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Cone-beam computed tomography analysis of degenerative changes, condylar excursions and positioning and possible correlations with temporomandibular disorder signs and symptoms

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Aim: To describe cone-beam computed tomography (CBCT) features in patients with temporomandibular disorders (TMDs), in terms of degenerative changes, condylar excursions and positioning as well as their possible correlations with signs and symptoms. **Methods:** Clinical records of patients diagnosed with TMD who were seen between January 2018 and December 2019 were retrospectively evaluated. These patients were divided into the following groups based on the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD): arthralgia, myalgia, and arthralgia and myalgia groups. The CBCT examination findings of the patients were evaluated in relation to degenerative changes, estimates of condylar excursion, and condylar positioning. The likelihood ratio test was used to verify the possible differences among the three groups, whereas the chi-square test was used to verify the possible differences among the signs and symptoms for the tomographic findings ($p \leq 0.050$). **Results:** In this study, 65 patients with TMD were included. These patients were predominantly female (84.6%) with a mean age of 40.6 years. Tomographic findings of flattening, hyperexcursion and posterior condylar positioning were frequent. A significant correlation was noted between osteophyte and lateral capsule pain ($p = 0.027$), erosion and posterior capsule pain ($p = 0.026$), and flattening, pseudocysts ($p < 0.050$) and condylar excursion ($p < 0.001$) with mouth opening. **Conclusion:** Few correlations were noted between degenerative changes and signs of joint pain as well as degenerative changes and condylar hypoexcursion with mouth opening. These correlations were likely associated with division by diagnosis, whereas condylar positioning did not correlate with signs and symptoms.

Keywords: Cone-beam computed tomography. Mandibular condyle. Signs and symptoms. Temporomandibular joint disorders.

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Introduction

Temporomandibular disorders (TMDs) are diagnosed on the basis of a combination of clinical features and diagnostic imaging findings[1]. When indicated, diagnostic imaging is an important part of the examination process for patients with TMD. Diagnostic imaging is used to confirm suspected disease, rule out disease, or obtain additional information[2]. Computed tomography (CT) is considered valuable for evaluating tissues[3]. However, the identification of pathologies on the basis of imaging findings can be difficult[4].

In recent years, cone-beam computed tomography (CBCT) has been the method of choice for assessing the bone morphology of the temporomandibular joint (TMJ)[5,6]. CBCT provides high-resolution multiplanar images with a lower radiation dose than multislice CT. This imaging technique allows examination of the TMJ without superimposition or distortion, facilitating the analysis of bone morphology, joint spaces and dynamic function[5,6].

The signs and symptoms of patients with TMD include localized or diffuse pain in the TMJ and masticatory muscles, articular sounds and functional disorders, which can occur in isolation or in association[7,8]. Pain-related TMD can impact the individual's daily activities, psychosocial functioning, and quality of life[9]. The main functional disorder is partial limitation of mouth opening. This condition occurs predominantly in females, representing from 67 to 82.2% of cases[7,8]. Myalgia (M) is classified into three types: local myalgia, which is defined as pain localized to the site of palpation; myofascial pain, which is defined as pain spreading beyond the site of palpation but within the boundary of the muscle being palpated; and myofascial pain with referral, which is defined as pain at a site beyond the boundary of the muscle being palpated. Arthralgia with disc displacement (ADD) represents three main types: disc displacement with reduction, disc displacement without reduction and degenerative joint disease. Finally, myopain with arthralgia and disc displacement (MAAD) represents the association of the two main previous diagnoses[9].

Many types of degenerative bone changes identified by CBCT, such as flattening, erosion, sclerosis and osteophytes, have been described in individuals with TMD, and the changes reported vary in different studies[10,11]. However, degenerative alterations are common in asymptomatic individuals, representing up to 40% of cases[12]. In addition, there are reports of some correlations between hypermobility and joint symptoms[13,14]. On the other hand, correlations as well as an absence of correlations between condylar positioning and certain symptoms of TMD have been described[15,16]. Thus, it is important to describe these features of CBCT in patients with TMD due to the controversy regarding the presence or absence of correlations between tomographic findings and signs and symptoms of TMD.

