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Association between clinical and cone-beam computed tomography findings in patients with temporomandibular disorders

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Original Article

Abstract

BACKGROUND AND AIM: The aim of this study was to assess the association between the clinical and cone-beam computed tomography (CBCT) findings in relation to bony changes in patients with temporomandibular disorders (TMD).

METHODS: According to the research diagnostic criteria for temporomandibular disorder (RDC/TMD), forty-one patients with type II TMD (42 TM joints) and type III TMD (40 TM joints) were recruited for this study. Condylar position and bony changes including flattening, sclerosis, osteophytes, resorption, and erosion of joint were evaluated by CBCT and compared with clinical findings. Data were analyzed by SPSS software.

RESULTS: Condylar flattening, sclerosis, resorption, and erosion were not significantly associated with joint/masticatory muscles pain or crepitus sound. The vertical or horizontal position of the condyle showed no significant relationship with the clinical findings. Condylar osteophyte was significantly associated with pain in masticatory muscles and crepitus (P = 0.030 and P = 0.010, respectively). There was no association between the condylar range of motion and pain in joint or masticatory muscles.

CONCLUSION: Condylar osteophyte was significantly associated with both masticatory muscles pain and crepitus sound. No significant relationship was found between the other temporomandibular joint (TMJ) radiographic and clinical findings in patients with TMD.

KEYWORDS: Cone-Beam Computed Tomography; Mandibular Condyle; Temporomandibular Joint Disorders

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Temporomandibular disorder (TMD) is the term used to include all functional disturbances of the masticatory system. TMDs are identified by a triad of clinical symptoms such as pain, jaw sounds and limitation/deviation on mouth opening.[1] TMDs are diagnosed as frequently as 33%, with a predilection for women.[2] This disorder has been found to be associated with psychosocial factors such as depression and anxiety disorders and parafunctional activities such as clenching and bruxism.[3]

Both clinical and radiographic examinations of temporomandibular joint (TMJ) are needed to diagnose TMD. A comprehensive clinical examination should be performed based on the research

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diagnostic criteria for TMD (RDC/TMD) considering both physical and psychological etiologic factors of TMD. The RDC/TMD criteria are based on the physical symptoms including three categories of muscular disorders (group 1), disk displacement (group 2), and arthralgia, osteoarthritis or osteoarthrosis (group 3). Group-2 includes disk displacement with and without reduction.[4] The RDC/TMD criteria for disk displacement with reduction are known as reciprocal clicking (click on vertical opening and closing that happens at 5 mm greater interincisal space on opening than closing and is omitted on protrusive opening), repeatable on 2 out of 3 sequential attempts, or clicking on vertical range of motion (either opening or closing), repeatable on 2 out of 3 sequential attempts, and click during lateral movement or protrusion which are reproducible on 2 out of 3 consecutive trials. The RDC/TMD criteria for disk displacement without reduction are known as a considerable limitation in the opening, maximum unassisted opening ≤ 35 mm, passive stretching increasing opening by ≤ 4 mm more than the maximum unassisted opening, contralateral excursion < 7 mm and/or uncorrected deviation to the same side on opening. The RDC/TMD criteria for TMD type III include pain on palpation for one or two joints, coarse crepitus and self-reported pain of the joints or radiographic signs of arthritis.[5]

Radiographic examination of TMJ is usually necessary to differentiate these pathologic conditions. Advanced radiographic methods, such as magnetic resonance imaging (MRI), are used to evaluate the soft tissue of disk and its dislocation, whereas Cone-Beam computed tomography (CBCT) is the gold standard method to assess the bony changes of TMJ.[6,7]

There are few number of studies evaluating the relationship between clinical and radiographic findings of TMD by CBCT.[3] Among these, an association was found between functional pain and radiographic bony changes on the articular surface of condyle by Kurita et al.[2] However, several other studies have found no relationship between the intensity of pain and range of mandibular motion on the one hand and the degree of condylar bony changes on the other.[3,8-10]

Considering the divergent results in this field, the current study was conducted to assess the association between clinical and radiographic findings in patients with TMJ disk displacement and osteoarthritis.

