DDWR can affect the AD and pain levels, and investigating the association between the morphology of the AD and JE in patients with this disorder can lead to a better understanding to contribute to positive changes in those suffering.

Therefore, the aim of this study was to evaluate the presence of JE and the morphology of the AD, as

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viewed in the sagittal plane in patients with DDWR, and to correlate the findings with gender, age, affected side of the TMJ (right/left), pain level, and maximum interincisal distance (MID). The null hypothesis tested showed no significant association with the findings studied.

Materials and methods

This study was approved by the Ethics Committee for Research Involving Human Beings of the State University of Maringá, Maringá, Brazil (CAAE: 43121415.4.0000.0104). This retrospective, observational, cross-sectional analytical study was conducted according to the recommendations of the Strobe guidelines [14]. The Committee, due to the retrospective nature of this study, did not require a signed informed consent.

Secondary data were used from the medical records of patients attended between January 2005 and January 2016 in CENDDOR, Porto Alegre – RS. The same dentist with experience in TMD and orofacial pain performed all clinical evaluations and collected all clinical information.

The sample consisted of males and females over the age of 18 who demonstrated clinical signs and symptoms of intra-articular TMJ dysfunction, compatible with DDWR, according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) – axis I [15]. The positioning, morphology, and JE of the AD were evaluated from MRI and patients' respective medical reports. The exclusion criteria included individuals with rheumatoid arthritis; patients who presented with agenesis, hyperplasia, hypoplasia, and/or malignant neoplasm of the mandible head; bone ankylosis; previous surgery of the TMJ; and/or surgical intervention within the face.

The clinical information was acquired from the medical records and included gender, age (in years), side of the complaint, duration of pain (in months), pain level measured by means of the visual analog scale (VAS) (0–10), and the maximum interincisal distance (MID) measured in millimeters using a digital caliper (Mitutoyo®, Takatsu-ku, Kawasaki, Japan).

MRI examinations

MRI scans were obtained with a 1.5-T magnetic field apparatus (General Electric Signa HDX). T1-weighted sequences (return of longitudinal magnetization) were used, using a repetition time (RT) of 567 ms and an echo time (ET) of 11.4 ms. T2-weighted sequences (transverse magnetization decay) employed an RT of 5.200 ms and an ET of 168.5 ms, with a spherical surface coil of 9 cm in diameter. The matrix used for T1 sequences was 288 × 192 and 3 NEX (number of excitations) and for T2 sequences 288 × 160 and 4 NEX, with a field of view of 11 × 11 cm.

Six images of each TMJ in the sagittal oblique plane were obtained, perpendicular to the axis of the mandible head both in the maximum intercuspation and in the maximum mouth opening positions in each weighting (T1 and T2), with 3 mm cutting thickness and spacing between the sections of 10%. Previously, an axial view was used to find the image of the heads of the jaw (scanogram). Six images of each TMJ in the coronal oblique plane (T1 and T2) in a single heading, i.e., in the usual maximum intercuspation, were obtained parallel to the axis of the head of the mandible.

To keep the patient relaxed and minimize the movement to maintain the maximum mouth opening, an interocclusal device was placed in the interincisal space. The average time for completion of the procedure was 30 m.

A film with dimensions of 43 × 35 cm with documentation of images 3 × 4 (12 images) and magnification of 1.5 times was used. All MRI images were analyzed by the same experienced radiologist, based on the studies of Ahmad et al. [6].

In the evaluation of the images, the following changes were observed: AD morphology in T1; AD viewed in the sagittal plane in proton density (PD); and the presence of edema or JE in T2, based on the criteria of Gibbs and Simmons III [16].

AD morphology

The AD morphology was carried out according to the following formats: biconcave, biplanar, hemiconvex, biconvex, and folded [1,6] (Figure 1).