The objective of this study was to describe CBCT features in patients with TMD in terms of degenerative changes, condylar excursions and positioning as well as their possible correlations with signs and symptoms.

Materials and Methods

A retrospective study was conducted with information collected from the medical charts of patients with TMD seen between January 2018 and December 2019 and aged 18 years or older regardless of their gender, race and social status. Patients with dental absences of up to three elements were admitted provided that they were isolated and included two posterior and one anterior teeth and did not include central incisors. Patients with a history of parafunctional habits (e.g., bruxism) were admitted. Patients who presented a history of previous orthodontic treatment, maxillofacial trauma, orthognathic or TMJ surgery or neurological disorders were excluded from the study. TMD was diagnosed on the basis of the chief complaint and the findings from a clinical examination conducted according to the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)[9]. TMD was diagnosed using the DC/TMD diagnostic decision tree, the completed clinical examination form, and the symptom questionnaire. The patients were divided into groups based on their TMD diagnosis to assess for possible correlations between CBCT findings and dysfunction groups or specific symptoms. The cases were divided into 3 groups according to the TMD diagnosis: M - comprising localized myalgia, myofascial pain, and myofascial pain with referral; ADD - comprising disc displacement with reduction, disc displacement without reduction and degenerative joint disease; and MADD - comprising the association of the two main above diagnoses[9]. Prior to the initiation of the clinical examination, the first author (research fellow) underwent calibration sessions with a specialist trained in the use of the DC/TMD protocol[9]. Ethical approval for this study was provided by the Human Research Ethics Committee of the School of Dentistry, University of São Paulo, Brazil (Protocol CAAE 09536918.5.0000.0075).

All of the tomographic images were obtained at the same radiological facility using a Carestream Dental CS 9600 scanner (Carestream Dental LLC, Atlanta, GA, USA). The sagittal and coronal tomographic views were analyzed under standard conditions separately by the authors. The second author, who specializes in dentomaxillofacial radiology, analyzed the CBCT findings. No tomographic examinations were performed for the purpose of this study.

The occurrence of degenerative bony changes was defined as the presence of flattening of the condylar head due to loss of condylar convexity; sclerosis due to increased bone density; osteophyte formation as the result of a bony protrusion on the condylar margins; erosion, which represents a decrease in cortical and subcortical bone densities; and single or multiple subchondral cysts (SCs) or pseudocysts, which represent pyriform-shaped subchondral lesions with sclerotic margins (Figure 1)[1,2].

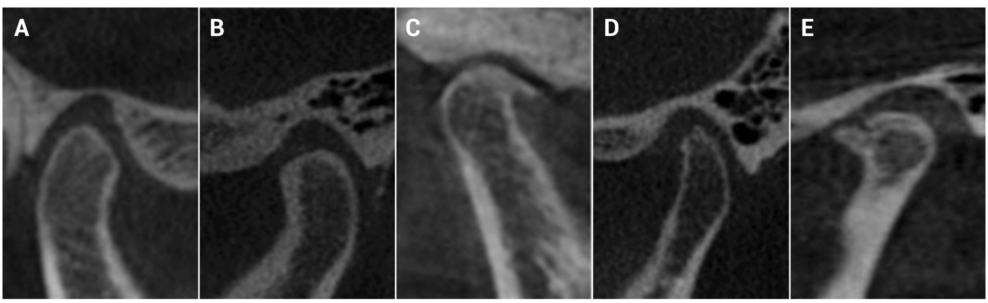

Figure 1. Examples of degenerative bone changes. (A) erosion; (B) sclerosis; (C) flattening; (D) osteophytes; (E) subchondral cysts.

