Relationship between symptoms and imagenological signs of degenerative temporomandibular joint disorders using the Research Diagnostic Criteria for Temporomandibular Disorders and cone-beam computed tomography

Relação entre sintomas e sinais imagenológicos das disfunções degenerativas da articulação temporomandibular com o Research Diagnostic Criteria for Temporomandibular Disorders e a tomografia computadorizada de feixe cônico

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ABSTRACT

BAKGROUND AND OBJECTIVES: Arthralgia is a common complaint among patients with temporomandibular osteodegeneration, however, for the accurate diagnosis of osteodegeneration, it is suggested the adoption of imaging tests associated with standardized clinical diagnosis protocols. The objective of this study was to evaluate patients with degenerative changes in the temporomandibular joint previously visualized by cone beam computed tomography, relating these changes with the clinical diagnoses and symptoms of temporomandibular disorders, in order to conclude which of the degenerative changes develop more painful symptomatology.

METHODS: A cross-sectional observational descriptive study. Thirty-eight patients who had previously done the cone beam computed tomography exam were evaluated. Subjects were grouped according to clinical diagnosis of temporomandibular joint changes using the Research Diagnostic Criteria for Temporomandibular Disorders questionnaire. The presence of pain was considered during lateral palpation; intra-articular palpation; excursive movements; and active mouth opening.

RESULTS: Among the purely clinical diagnoses, only 10.5% were conclusive, classifying patients as suffering from osteoarthritis/osteoarthrosis. Painful joint symptoms were found in all groups, with no statistically significant difference. Similarly, the presence of degenerative disorders, including flattening, osteophytes, sclerosis, and erosion were found in similar proportions in all diagnosis groups.

CONCLUSION: 89.5% of the degenerative changes were clinically underdiagnosed. There was a positive association between the presence of symptoms and the number of correct clinical diagnoses of osteoarthritis/osteoarthrosis obtained with the Research Diagnostic Criteria for Temporomandibular Disorders.

Keywords: Arthralgia, Cone-beam computed tomography, Osteoarthritis, Temporomandibular joint disorders.

RESUMO

JUSTIFICATIVA E OBJETIVOS: Entre os pacientes com osteodegeneração cortical temporomandibular, a artralgia é uma queixa comum, entretanto, para o diagnóstico preciso de osteodegeneração sugere-se a adoção de exames de imagem associados a protocolos de diagnóstico clínico padronizados. O objetivo deste estudo foi avaliar pacientes com alterações degenerativas da articulação temporomandibular previamente visualizados por tomografia computadorizada de feixe cônico, relacionando essas alterações com os diagnósticos e sintomas clínicos da disfunção temporomandibular, a fim de concluir quais das alterações degenerativas causam mais dor.

MÉTODOS: Trata-se de um estudo observacional descritivo transversal. Foram avaliados 38 pacientes que já haviam realizado a tomografia computadorizada de feixe cônico. Os indivíduos foram agrupados de acordo com o diagnóstico clínico de alterações na articulação temporomandibular, utilizando o questionário *Research Diagnostic Criteria for Temporomandibular Disorders*. A presença de

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dor foi considerada durante: palpação lateral; palpação intra-articular; movimentos excursivos; e abertura ativa da boca.

RESULTADOS: Entre os diagnósticos puramente clínicos, apenas 10,5% foram conclusivos, classificando os pacientes como portadores de osteoartrite/osteoartrose. Sintomas articulares dolorosos foram encontrados em todos os grupos, sem diferença estatisticamente significante. Da mesma forma, a presença de distúrbios degenerativos, incluindo achatamento, osteófitos, esclerose e erosão, foi encontrada em proporções semelhantes em todos os grupos de diagnóstico.

CONCLUSÃO: 89,5% das alterações degenerativas foram clinicamente subdiagnosticadas. Houve associação positiva entre a presença de sintomas e o número de diagnósticos clínicos corretos de osteoartrite/osteoartrose obtidos com o *Research Diagnostic Criteria for Temporomandibular Disorders*.