Methods

All patients with symptoms of type II and III TMD attending the Prosthodontics Department of Mashhad Dental School, Iran, from April 2013 to April 2014, were recruited for this cross-sectional study. The inclusion criteria were considered based on RDC/TMD. The exclusion criteria were congenital craniofacial disorders, history of TMJ therapeutic interventions (surgery, laser therapy, and medication), those receiving orthodontic treatment, pregnancy, systemic diseases involving TMJ (e.g. rheumatoid arthritis) and pyogenic arthritis.[5]

The research protocol was approved by the Ethics Committee of Mashhad University of Medical Sciences (Code: 920112) and written consent was obtained.

Clinical examination was performed by an expert prosthodontist and history of TMJ trauma or parafunctional habits were also recorded.

The maximum mouth opening was assessed by a tape measure and patients were classified into normal (35-50 mm) and limited (< 35 mm) groups.[4] Myofascial pain was characterized by any symptom of ache in the jaw, face, temples, preauricular region or inside the ear during rest or function. Moreover, the pain on palpation of masseter or temporalis muscles, posterior region of the mandible, submandibular site, lateral pterygoid and tendon of temporalis was also registered. Additionally, TMJ pain elicited by palpation at rest or during function alongside jaw sounds including click and crepitus was recorded.[5]

Bilateral CBCT images were taken by Promax 3D (Planmeca, Helsinki, Finland) from the TMJ in opened and closed mouth states [field of view (FOV) = 80 × 80 mm, kilovoltage peak (kVP) = 64-68, mA = 6-10, slice thickness = 0.16 mm, slice interval = 1 mm)].

Three-dimensional images of coronal, sagittal and axial planes were constructed by multi-planar reconstructions of CBCT, using Romexis 3.1.1 (Planmeca, Helsinki, Finland). The sagittal slices were reconstructed perpendicular to the panoramic line that was drawn on the axial plane. The slice corresponding to the center of the condyle was considered as the reference.[11] All of the images were interpreted by two expert oral and maxillofacial radiologists under blinded condition. Divergent interpretations were discussed and the final agreement was reached in all cases.

To assess the vertical condylar position, the distance between the uppermost region of the condyle and deepest area of the joint fossa was measured. The distance between 1.5-4 mm was considered as normal.[12] In order to evaluate the horizontal position of the condyle, anterior and posterior joint spaces were determined by the method of Kinzinger et al.[13] The shortest distance between the most anterior region of the condyle to the articular eminence (anterior joint space) and the most posterior region of the condyle to the tympanic process of the temporal bone (posterior joint space) were measured. The joint space index (JSI) was estimated as follows: JSI = [(Post - Ant) / (Post + Ant)] × 100, where Ant is anterior joint space, and Post is posterior joint space. The index values were interpreted as follows, 0: central location of the condyle, > 0: anterior location of the condyle, and < 0: posterior location of the condyle.

If the most superior region of condyle was located around 5 mm posterior and 8 mm anterior to the most inferior region of articular eminence, it was considered normal. If the condyle moved posteriorly more than this range, it was considered a limitation in motion and anteriorly, out of this range, was named hypermobility or subluxation.[14]

Bony changes, including flattening, sclerosis, osteophytes, resorption, and erosion were also identified in at least two consecutive cross-sections of CBCT images (Figure 1).

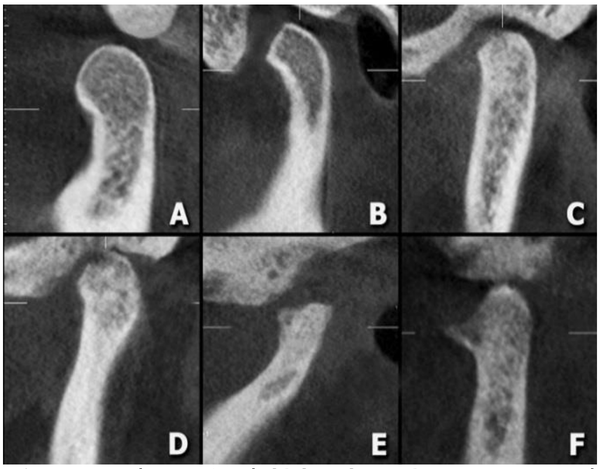

Figure 1. The sagittal CBCT (Cone-Beam computed tomography) appearance of normal mandibular condyle (A), flattening of condylar head (B), sclerosis (C), erosion (D), resorption (E) and osteophyte (F)

The Fisher's exact test was used to assess the association between the clinical and CBCT findings using SPSS (version 18, SPSS Inc., Chicago, IL, USA) and the significance level was set at P < 0.050.