To obtain condylar excursion estimations, sagittal images that were taken while the patient was in maximum opening were used. The type of condylar excursion was classified as: normal excursion when top-to-top positioning of the apex of the articular eminence and the condyle was present, hyperexcursion when the condylar location was in front of the apex of the articular eminence, and hypoexcursion when the condyle was positioned below the apex of the articular eminence (Figure 2)[14,17].

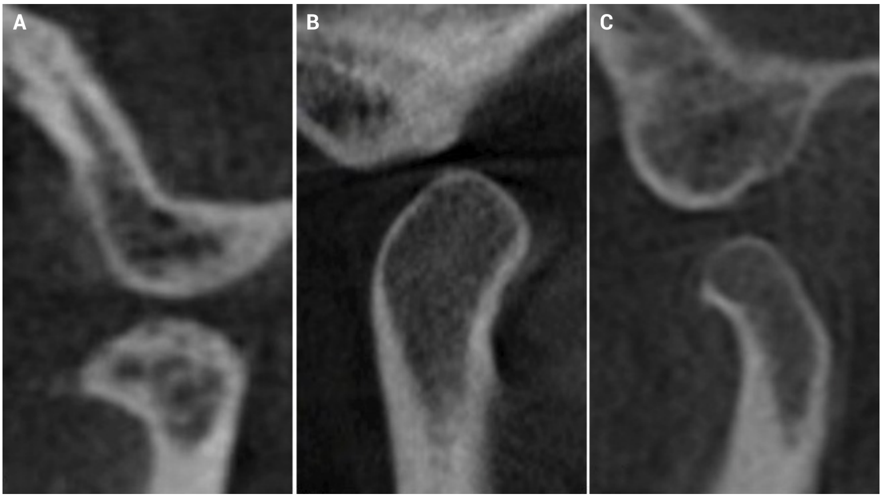

Figure 2. Examples of condylar excursion estimates. (A) hypoexcursion; (B) normal excursion; (C) hyperexcursion.

Linear measurements of the superior, anterior, and posterior joint spaces were made using the following formula, and the images of the patient were obtained in maximum intercuspation to evaluate the positioning of the condyle in the mandibular fossa: (posterior − anterior)/(posterior + anterior). A zero value was classified as the equidistant position, a positive value was classified as the anteriorized position, and a negative value was classified as the posteriorized position (Figure 3)[18,19].

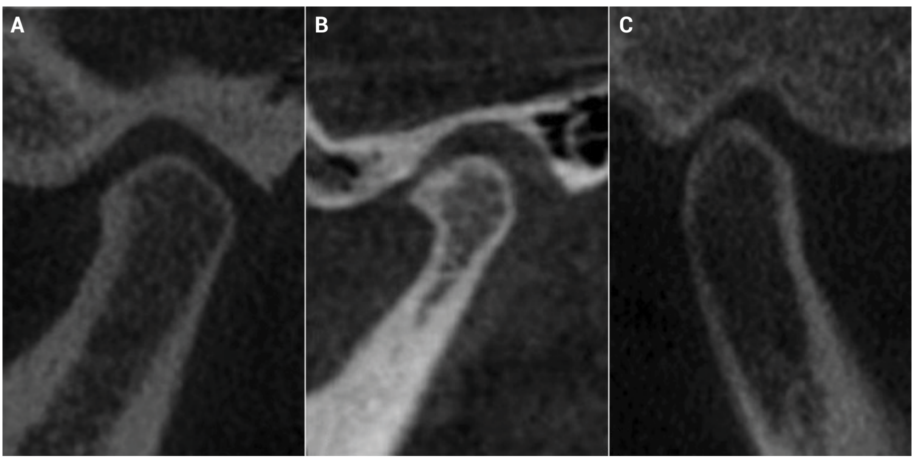

Figure 3. Example positions of the condyle in the mandibular fossa. (A) equidistant; (B) anteriorized; (C) posteriorized.