Descritores: Artralgia, Osteoartrite, Tomografia computadorizada de feixe cônico, Transtornos da articulação temporomandibular.

INTRODUCTION

The temporomandibular joint (TMJ) is a complex structure that can be affected by degenerative processes[1], with osteoarthritis being one of the most prevalent arthrogenic manifestations in this joint[2]. The degenerative process generally is manifested in a debilitating chronic form, with degradation of articular cartilage and subchondral bone changes evolving into synovial fibrosis[3,4]. It is believed that despite the multifactorial etiology, such changes are associated with a dysfunctional remodeling[5] due to diminished adaptive capacity and/or functional overload of this joint[6,7]. Changes in the protein of the beta-type transforming growth factor (TGF-β) have fundamental importance in the development of this pathology, since it is responsible for stimulating production of proteoglycans and type II collagen in the TMJ[3,5,8].

To date, there are few instruments that can determine the presence, severity, and progression of these degenerative processes in the TMJ, with treatment and diagnosis being based on clinical exams and imaging[9]. Depending on the diagnostic method used, on its specificity and sensitivity, the prevalence of these disorders can affect from 1 to 84% of the general population[2].

Currently, the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) is the most widely used instrument, especially in research. Although it is possible to perform the diagnosis of osteoarthritis/osteoarthrosis with this instrument, the use of tomograms is recommended as the gold standard for the diagnosis of such degenerative processes[10]. Imaging tests are necessary for the diagnosis of degenerative TMJ process, but this does not mean that the disease is active or needs treatment[10,11]. In 2014, an evolution of the old RDC/TMD - the "Diagnostic Criteria for Temporomandibular Disorders" (DC/TMD - was published in English, created with clinical and research objectives. This new tool has a sensitivity of 0.55 and specificity of 0.61 related to the diagnosis of degenerative changes, which sustains the need for the use of images[11].

Thus, magnetic resonance imaging (MRI) and computed tomography (CT) are still recommended to aid in the diagnosis of these disorders, enabling the visualization of changes even in the early stages of the disease[2]. While the first is able to show inflammation activity by T2 ponderation, the latter is considered the gold standard and, represented by cone beam computed tomography (CBCT), is a useful imaging modality for dentistry, with high dimensional accuracy for evaluation of facial structures, including TMJ[12]. With this exam it's possible to observe the presence of flattening, sclerosis, osteophytes, erosion, resorption of the mandibular condyle and/or fossa, as well as decreased joint space[13].

It's noted that, although for intra-articular conditions there is a need to use images for the determination of pathological changes, the authors of the DC/TMD themselves emphasize that imaging exams should not be used routinely[11], emphasizing the importance of clinical examination. Professionals should be alert for the existence of signs and symptoms related to inflammatory processes (even subclinical), including the presence of ear and joint pain, joint stiffness, clicking, crackling, and limitation of mandibular movement[14], in an attempt to make the diagnosis ever more accurate, even without the use of additional tests.

This study aims to evaluate patients with degenerative changes in the TMJ previously visualized through CBCT, relating such changes to the quality and quantity of clinical diagnoses and arthrogenic symptoms of TMD.

METHODS

This is a cross-sectional observational descriptive study. The sample was selected using the analysis of CBCT previously obtained at the radiology department of the School of Dentistry. Individuals were selected from both genders, with ages from 18 to 75 years, and who had imaging signs of degeneration in at least one TMJ. Patients who had already undergone treatment for TMD were excluded, as well as those with craniofacial trauma history who had already done some surgery, and patients with other pathologies involving this joint region.

The study methodology was divided into three levels:

1. Assess the presence of degenerative TMJ disorders through analysis of CBCT.

For the examination of each TMJ, the representative coronal section (most central region) of the mandibular condyle was selected, obtained using the TMJ window of the iCat Vision tomographic image handling software (Imaging Sciences International, Hatfield, Pennsylvania, USA). From this coronal section sequential parasagittal sections were generated, where the articular bone changes were evaluated.