Sagittal view

To evaluate the AD position with the mouth closed, the AD space was divided into four compartments (A, B, C, and D), according to Murakami [1]; a line (H0) was drawn joining the lowest point of the articular tubercle *(e)* to the lowest point of the postglenoid process *(g)*. A second line (H1) was drawn parallel to the first, passing through the most anterior point of the functional surface of the mandibular head (*a*). Two more lines, parallel to each other and perpendicular to the H0 and H1, were drawn: L1, passing through the posterior edge of the functional surface of the mandible head and L2, perpendicular to point *(a)* (Figure 2).

For the analysis of the AD from the sagittal view with the mouth open, the AD space was divided into

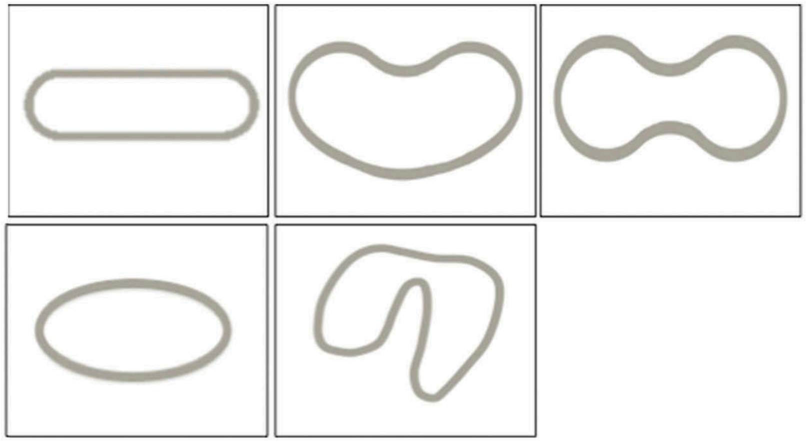

Figure 1. Possible morphologies of articular disc (AD), according to the criteria of Murakami et al., 1993. H0: the line joining the lowest point of the articular tubercle *(e)* to the lowest point of the postglenoid process *(g)*. H1: the line parallel to the first, passing through the most anterior point of the functional surface of the mandibular head *(a)*. L1: the line perpendicular to H0 passing through the posterior edge of the functional surface. L2: the line perpendicular to H0 passing through the anterior edge of the functional surface.

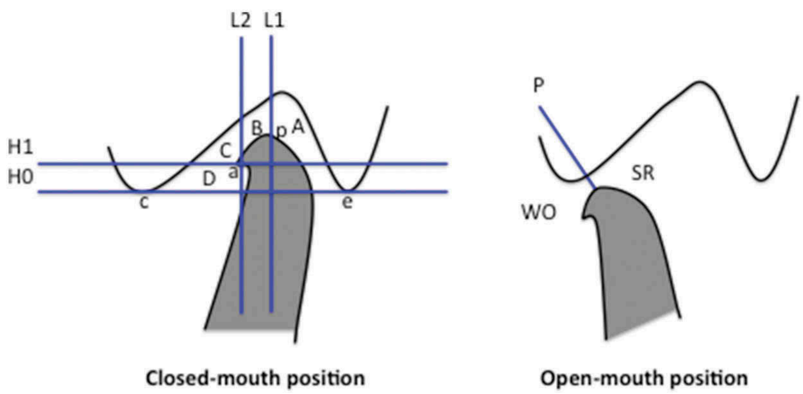

Figure 2. Divisions of joint space in the mouth closed and open, according to Murakami et al., 1993. WO: anterior position; SR: posterior position; P: the line passing through the point at which the mandible head was closer to the articular surface.

two spaces: anterior position (WO) and posterior position (SR), and a line (P) was drawn passing through the point at which the mandible head was closer to the articular surface [1] (Figure 2).

Joint effusion

JE is characterized by an increased signal in T2-weighted MRI in any compartment of the TMJ [6,10,16]. In the present study, JE was categorized as absent or present.

Statistical analysis

To calculate the patients' clinical findings and compare the different morphologies viewed in the sagittal plane in relation to the side of the affected TMJ, the chi-square test was applied. For the age (quantitative variable), location, and dispersion measures, means and standard deviations were calculated.