The data were submitted for statistical analysis. The likelihood ratio test was used to verify the possible differences among the three groups studied in the variables of interest. The chi-square test was used to verify the possible differences among the categories of signs and symptoms for the tomographic findings of interest. The Statistical Package for Social Sciences (SPSS) version 25.0 (IBM Software Group, Chicago, USA) was used for the analysis. The level of significance adopted was $p \leq 0.050$.

Results

In this study, 78 cases of TMD were identified and 65 cases were included. The mean age of the patients was 40.6 years, with an age range of 18 to 74 years, and a predominance of females (84.6%). The main diagnoses were myopain with arthralgia and disc displacement (MAAD) in 32 cases (49.2%), myopain (M) in 26 cases (40.0%) and arthralgia with disc displacement (ADD) in 7 cases (10.8%). There was a predominance of normal amplitude of mouth opening (73.1% of cases).

The most frequent degenerative change was flattening. In the ADD group, flattening (55.6%) was followed by erosion (27.8%). In the MADD group, flattening (60.2%) was followed by osteophytes (22.7%). Finally, in the M group, flattening (64.6%) was followed by osteophytes (21.5%) (Table 1). No significant differences were noted among groups.

The most common condylar excursion estimate was hyperexcursion. In the ADD group, hyperexcursion (64.3%) was followed by hypoexcursion (21.4%). In the MADD group, hyperexcursion (67.2%) was followed by normoexcursion (18.8%). Finally, in the M group, hyperexcursion (59.6%) was followed by hypoexcursion (21.2%) (Table 1). No significant differences were noted among groups.

Table 1. Cross tabulation of the occurrence of degenerative changes, estimates of condylar excursion and positions, the DC/TMD and the significance of the likelihood ratio test.

Variable		Category	DC/TMD classification*						P value
			ADD		MADD		M		
			n	%	n	%	N	%	
Degenerative changes	Flattening	P	10	71.4	53	82.8	42	80.8	0.619
		A	4	28.6	11	17.2	10	19.2	
	Sclerosis	P	0	0.0	8	12.5	5	9.6	0.366
		A	14	100.0	56	87.5	47	90.4	
	Osteophyte	P	2	14.3	20	31.3	14	26.9	0.432
		A	12	85.7	44	68.8	38	73.1	
	Erosion	P	5	35.7	3	4.7	0	0.0	0.109
		A	9	64.3	61	95.3	52	100.0	
	SCs	P	1	7.1	4	6.3	3	5..8	0.981
		A	13	92.9	60	93.8	49	94.2	
Condylar excusions		Hyperexcursion	9	64.3	43	67.2	31	59.6	0.853
		Hypoexcursion	3	21.4	9	14.1	11	21.2	
		Normoexcursion	2	14.3	12	18.8	10	19.2	

Continue

Continuation

Condylar position	Anterior	3	21.4	20	31.3	24	46.2	0.109
	Equidistant	7	50.0	16	25.0	11	21.2	
	Posterior	4	28.6	28	43.8	17	32.7	

*According to the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD).[15] M=myopain, ADD=arthralgia with disc displacement, MADD= myopain with arthralgia and disc displacement. P=present, A=absent. Total degenerative changes exceed 100%, as many patients had more than one finding.

No predominant condylar position was common to the three groups. In the ADD group, there was a predominance of the equidistant position (50.0%) followed by the posteriorized (28.6%) position. In the MADD group, there was a predominance of the posteriorized position (43.8%) followed by the anteriorized (31.3%) position. Finally, in the M group, there was a predominance of the anteriorized (46.2%) position followed by the posteriorized (32.7%) position (Table 1). No significant differences were noted among groups.

The distribution of the occurrence of muscle signs regarding degenerative changes is shown in Table 2. In the category of masseter muscle pain, flattening (82.7%) was more frequent, followed by osteophytes (31.6%). In the temporal muscle, there was a predominance of flattening (82.7%) followed by osteophytes (28.6%). Finally, in the medial pterygoid muscle, there was a predominance of flattening (83.8%) followed by osteophytes (33.8%) (Table 2). No significant differences were noted among groups.