The bone surfaces of the mandibular condyle and articular eminence of each TMJ were classified according to the methodology described by the study[15], according to the presence of: healthiness (no change); flattening (loss of rounded contour of surfaces); erosion (loss of continuity in cortical bone); osteophytes (exophytic formations growing from surfaces); and sclerosis (any increase in cortical thickness in load-bearing areas). Each possible change could appear alone or in combination, in at least two sequential parasagittal sections. This assessment was performed by a radiologist with experience in TMJ CBCT images, without knowledge of the patient's clinical data.

To perform the CBCT, the i-Cat Next Generation system was used, operating at 120 kV and 3-8mA, with the following image acquisition protocol specific to the TMJ region: exposure time 26.9 s, FOV of 8 cm, and voxel (slice thickness) of 0.25mm. All images were obtained in the open and closed mouth positions.

2. Clinical diagnosis of TMD

Once selected, the individuals who had degenerative changes observed in the CBCT examination were asked to return to the School of Dentistry to participate in the study and a subsequent clinical examination of the TMJ.

The RDC/TMD - Axis I[10,16] enabled verification of whether the patients had some type of TMD, as well as classification according to their type: 1) muscle disorders (Group I); 2) articular disc position changes (Group II); and 3) painful and degenerative conditions of the TMJ (Group III). The instrument was administered to all patients by a single trained and calibrated examiner. This diagnostic method is considered the gold standard for diagnosis in TMD research[10,16]. RDC/TMD does not include imaging exams but suggests performing CT or MRI scans based on information obtained[10,11,15].

3. Assessment of the number of painful symptoms present in each joint

Through the clinical examination of the RDC/TMD, the joint symptoms present were assessed, considering a) pain on lateral palpation; b) pain on intra-auricular palpation; c) pain during excursive movements; and d) pain during active mouth opening.

This study was approved by the institution's Research Ethics Committee, CAAE: 308.39714.4.0000.5147 and registration number. 708,678. The patients signed the Free and Informed Consent Term (FICT) before signing the survey.

Statistical analyses

The absolute and relative frequencies of changes found were presented and the relationship between the presence of imaging changes, clinical diagnostics, and pain symptoms was shown using the Spearman correlation test. A significance level of 5% ($p \leq 0.05$) and a 95% confidence interval were adopted. The calculations were performed using SPSS 16.0 for Windows (IBM, Chicago, Illinois, USA).

RESULTS

From the analysis of CBTC, it was possible to select 38 individuals with degenerative changes in at least one of the TMJs, being 34 females and four males. The mean age of the sample was 48.8±9.2 years.

Clinically, according to the classification proposed by the RDC/TMD, it was possible to divide the sample into three groups according to diagnosis obtained, for comparison purposes: patients without TMD; patients without a group III clinic diagnosis; and patients with a group III clinic diagnosis (Table 1).

According to the symptoms presented, in the group of individuals clinically diagnosed without TMD, 28.5% had pain during mouth opening, as well as pain on intra-auricular palpation. In participants without a group III diagnosis, the main symptom found was joint pain during excursive movements, 46.6% were symptomatic during lateral palpation and on intra-auricular palpation. In those with degenerative changes observed both via imaging as well as the RDC/TMD, 100% had pain on lateral palpation (Table 2). Using the Spearman correlation test, positive correlation was observed between the presence of symptoms and the number of clinical diagnosis ($r=0.5585$) with a statistically significant p-value ($p=0.0003$), suggesting that as more symptoms were presented by patients, more diagnoses of degenerative changes were obtained.

Evaluating the prevalence of degenerative changes in the articular eminence region observed in the tomography exam in the group that did not receive a clinical diagnosis of TMD, five individuals had planning in at least one TMJ and four had sclerosis, however, in none of the study participants was the presence of osteophytes and/or erosion in this structure observed.

In the group with TMD, but without a group III clinic diagnosis (n=15), it was observed that 100% of those evaluated had flattening in at least one TMJ, 93.3% had sclerosis, 73.3% osteophytes, and 40% had erosions.