Results

A total of 41 patients (22 women and 19 men) fulfilled the inclusion and exclusion criteria. The mean age of the patients was 42.5 ± 27.5 years. The sex did not have any influence on the study parameters. The association between clinical and CBCT findings were evaluated as follows:

Erosive changes and TMJ/muscular pain: Of 82 joints evaluated, 1 joint was characterized by pain and erosive changes of the glenoid fossa. 8 joints were identified with erosive changes in the region of articular eminence, and 3 joints were reported as joint pain. Among 44 cases with the erosion of the

Table 1. Association between temporomandibular joint (TMJ) pain and bony changes of joint

Bony change		TMJ pain		P*
		Yes [n (%)]	No [n (%)]	
Erosion of condylar head	Yes (n = 44)	21 (47.8)	23 (52.2)	> 0.999
	No (n = 38)	19 (50.0)	19 (50.0)	
Sclerosis of condylar head	Yes (n = 3)	2 (66.7)	1 (33.3)	> 0.999
	No (n = 37)	21 (56.8)	16 (43.2)	
Osteophyte of condylar head	Yes (n = 12)	9 (75.0)	3 (25.0)	0.179
	No (n = 28)	14 (50.0)	14 (50.0)	
Resorption of condylar head	Yes (n = 1)	1 (100)	0 (0)	> 0.999
	No (n = 39)	22 (56.4)	65 (43.6)	
Fattening of condylar head	Yes (n = 12)	8 (66.7)	4 (33.3)	0.505
	No (n = 28)	15 (53.6)	13 (46.4)	

*Fisher's exact test
TMJ: Temporomandibular joint

condylar head, 11 cases were identified with disk displacement signs and 33 cases with osteoarthritis. There was no significant association between condylar erosion and joint or masticatory muscles pain (Tables 1 and 2).

Sclerosis and TMJ/muscular pain: 3 of 82 joints exhibited sclerosis of the glenoid fossa, 2 of which had joint pain but none of them had pain in masticatory muscles. In addition, 4 joints had articular eminence sclerosis with joint pain, but only 1 of them showed pain in masticatory muscles. No significant association was found between condylar sclerosis and joint or muscular pain (Tables 1 and 2).

Osteophyte and TMJ/muscular pain: No osteophyte was found in the region of glenoid fossa or articular eminence in the patients with type III TMD. 12 joints showed condylar osteophyte. There was no significant association between condylar osteophyte and joint pain; however, the relationship between condylar osteophyte and masticatory muscles pain was significant (P = 0.039) (Tables 1 and 2).

Resorption and TMJ/muscular pain: No joint exhibited resorption of the glenoid fossa or articular eminence in the subjects with type III TMD. Condylar resorption was observed in only one joint. There was no association between condylar resorption and joint or masticatory muscles pain (Tables 1 and 2).

Flattening and TMJ/muscular pain: No flattening was detected in the region of glenoid fossa or articular eminence. However, 66 cases of condylar flattening were detected. No significant association was found between condylar flattening and joint or masticatory muscles pain (Table 1).