Table 2. Cross tabulation of the occurrence of degenerative changes and muscle signs and the significance of the chi-square test.

Degenerative changes	**Category**	**Muscle signs**											
		Masseter				**Temporal**				**Medial pterygoid**			
		Y		**N**		**Y**		**N**		**Y**		**N**	
		n	**%**	**n**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**n**	**%**
Flattening	P	81	82.7	24	75.0	81	82.7	24	75.0	62	83.8	43	76.8
	A	17	17.3	8	25.0	17	17.3	8	25.0	12	16.2	13	23,2
P value		0.340				0.340				0.316			
Sclerosis	P	10	10.2	3	9.4	11	11.2	2	6.3	7	9.5	6	10.7
	A	88	89.8	29	90.6	87	88.8	30	93.8	67	90.5	50	89.3
P value		0.892				0.415				0.813			
Osteophyte	P	31	31.6	5	15.6	28	28.6	8	25.0	25	33.8	11	19.6
	A	67	68.4	27	84.4	70	71.4	24	75.0	49	66.2	45	80.4
P value		0.079				0.695				0.074			
Erosion	P	0	0.0	8	25.0	0	0.0	8	25.0	0	0.0	8	14.3
	A	96	100.0	24	75.0	98	100.0	24	75.0	74	100.0	48	85.7
P value		0.072				0.068				0.069			
SCs	P	7	7.1	1	3.1	6	6.1	2	6.3	5	6.8	3	5.4
	A	91	92.9	31	96.9	92	93.9	30	93.8	69	93.2	53	94.6
P value		0.412				0.979				0.742			

Y=yes, N=no, P=present, A=absent.

The distribution of articular signs in relation to the occurrence of degenerative changes is shown in Table 3. Regarding the presence of lateral pain to the capsule, there was a predominance of flattening (83.7%) followed by osteophytes (32.7%). Regarding the presence of posterior pain to the capsule, flattening (82.7%) was most frequent followed by osteophytes (27.1%). In the presence of clicking, there was a predominance of flattening (81.3%) followed by osteophytes (27.1%). Finally, when crepitation was present, there was a predominance of flattening (75.0%) followed by osteophytes (50.0%). There was a significant difference in osteophyte findings in the group with lateral pain to the capsule, and in erosion findings in the group with posterior pain to the capsule.

Table 3. Cross tabulation of the occurrence of degenerative changes and articular signs and the significance of the chi-square test.

Degenerative changes	Category	Articular signs															
		Lateral pain to the capsule				Posterior pain to the capsule				Clicking				Crepitation			
		Y		N		Y		N		Y		N		Y		N	
		n	%	n	%	n	%	N	%	n	%	n	%	n	%	n	%
Flattening	P	82	83.7	23	71.9	81	82.7	24	75.0	39	81.3	66	80.5	6	75.0	99	81.1
	A	16	16.3	9	28.1	17	17.3	8	25.0	9	18.8	16	19.5	2	25.0	23	18.9
P value		0.141				0.340				0.915				0.669			
Sclerosis	P	8	8.2	5	15.6	11	11.2	2	6.3	5	10.4	8	9.8	0	0.0	13	10.7
	A	90	91.8	27	84.4	87	88.8	30	93.8	43	89.6	74	90.2	8	100.0	109	89.3
P value		0.222				0.415				0.904				0.330			
Osteophyte	P	32	32.7	4	12.5	29	29.6	7	21.9	13	27.1	23	28.0	4	50.0	32	26.2
	A	66	67.3	28	87.5	69	70.4	25	78.1	35	72.9	59	72.0	4	50.0	90	73.8
P value		0.027				0.397				0.905				0.146			
Erosion	P	6	6.1	3	9.4	4	4.1	5	15.6	3	6.3	6	7.3	1	12.5	8	6.6
	A	92	93.9	29	90.6	94	95.9	27	84.4	45	93.8	76	92.7	7	87.5	114	93.4
P value		0.529				0.026				0.817				0.521			
SCs	P	7	7.1	1	3.1	8	8.2	0	0.0	2	4.2	6	7.3	0	0.0	8	6.6
	A	91	92.9	31	96.9	90	91.8	32	100.0	46	95.8	76	92.7	8	100.0	114	93.4
P value		0.412				0.095				0.471				0.455			