Of the participants with a group III clinic diagnosis, in those with arthralgia (n=12), 83.3% had flattening, 66.6% sclerosis, 58.3% osteophytes, and 41.6% erosions. In the group clinically diagnosed as presenting osteoarthritis or osteoarthrosis (n=4), the values found were respectively 50, 50, 25 and 25% (Table 3).

Table 1. Clinical diagnosis of individuals, carried out by applying the RDC/TMD questionnaire

No TMD	Without group III clinic diagnosis		With group III clinic diagnosis	
	Group I	Group II	Arthralgia	Degenerative changes
7 (18.5%)	12 (31.5%)	3 (8%)	12 (31.5%)	4 (10.5%)
Total	15 (39.5%)			16 (42%)

TMD = temporomandibular joint disorder.

Table 2. Assessment of the presence of pain by RDC/TMD clinic diagnosis groups

Presence of pain	No TMD (n=7)	Without group III clinic diagnosis (n=15)	With group III clinic diagnosis (n=16)	
			Arthralgia (n=12)	Degenerative changes (n=4)
During active mouth opening	2 (28.5%)	7 (46.6%)	9 (75%)	1 (25%)
During excursive movements	0 (0%)	8 (53.3%)	9 (75%)	2 (50%)
On lateral palpation	0 (0%)	7 (46.6%)	10 (83.3%)	4 (100%)
On intra-auricular palpation	2 (28.5%)	7 (46.6%)	10 (83.3%)	2 (50%)

TMD = temporomandibular joint disorder.

Table 3. Prevalence of degenerative changes in the articular eminence region by RDC/TMD clinic diagnosis groups

	No TMD (n=7)	Without group III clinic diagnosis n=15)	With group III clinic diagnosis (n=16)	
			Arthralgia (n=12)	Degenerative changes (n=4)
Planning	5 (71.4%)	15 (100%)	10 (83.3%)	2 (50%)
Sclerosis	4 (57.1%)	14 (93.3%)	8 (66.6%)	2 (50%)
Osteophytes	0 (0%)	11 (73.3%)	7 (58.3%)	1 (25%)
Erosion	0 (0%)	6 (40%)	5 (41.6%)	1 (25%)

TMD = temporomandibular joint disorder.

Table 4. Prevalence of degenerative changes in the mandibular condyle region by RDC/TMD clinic diagnosis groups

	No TMD (n=7)	Without group III clinic diagnosis (n=15)	With group III clinic diagnosis (16)	
			Arthralgia (n=12)	Degenerative changes (n=4)
Planning	7 (100%)	12 (80%)	7 (58.3%)	3 (75%)
Sclerosis	6 (85.7%)	12 (80%)	8 (66.6%)	2 (50%)
Osteophytes	3 (42.8%)	7 (46.6%)	4 (33.3%)	1 (25%)
Erosion	1 (14.2%)	4 (26.6%)	3 (25%)	0 (0%)

TMD = temporomandibular joint disorder.

