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RESEARCH BRIEF

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The evaluation of position and degenerative changes of condyle in CBCT radiography

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Abstract

Background: Incomplete understanding of the anatomy of the temporomandibular joint (TMJ), its function and physiological changes, has led to diagnostic mistakes. **Aim:** We aimed to evaluate the position and bone changes of condyle using cone beam computed tomography (CBCT). **Conclusion:** Twenty-eight patients who had CBCT images of TMJ joints of both sides and had referred with signs of temporomandibular disorder to a private radiology center in Mashhad were enrolled. The location of condyle in the joint socket in closed mouth position in maximum intercuspation based on measurements of the superior, posterior, and anterior spaces of the joint, and bone changes of the condyle were studied. Of the 28 patients, most (89.3%) were female. The horizontal dimension of the CBCT images of 2.3% of patients was in the normal range and 97.7% were abnormal. The condyle's position in the vertical dimension was normal in 40.9% of patients and abnormal in 59.1%. The most prevalent position of the condyle in horizontal dimension was the posterior position (79.5%). Increased superior joint space was the most prevalent position of the condyle in vertical dimension (54.5%). At least one type of bone changes was seen in 67.9% of patients. In evaluating condylar bone changes the frequency of flattening, erosion, osteophyte, sclerosis, absorption, and Ely cyst was 46.6%, 25%, 14.3%, 7.1%, 5.3%, and 3.6%, respectively. **Clinical Significance:** The most prevalent condyle position in horizontal dimension was posterior. In evaluation of bone changes of condyle, the highest frequency was related to flattening and the lowest was Ely cyst.

Keywords: Cone beam computed tomography, temporomandibular joint, temporomandibular joint disorders

Introduction

The temporomandibular joint (TMJ) has many specific features regarding its function and chronologic changes, which is important from the perspective of surgery, occlusion and radiology, and because of lack of enough knowledge on its anatomy, function and physiologic changes, many diagnostic mistakes which have occasionally affected treatment of TMJ diseases, has been observed.[1] Different conditions such as osteoarthritis and intra-articular disk disorder can affect this joint and cause skeletal deformities, malocclusion, and dysfunction of the masticatory system.[2]

Initial assessment of the disorders of this joint is based on clinical examination of the masticatory muscles. Although several studies have indicated that clinical examination is unreliable in many cases.[3-5] Imaging is an important diagnostic component in determining and interpretation of TMJ disorders. Diagnostic imaging methods of TMJ include arthrography, computer tomography (CT), and magnetic resonance imaging (MRI). CT provides optimal observation of bone structures but high radiation dose and cost are its disadvantages.

With the advent of cone beam computed tomography (CBCT) and its utilization in the head and neck region, due to lower radiation dose and higher resolution compared to CT, the use of CT in TMJ evaluation has become very limited nowadays.[6] CBCT allows the evaluation of bone structures, articular space, and dynamic function in all three dimensions without superimposition and deformity.[7,8]

Therefore, considering the growing use of CBCT images as a gold standard, by dentists and ear-nose-throat specialists, we aimed to study the position and bone changes of the condylar head using CBCT.

Materials and Methods

The protocol of this study was approved by the Ethics Committee of Mashhad University of Medical Sciences (IR.mums.sd.REC.1393.922578), and written consent was obtained from patients. In this cross-sectional study, patients who had referred to a private radiology clinic in Mashhad with a prescription of a physician, because of TMJ problems such as pain with or without TMJ sounds, open mouth restriction, etc., and had CBCT images of both joints entered the study. 28 patients (56 joints) who had the inclusion criteria entered the study.

CBCT imaging was done using Planmeca Promax® 3D max device (Helsinki, Finland), with maximum output 46 KVP and 14MA, FOV (field of view 13 × 13 cm^2) and 200 micron voxel size. Imaging was done by multiplanar reconstructions and using "Planmeca Romexis 3.8.30" software, coronal, sagittal, and axial images of TMJ were obtained. Since the most accurate images with improved diagnostic value is gained when the evaluated sections are parallel or vertical to the condyle's axis (longitudinal axis), the preparation of slices was done in a way that sagittal images were exactly vertical to the condyle's axis and coronal images parallel to this axis.[9] For this purpose, in one of the axial images which was consistent with the condyle's internal and external axis, the panoramic curve line was drawn so that it connects condyle's external axis to its internal axis along the condyle curve. Since the reconstruction of coronal sections is parallel to this line and sagittal sections are vertical to it this axial section was considered as a reference for the coronal and sagittal reconstructed images[9] [Figure 1]. In the evaluation of all coronal and sagittal sections, slice thickness (voxel size) was set (regulated) on the lowest possible. For assessment of condyle's bone changes in CBCT, different sections including coronal, axial, and sagittal, each in the open and closed mouth states was used. It was agreed that for each of the factors related to bone changes to be assigned as a change, it needs to be observed in at least two consecutive cuts. For measurements, the most central sagittal section of the CBCT in the closed mouth position with maximum intercuspation was used. Measurements were repeated within 1 week and average of the two measurements was considered as the size of the articular space.