Y=yes, N=no, P=present, A=absent.

The distribution of muscle signs according to the excursion estimates and condylar positioning is shown in Table 4. In the masseter muscle, the most frequent type was hyperexcursion (65.3%) followed by hypoexcursion (20.4%). In the temporal muscle, the most frequent type was hyperexcursion (64.3%) followed by normoexcursion (20.4%). Finally, in the medial pterygoid muscle, the most frequent type was hyperexcursion (60.8%) followed by normoexcursion (21.6%). No significant differences were noted among groups.

Table 4. Cross tabulation of the excursion estimates, condylar positions, muscular signs and the significance of the chi-square test.

Variable	Category	Masseter				Temporal				Medial pterygoid			
		Y		N		Y		N		Y		N	
		n	%	n	%	n	%	N	%	n	%	N	%
	Hiperexcursion	64	65.0	19	59.4	63	64.3	20	62.5	45	60.8	38	67.9
Condilar excursion	Hipoexcursion	20	20.4	3	9.4	15	15.3	8	25.0	13	17.6	10	17.9
	Normoexcursion	14	14.3	10	31.3	20	20.4	4	12.5	16	21.6	8	14.3
P value		0.062				0.348				0.555			
Condilar position	Anteriorized	38	38.8	9	28.1	43	43.9	4	12.5	32	43.2	15	26.8
	Equidistant	25	25.5	9	28.1	21	21.4	13	40.6	16	21.6	18	32.1
	Posteriorized	35	35.7	14	43.8	34	34.7	15	46.9	26	35.1	23	41.1
P value		0.540				0.140				0.133			

Y=yes, N=no.

For condylar positioning, when pain in the masseter muscle was present, there was a predominance of the anteriorized condylar position (38.8%) followed by the posteriorized (35.7%) position. In the temporal muscle, there was a predomince of the anteriorized position (43.9%) followed by the posteriorized (34.7%) position. Finally, in the medial pterygoid muscle, there was a predominance of the anteriorized position (43.2%) followed by the posteriorized position (35.1%). No significant differences were noted among groups.

The distribution of articular signs according to the excursion estimates and condylar positioning is shown in Table 5. In the presence of pain lateral to the capsule, there was a predominance of hyperexcursion (64.3%) followed by normoexcursion (18.4%). In the presence of posterior pain to the capsule, there was a predominance of

Table 5. Cross tabulation of the excursion estimates, condylar positions, articular signs and the significance of the chi-square test.

Variable	Category	Lateral pain to the capsule				Posterior pain to the capsule				Clicking				Crepitation			
		Y		N		Y		N		Y		N		Y		N	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	N	%
	Hiperexcursion	63	64.3	20	62.5	63	64.3	20	62.5	33	68.8	50	61.0	4	50.0	79	64.8
Condilar excursion	Hipoexcursion	17	17.3	6	18.8	19	19.4	4	12.5	8	16.7	15	18.3	3	37.5	20	16.4
	Normoexcursion	18	18.4	6	18.8	16	16.3	8	25.0	7	14.6	17	20.7	1	12.5	23	18.9
P value		0.980				0.440				0.621				0.315			
	Anteriorized	37	37.8	10	31.3	36	36.7	11	34.4	14	29.2	33	40.2	1	12.5	46	37.7
Condilar position	Equidistant	24	24.5	10	31.3	25	25.5	9	28.1	14	29.2	20	24.4	2	25.0	32	26.2
	Posteriorized	37	37.8	12	37.5	37	37.8	12	37.5	20	41.7	29	35.4	5	62.5	44	36.1
P value		0.703				0.951				0.447				0.257			