Condylar erosion/sclerosis/osteophyte/ resorption/flattening and crepitus: No

Table 2. Association between muscular pain and bony changes of joint

Bony changes		Muscular pain		P*
		Yes [n (%)]	No [n (%)]	
Erosion of condylar head	Yes (n = 44)	9 (20.4)	35 (79.6)	0.605
	No (n = 38)	10 (26.3)	28 (73.7)	
Sclerosis of condylar head	Yes (n = 3)	0 (0)	3 (100)	> 0.999
	No (n = 37)	8 (21.6)	29 (78.4)	
Osteophyte of condylar head	Yes (n = 12)	5 (41.7)	7 (58.3)	0.039
	No (n = 28)	3 (10.7)	25 (89.3)	
Resorption of condylar head	Yes (n = 1)	0 (0)	1 (100)	> 0.999
	No (n = 39)	8 (20.5)	31 (79.5)	
Fattening of condylar head	Yes (n = 66)	14 (21.2)	52 (78.8)	0.509
	No (n = 16)	5 (31.2)	11 (68.8)	

*Fisher's exact test

Table 3. Association between crepitus and bony changes of joint

Bony changes		Crepitus		P*
		Yes [n (%)]	No [n (%)]	
Erosion of condylar head	Yes (n = 40)	29 (72.5)	11 (27.5)	0.170
	No (n = 42)	37 (88.1)	5 (11.9)	
Sclerosis of condylar head	Yes (n = 3)	2 (66.7)	1 (33.3)	0.090
	No (n = 79)	14 (17.7)	65 (82.3)	
Osteophyte of condylar head	Yes (n = 12)	6 (50.0)	6 (50.0)	0.010
	No (n = 70)	10 (14.3)	60 (85.7)	
Resorption of condylar head	Yes (n = 1)	0 (0)	1 (100)	> 0.999
	No (n = 81)	16 (19.8)	65 (80.2)	
Fattening of condylar head	Yes (n = 66)	13 (19.7)	53 (80.3)	> 0.999
	No (n = 16)	3 (18.7)	13 (81.3)	

*Fisher's exact test

association was found between crepitus sound and condylar head erosion, sclerosis, resorption, and flattening. A significant relationship was established between crepitus and condylar osteophytes (P = 0.010) (Tables 1 and 3).

Condylar position in closed mouth and TMJ/muscular pain: The horizontal position of condyle was centric in 23 patients, whereas in 18 and 41 subjects it was located anteriorly and posteriorly, respectively. The vertical position of condyle was normal in 55 cases. However, 27 subjects exhibited increased vertical joint space. There was no association between the horizontal or vertical position of condyle and pain in joint or masticatory muscles (Tables 4 and 5).

Condylar range of motion and TMJ/muscular pain: From the 82 evaluated joints, 48 condyles were in the normal range on mouth opening. Limitation in motion was noticed in 25 joints, whereas 9 ones showed hypermobility. There was no association between the condylar range of motion and pain in joint or masticatory muscles (Table 6).

Discussion

This study was designed to evaluate the relationship between clinical and CBCT findings in patients with TMD according to the RDC/TMD criteria. The efficacy of CBCT has been demonstrated by previous studies.[12,15,16]

Larheim et al. reported that 35% of patients with disk displacement had no pain.[17] Some authors proposed pain as a multi-dimensional experience, the origin of which, joints or muscles, might not be identified by patients.[18,19] Joint pain was not significantly associated with TMD in the current study. This finding was consistent with other studies.[3,20-22]

In a CBCT study on a symptomatic TMD group of Korean children and adolescents, multiple cases of erosion and posterior position of condyle were reported. Sclerosis was the most frequent finding in the asymptomatic group.

Erosion occurred more frequently in patients with pain and limited mouth

Table 4. Association of the horizontal position of the condyle and pain in joint or masticatory muscles

Pain		Horizontal position of condyle			P*
		Anterior [n (%)]	Centric [n (%)]	Posterior [n (%)]	
Jaw pain	Yes (n = 40)	13 (32.5)	7 (17.5)	20 (50.0)	0.060
	No (n = 42)	5 (11.9)	16 (38.1)	21 (50.0)	
Masticatory muscle pain	Yes (n = 19)	4 (21.0)	5 (26.3)	10 (52.7)	0.885
	No (n = 63)	14 (22.2)	18 (28.6)	31 (49.2)	

*Fisher's exact test

Table 5. Association of the vertical position of the condyle and pain in joint or masticatory muscles