The bivariate analysis was applied, using Fisher's exact test, in order to find possible associations in clinical variables (predictor) with JE (response variable). The Kruskal–Wallis test was used for multiple regression analysis, and to analyze the variables, the Mann–Whitney test was used.

The data were analyzed with the program SAS, version 9.03, available at the Piracicaba Dental School (UNICAMP). The level of significance adopted for the tests and models was set at 5%.

Results

A total of 116 patients filled the search criteria, of which 37 (31.90%) showed no JE and 79 (68.10%) did have a presence of JE. With regard to gender, females

(78, 67.2%) were more prevalent ($p < 0.0001$) in relation to males (38, 32.8%). However, there was no positive association ($p > 0.05$) between gender and JE (Table 1).

Table 2 shows that there were no statistically significant values regarding the relationship between DDWR and presence of JE ($p > 0.05$). According to Fisher's exact test, there was no association between JE and the affected side of the TMJ ($p = 0.9652$). The same occurred separately for right and left sides associated with DDWR ($p = 0.2920$). However, there was a suggestive association between JE and DDWR in both sides ($p = 0.0414$) (Table 2).

The AD viewed from the sagittal plane, with the mouth open and closed, presented no statistically significant association with the presence or absence of JE ($p < 0.05$) (Table 3).

Similarly, there was no statistically significant association between AD morphology and the presence of JE ($p < 0.05$) (Table 4).

No statistically significant association was found by Fisher's exact test between age and JE ($p = 0.209$). According to VAS, although there was no association between pain and JE, 71% of the patients showed pain above a VAS equal to 5, which is characterized as moderate to severe pain.

The Mann–Whitney test results, which were analyzed according to the presence or absence of JE with the following variables: age, duration of pain (in months), VAS, and MID, suggested that there is no relation of these clinical variables with JE ($p > 0.05$) (Table 5).

Discussion

The JE is observed on the T2-weighted MRI where an accumulation of synovial fluid in the top and/or bottom compartments was present, as seen during inflammation. The present study showed that there are no significant associations between JE and AD morphology for either affected TMJ side or with the other clinical variables, therefore supporting the confirmation of the null hypothesis.

The prevalence in this study was of 68.10% of JE presence, agreeing with the findings of Emshoff et al. [17], where JE was present in 72.2% of the patients. Westesson and Brooks [18] observed 40% of JE in patients assessed. Furthermore, the literature suggests the need for a quantitative definition of JE because this varies from lightweight to moderate and may be present in non-symptomatic TMJs [13].

The female gender was the most prevalent in the sample (67.8%), agreeing with other studies [19–21], and the most affected age was between 30 and 40 years old, according to Oliveira et al. [20] and Muraoka et al. [21]. This prevalence of the female gender can be expected due to several factors affecting the female TMJ, such as increased intra-articular pressure [22] and increased ligament laxity [23].

The prevalence of JE in symptomatic patients was observed in 13–83% [15] and in the non-symptomatic patients was observed in 0–38.5%, confirming the idea that JE is present significantly in cases of pain [1–3]. Although this study showed no statistically significant association between pain and JE, the ranking of the current study presented 71% of the patients with pain from moderate to severe, suggesting that it may be a sign of TMD accompanied by JE.

Other studies demonstrated the biological mechanism of the articular disc displacement (ADD) as being the cause of JE, with the explanation that the excessive loads found in retrodiscal tissue of the TMJ with ADD have the ability to produce free radicals and nitric oxide, substances which contribute to the processes of degeneration and inflammation [11,12].

This study found a correlation between JE and bilateral DDWR ($p = 0.0414$), mainly for the left side ($p = 0.0204$), agreeing with other authors [19–24]. These authors found a stronger correlation between JE, pain, and ADD. Contrarily, Lin et al. [8] concluded that DDWR is not an important factor in the pathogenesis of the signs and symptoms of TMD. Thus, the painful symptoms can be the result of changes in other structures of the TMJ, like synovial liquid, bone, and ligament structures.

No other studies demonstrate so specifically the different AD morphologies examined in the sagittal plane, nor do they correlate this with JE. This study demonstrated that there was no significant association among them, suggesting that the AD morphology is

Table 1. Prevalence and association between gender and the presence of joint effusion.