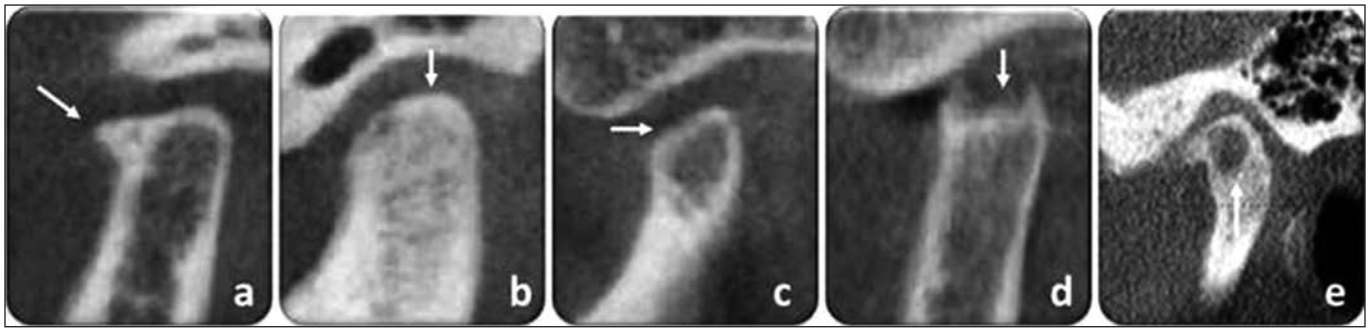

Figure 1. Cone bean computed tomography of different temporomandibular joints analyzed in parasagital sections
(a) osteophyte in the condyle; (b) sclerosis; (c) planning; (d) erosion; (e) generalized sclerosis in the articular eminence and subchondral pseudocyst in the condyle

Regarding the presence of osteodegenerative imaging signs in the mandibular condyle region (Figure 1), 100% of those assessed as without TMD had flattening, 85.7% sclerosis, 42.8% osteophytes, and 14.2% erosion. Of the 15 individuals without a clinic diagnosis of painful or degenerative conditions, 80% showed flattening, 80% sclerosis, 46.6% osteophytes, and 25% showed erosion, seen in imaging. In those diagnosed with arthralgia exclusively, it was observed that 58.3% had flattening in at least one TMJ, 66.6%sclerosis, 33.3% osteophytes, and 25% had erosion. While in those with a clinic diagnosis of osteoarthritis or osteoarthrosis (RDC/TMD), 75% had flattening, 50% sclerosis, 25% osteophytes, and no participant had erosion in the mandibular condyle region (Table 4). According to Spearman's test, there was no statistically significant relationship between the amount of imaging-based changes and the number of clinical diagnoses of group III (r=-0.0896, p=0.59). However, the result suggests that the higher the number of imaging-based changes present, the lower the number of correct diagnoses obtained by the RDC/TMD (negative correlation).

There also was no significant correlation between the presence of symptoms and image-based changes (r=0.1032, p=0.5374).

DISCUSSION

Degenerative changes of the TMJ are a group of disorders related to advancing age and are characterized as the most prevalent pathological condition that affect this joint[17]. The RDC/TMD is the research tool most widely used today for the diagnosis of TMD. Even so, although it aims for minimum inter-observer differences in its diagnoses, its accuracy in the clinic diagnosis of degenerative processes is unknown, since there are no clinical criteria considered the gold standard for the diagnosis of deterioration of the TMJ[9], which highlights the need for images for accurate diagnosis of such changes[9,17].

In a previous study[18], six specialists in TMD and Orofacial Pain assessed 204 patients clinically, using the RDC/TMD and they compared the clinical diagnosis with the presence of imaging changes found in the conventional tomography exam. According to the results, it was observed that the specialists underestimated the presence of imaging changes (including the presence of osteophytes, flattening, sclerosis, and erosion). This demonstrates that the clinical diagno-

sis of degenerative diseases has high specificity (ability to correctly identify TMJs without changes) (0.86 to 0.94), and low sensitivity (ability to correctly identify TMJs with changes) (0.14 to 0.40), with regard to osteodegenerative changes. The present study evaluated only patients who had degenerative changes observed via CBCT exam, and did not include a group of healthy individuals, considered the "control". However, the clinical diagnosis of osteoarthritis/osteoarthrosis made exclusively with the RDC/TMD comprised only 10.5% of the cases evaluated, revealing how much the degenerative processes are clinically underdiagnosed, since the entire sample had some image-based sign of osteodegeneration.

The most common signs and symptoms that accompany this process include joint or ear local pain, stiffness in the face and jaw, pain and limitation during mouth opening, pain when chewing, jaw crackling, and joint noises[19]. However, to date, considering previous studies that used different clinical exam protocols, as well as different radiographic techniques, it has not been possible to describe which imaging findings could be predicted from a clinical examination of the TMJ and adjacent structures[18]. What is known is that the presence of coarse crackling of the TMJ, as well as increased age and the influence of gender (women), present increased risk of having degenerative changes of the TMJ, while there are no variables related to pain that are associated with imaging findings[18,20]. In the present study, considering the clinical characteristics of sex and age, 89.5% of the female sample was found and the mean age was 48.8±9.2 years, slightly higher than what is described in the literature. The average age among patients with TMJ osteoarthritis was 36 ± 15.6 years, while the prevalence of women was 81.5% in another study[21]. A survey of Chinese women with osteoarthritis/osteoarthrosis[8] revealed a mean age of 33.5±14.3 years.