Y=yes, N=no.

hyperexcursion (68.8%) followed by hypoexcursion (19.4%). When clicking was present, there was a predominance of hyperexcursion (68.8%) followed by hypoexcursion (16.7%). Finally, in the presence of crepitation, there was a predominance of hyperexcursion (50.0%) followed by hypoexcursion (37.5%). No significant differences were noted among groups.

For condylar positioning, when pain lateral to the capsule was present, the anteriorized and posteriorized positions were the most frequent (37.8%). In the presence of pain posterior to the capsule, the posterior position was most frequent (37.8%), followed by the anterior position (36.7%). In cases with clicking, the posteriorized position was more frequent (41.7%) followed by the anteriorized and equidistant positions (29.2%). Finally, when crepitation was present, there was a predominance of the posterior position (62.5%) followed by the equidistant position (25.0%). No significant differences were noted among groups.

The distribution of the amplitudes of mouth opening in relation to the occurrences of degenerative changes is shown in Table 6. In patients with decreased mouth opening, flattening (92.9%) was predominant followed by osteophytes (32.1%). In patients with normal opening, flattening (75.0%) was the most frequent condition followed by osteophytes (25.0%). Significant differences in the degenerative changes regarding flattening and the formation of subchondral cysts were noted.

Table 6. Cross tabulation of the occurrence of degenerative changes, the mouth opening and the significance of the chi-square test.

Degenerative change	Category	Mouth opening				P value
		Decreased		Normal		
		n	%	n	%	
Flattening	P	26	92.9	57	75.0	0.044
	A	2	7.1	19	25.0	
Sclerosis	P	2	7.1	6	7.9	0.898
	A	26	92.9	70	92.1	
Osteophyte	P	9	32.1	19	25.0	0.466
	A	19	67.9	57	75.0	
Erosion	P	3	10.7	4	5.3	0.325
	A	25	89.3	72	94.7	
SCs	P	5	17.9	1	1.3	0.001
	A	23	82.1	75	98.7	

P=present, A=absent.

The distribution of the excursion estimates and condylar positioning in relation to the mouth opening classifications is shown in Table 7. In cases of hyperexcursion, there was a predominance of normal mouth opening (71.1%) and in cases of hypoexcursion and normoexcursion, decreased mouth opening predominated (42.9% and 28.6%, respectively). A significant difference was noted. In cases with the anteriorized position, decreased mouth opening predominated (42.9%); in cases with the equidistant position, normal opening predominated (26.3%); and in cases with the posteriorized position, decreased opening predominated (42.9%). No significant differences among groups were noted.

Table 7. Cross tabulation of the condylar excursion estimates, condylar positions, the mouth opening and the significance of the chi-square test

Variable	Category	Mouth opening				P value
		Decreased		Normal		
		n	%	n	%	
Condylar excursion	Hiperexcursion	8	28.6	54	71.1	< 0.001
	Hipoexcursion	12	42.9	9	11.8	
	Normoexcursion	8	28.6	13	17.1	
Condylar position	Anteriorized	12	42.9	25	32.9	0.392
	Equidistant	4	14.3	20	2.3	
	Posteriorized	12	42.9	31	40.8	

Discussion

The present study revealed few correlations between degenerative changes and signs of joint pain as well as degenerative changes and condylar hypoexcursion with mouth opening, whereas condylar positioning did not correlate with signs and symptoms. There was a predominance of females, and the mean age was 40.6 years. These findings are consistent with the characteristics reported in the literature[7,8,20,21]. However, given the wide age range, age-related degenerative changes could be present in this sample[22,23].