	Without joint effusion (n = 36)	With joint effusion (n = 79)	Total (n = 116)
Female	23 (63.9%)	55 (69.6%)	78 (67.8%)
Male	13 (36.1%)	24 (30.4%)	38 (32.2%)

$p > 0.05$.

Table 2. Prevalence and association between disc displacement with reduction (DDWR) and the presence of joint effusion, according to the affected side.

		Without joint effusion	With joint effusion	Total
DDWR	Bilateral#	4 (11.1%)	6 (7.5%)	10 (8.6%)
	Right side*	15 (41.7%)	28 (35%)	43 (37.1%)
	Left side*	17 (47.2%)	46 (57.5)	63 (54.3%)

#$p < 0.05$; *$p > 0.05$.

Table 3. Prevalence and association between the articular disc position and the sagittal plane in mouth open and closed and the presence of joint effusion, according to the affected side.

		Right side		Left side	
		Without joint effusion	With joint effusion	Without joint effusion	With joint effusion
Mouth closed	A	–	1 (1.3%)	–	–
	B	11 (30.6%)	18 (22.5%)	8 (22.2%)	19 (23.8%)
	C	10 (27.8%)	18 (22.5%)	16 (44.4%)	22 (27.5%)
	D	15 (41.7%)	43 (53.8%)	12 (33.3%)	39 (48.8%)
Mouth open	Normal	35 (97.2%)	79 (98.8%)	36 (31%)	79 (69%)
	SR	1 (2.8%)	–	–	–
	WO	–	1 (1.3%)	–	–

WO: anterior position; SR: posterior position.

Table 4. Prevalence and association between articular disc (AD) morphology and the presence of joint effusion, according to the side, both with mouth closed or open.

		Mouth closed		Mouth open	
		Without joint effusion	With joint effusion	Without joint effusion	With joint effusion
Right side	Biconcave	10 (27.8%)	11 (13.8%)	30 (29.4%)	72 (70.6%)
	Biconvex	2 (5.6%)	1 (1.3%)	–	–
	Biplanar	7 (19.4%)	18 (22.5%)	2 (1.9%)	2 (1.9%)
	Hemiconvex	17 (47.2%)	50 (62.5%)	4 (3.9%)	6 (5.8%)
Left side	Biconcave	10 (27.8%)	15 (18.8%)	29 (80.6%)	69 (86.3%)
	Biconvex	1 (2.8%)	1 (1.3%)	1 (2.8%)	1 (1.3%)
	Biplanar	6 (16.7%)	17 (21.3%)	2 (5.6%)	5 (6.3%)
	Folded	–	1 (1.3%)	–	–
	Hemiconvex	19 (52.8%)	46 (57.5%)	4 (11.1%)	5 (6.3%)

Table 5. Correlation between age, duration of pain, pain on VAS scale, maximum interincisal distance, and the presence of joint effusion.

	Median (1º–3º quartiles)		
	Without joint effusion	With joint effusion	p (Mann–Whitney)
Age	29.5 (22–46)	35.5 (26–46)	0.17
Duration of pain (in months)	17 (6–48)	12 (5.5–36)	0.08
VAS (visual analog scale)	5 (4–8)	5 (4–7)	0.56
Maximum interincisal distance	45.62 (36.28–48.13)	41.97 (36.02–47.07)	0.26

not associated with the appearance of JE. Clinically, it showed that there was statistically significant prevalence between JE and the hemiconvex AD when the mouth was closed (62.5%) and the biconcave AD and JE when the mouth was open (86.3%).

Conclusion

Statistically, the current study can infer that there is a strong correlation between the presence of JE with the female gender and DDWR. Clinically, there is a possibility that the pain may be associated with JE. However, there is no correlation between both AD morphology, as viewed from the sagittal plane, and the appearance of JE.

Disclosure statement

The authors report no conflicts of interest.

Geolocation information

The present study was carried out in southern Brazil.

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