Also, according other study[20], clinically evaluating the variables related to the presence of pain (muscle or joint), its intensity and duration, and depression scores, it was not possible to associate them with the presence of degenerative changes in the TMJ. Similarly, in our assessment, the presence of pain during active mouth opening, during excursive movements, pain on lateral and intra auricular palpation, showed no significant statistical difference between the groups. However, according to the Spearman correlation test, it was observed that as more symptoms were presented by the patients, more imaging diagnoses were obtened. Analyzing the results, it is even possible to observe that 31.5% of the individuals had arthralgia, whose diagnosis was clear and evidenced by RDC/TMD. According to the RDC/TMD, the presence of crackling is considered a clinical sign of the degenerative disorder, that is, related to osteoarthritis (group III), due to the change in intra-articular lubrication and possible friction between its components. However, the results of the present study revealed a low frequency of this signal, even in group III patients. These findings, as pointed out by the authors of DC/TMD[11], emphasize the importance of standardized clinical examination, considering the presence of each sign and symptom, even if subclinical or perceived only by the professional. Some authors propose an optimization of the method of perception of joint sounds using a stethoscope, as recommended[22].

Another explanation for the lack of association between the presence of clinical symptoms and the imaging findings (r=0.1032, p=0.5374) is that the joint cartilages in the initial stages are often not seen in the images and the bone alterations that manifest sufficiently enough to be detected in these exams take a lot of time to develop[18]. Likewise, the different kinds of images used also make the results distinct and hard to be combined[23]. In the study[20], considering the presence of changes in the mandibular head, mandibular fossa, and tuber joint, a prevalence of 78.5% of flattening, 34.8% of osteophytes, 35.2% of erosion and 17.6% of sclerosis was found.

The author used the conventional tomography exam, while the present study used CBCT specifically to cranio-maxillofacial area, which explains the larger prevalence of osteodegenerative alterations evaluated by the CBCT.

As stated by other researches[12,24], CBCT shows minimization of image artifacts and specific resolution for cortical assessment of the cranio-maxillofacial area, including bone components of the TMJ. This fact was considered for choosing the image acquisition method adopted by the present study. For many years, scientific research on TMD has dealt with the difficulty of comparing results of studies involving TMD patients due to the lack of a clinical diagnostic protocol. RDC/TMD and, more recently, DC/TMD have contributed a lot to solving this problem, however, there are many studies that do not use these instruments[25]. CBCT, in addition to being effective for diagnosing temporomandibular arthrogenic disorders, has the advantage of its low radiation dose and lower cost compared to conventional tomography[23]. However, it also differs from radiographic methods in that it reproduces a section of the human body in any of the three spatial planes, allowing the visualization of all stratified structures, especially mineralized tissues, in addition to delimiting three-dimensional irregularities[24,26]. Therefore, it is believed that degenerative TMJ changes have a considerable prevalence in the population with TMD and that the number of cases of osteoarthritis may be underdiagnosed.

It is also considered that more well-designed prospective studies are needed to verify the prevalence in the general population[27].

It can also be learned that other changes, such as disc displacement, are involved in the manifestation of arthralgia[15,27] and that other diagnostic tools, such as MRI for soft tissue evaluation, can clarify this possible association27.

CONCLUSION

Arthralgia was the most observed condition among the individuals evaluated after using the RDC/TMD. There was a positive association between the amount of joint symptoms and the

number of conclusive clinical diagnoses obtained by the RDC/TMD. It is suggested that further studies be carried out using cone beam TCy, comparing their findings with clinical information, so that it is possible to evaluate other associations between signs, symptoms, and osteodegenerative changes of the TMJ.

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