Regarding degenerative changes, most patients had flattening, many exhibited osteophytes, and few showed sclerosis, erosion and SCs. The predominance of flattening and osteophytes has been reported[8,10,11]. Other studies have suggested that the prevalence of erosion or sclerosis represents the condition with the greatest prevalence[24,25]. Studies with CBCT in TMJ osteoathritis showed common flattening, erosion and osteophytes[26,27]. A correlation between disc displacement and condylar degenerative changes has been demonstrated[28]. However, asymptomatic individuals can also present degenerative changes on CBCT, and such findings should be exclusively used with care[12]. In older age groups, TMD patients are expected to exhibit more degenerative bony changes[22,23].

A study reported that no significant correlation was found between degenerative changes verified in CBCT and clinical symptoms of TMD[29]. Another study evaluated whether a relationship existed between degenerative changes and bone quality of the mandibular condyle and articular eminence in patients with TMD, and no causality relationship between these factors was found[30]. It should be considered that these studies did not classify the cases according to groups of diagnoses in contrast to our study, which may have provided some correlations between degenerative alterations and signs and symptoms of TMD.

There was a predominance of hyperexcursion in the three groups based on the condylar excursion estimates. Patients with intra-articular dysfunctions are more likely to have joint hypermobility[13,17]. Hyperexcursion can lead to internal derangement, which can damage articular tissues. Condylar excursion can significantly influence pain perception in patients with TMD[15]. It has been noted that pain in the TMJ is correlated with a large amplitude of maximal mouth opening[14].

The predominant condylar position varied among the diagnostic groups, but without significant differences. Our findings are not consistent with those in previous studies. The condyle is more commonly positioned posteriorly in patients with TMD, and anterior and equidistant positions are more common in asymptomatic patients[15,18]. A relationship was found between the condylar position and tenderness of a specific muscle group[16]. The posterior condylar position is associated with anterior disc displacement[18]. A study that evaluated the bone components of the TMJ in asymptomatic individuals and patients with TMD using CBCT demonstrated that the presence of TMD was associated with the condylar position with the anterior joint space being larger[31]. Again, this study did not divide the cases according to groups of diagnoses, unlike our study, which may have led to no correlations between condylar positions and signs and symptoms of TMD.

There was a predominance of amplitudes of mouth opening that were considered normal. However, degenerative changes, especially flattening and SCs, were more prevalent in the group with decreased mouth opening compared with the other groups. CBCT studies have revealed a weak correlation with reduced maximum mouth opening[26].

No significant difference was noted between the categories of tomographic findings and the groups of diagnoses according to DC/TMD[9]. Additionally, no significant differences were noted between the tomographic findings and the signs of muscular pain. Few significant differences were noted between degenerative tomographic findings and signs of articular pain. The probability of these signs of articular pain being associated with intra-articular dysfunctions with articular disc displacement and degenerative joint disease must be considered[7,9]. Additionally, few significant differences were noted between degenerative changes and condylar hipoexcursion with mouth opening. The probability of these mouth opening limitations being associated with intra-articular dysfunctions with articular disc displacement must be considered[7,9].

One of the limitations of this study could be the sample size. Although 65 cases of TMD were included, the sample size was not calculated. Another limitation is the wide age range, which would lead to the inclusion of age-related degenerative changes.

This study confirmed that CBCT can reveal degenerative changes with high precision and detail. A previous study that used the same criteria for diagnosing dysfunctions and degenerative findings but used conventional CT reported a lower incidence of degenerative changes, such as osteophytes and erosion, and no cases of SCs[8]. Most likely, due to the use of CBCT, these findings were more frequent in this study.

Based on the data collected in this study, it was concluded that few correlations exist between degenerative changes and signs of joint pain as well as degenerative changes and condylar hypoexcursion with mouth opening. These correlations are likely associated with division by diagnosis. In contrast, condylar positioning exhibited no correlations with signs and symptoms.

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