Pain		Vertical position of condyle			P*
		High [n (%)]	Normal [n (%)]	Low [n (%)]	
Jaw pain	Yes (n = 40)	12 (30.0)	28 (70.0)	0 (0)	0.582
	No (n = 42)	15 (35.8)	27 (64.3)	0 (0)	
Masticatory muscle pain	Yes (n = 19)	5 (26.3)	14 (73.7)	0 (0)	0.484
	No (n = 63)	22 (34.9)	41 (65.1)	0 (0)	

*Fisher's exact test

opening.[23] In another study, patients with erosive changes reported more pain and dysfunction.[24] The present results showed no association between erosive changes and pain. The different clinical and radiological approaches may justify the difference.

Palconet et al. demonstrated a weak association between radiographic findings of condyle (erosion, flattening and osteophyte) in CBCT and pain in joint or masticatory muscles or other clinical findings.[3] These findings were similar to the current results. However, a significant association was found between osteophytes and pain in masticatory muscles. This might be due to the fact that the presence of osteophytes and pain upon function gradually leads to limited function and consequently splinting and fatigue of muscles.

Wiese et al. found no association between bony changes in TMJ tomograms and pain-related variables, including pain in joint and masticatory muscles upon palpation, duration of pain perception and chronic pain.[25] Clinical symptoms may appear 6 months prior to the appearance of radiologic bony changes and radiographic images may seem normal in the early stages of osteoarthritis. When the radiographic structural changes appear, but the patients have no pain, osteoarthritis is probably present. In this case, the inflammatory reactions and pain gradually abate, the suitable range of motion is restored, and joint sounds decrease, but the regenerative processes continue in the condyle and fossa.[26]

Kurita et al. demonstrated a positive relationship between pain and radiographic evidence of osteoarthritis.[2] This incoherence might be explained by different case selection, pain determination criteria and radiographic methods.

In the present study, condylar flattening was found in patients with signs of disk displacement. However, some authors found no association between osteophytes, erosion, flattening and disk displacement.[27] In addition, in Sener and Akganlu's study, degenerative changes in joints were not suggested as a special finding of disk displacement.[28]

Joint sounds are often considered as an indicator of internal derangement of TMJ. However, it should be noted that the absence of joint sounds is not essentially associated with normality.[29] In the present study, consistent with the Wiese's et al. study,[26] crepitus was shown to be associated with osteophytes. Moreover, similar to another survey, crepitus was not associated with other radiographic changes.[27]

In the present research, no association was found between the horizontal or vertical position of condyle and pain in the TMJ or muscles. The condyles were commonly observed in the posterior position.

The clinical significance of the horizontal position of the condyle is controversial. Many

Table 6. Association between maximum mouth opening and pain in joint or masticatory muscles

Pain		Maximum mouth opening		P*
		Limited [n (%)]	Normal [n (%)]	
Jaw pain	Yes (n = 40)	17 (42.5)	23 (57.5)	0.550
	No (n = 42)	17 (40.5)	25 (59.5)	
Masticatory muscle pain	Yes (n = 19)	8 (42.1)	11 (57.9)	0.550
	No (n = 63)	26 (41.3)	37 (58.7)	

*Fisher's exact test

researchers found no association between the horizontal position of the condyle and clinical findings.[26,30,31] However, several studies showed that the posterior position of the condyle was common in TMD patients.[32,33]

No association was found between the vertical position of condyle and pain in joint or masticatory muscles. The association of vertical position of the condyle with clinical findings was not previously studied. The current results showed an insignificant association between the condylar position in opened mouth and pain. In the study by de Senna et al., no association was found between the position of the condyle and disk with clinical symptoms.[34] In agreement with us, Hirsch and John did not find any changes in the jaw motion with the presence of TMD symptoms.[35]

Future studies could replicate the current results using a larger sample, MRI assessment, and quantitative clinical evaluations.

Conclusion

Condylar osteophyte was significantly associated with both masticatory muscles pain and crepitus sound. No significant relationship was found between the radiographic and clinical findings in patients with type II and type III TMD.

Conflict of Interests

Authors have no conflict of interest.

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