Regarding that in six patients CBCT imaging was done only in the open mouth position, assessments related to condyle position was not performed for them. The evaluated items include condyle's position in the articular fossa in closed mouth position and bone changes of condyle (including erosive changes and osteophyte formation, resorption, Ely cyst formation, flattening, and sclerosis). For evaluation of condyle's position in the closed mouth status, the Ikeda and Kawamura[10] study method for measurement of the superior, posterior, and anterior articular space, was used.

Condyle's position in the horizontal dimension

For calculating the anterior articular space, a line contacting the most prominent spot on the anterior axis of the condyle was drawn and the shortest distance between this line and posterior slope of the articular eminence was measured. To measure the posterior articular space, the shortest distance between the line contacting the most prominent spot of the posterior axis of the condyle head, and the articular fossa was calculated. According to Ikeda and Kawamura study,[10] the average normal articular space in anterior and posterior of the condyle, in the closed mouth position with maximum intercuspation is 1.3 ± 0.2 mm and 2.1 ± 0.3 mm, respectively. In case of increase in the anterior articular space and decrease in posterior space, it was considered as posterior position and the opposite of this was considered as anterior position of the condyle.

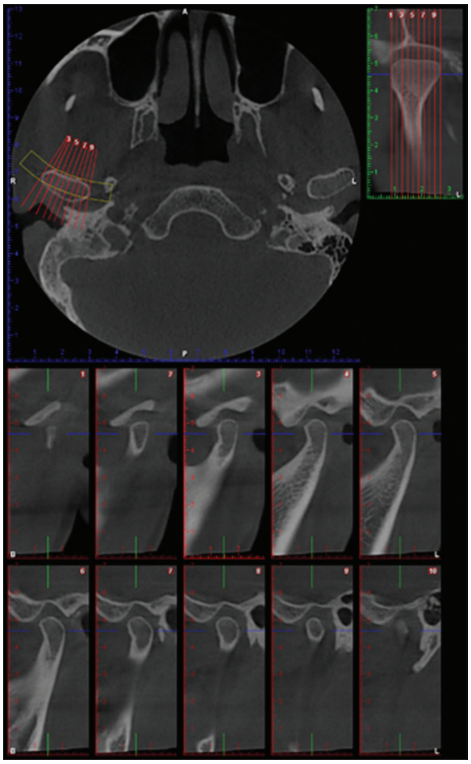

Figure 1: Cone beam computed tomography slices on right side condyle. Above, right: Show axial cutting, coronal images that parallel to the long axis of condyle (upper left) and sagittal images that perpendicular to the long axis of condyle (the bottom picture) were reconstructed

Condyle position in the vertical dimension

In the vertical dimension, the distance between the upper most part of condyle and the deepest part of the condyle fossa was measured [Figure 2]. According to Ikeda and Kawamura study,[10] the average normal articular space at the top of condyle in closed mouth position with maximum intercuspation is 2.5 ± 0.5 mm. The superior articular space in closed mouth position were evaluated, and in this position decrease or increase in width of the articular space were recorded.

The mentioned images were evaluated by two maxillofacial radiologists who were skilled in TMJ disorders and interpretation of CBCT images. In case of diversity of opinions between the two observers, it was asked for the view of a third radiologist. The stages of image evaluation were performed completely blind.

Analysis of the data and statistical assessment

Descriptive statistical methods (numerical and graphical methods) were used for describing the data. The SPSS software version 11.5 was used for obtaining parameters and describing the charts.

Results

Of all the 28 patients observed in this study, 3 (10.7%) were male and 25 (89.3%) female. The results of CBCT in the evaluation of condyle's position and bone in this study, has been demonstrated in the following tables.

As Table 1 shows, degenerative changes had similar prevalence in men and women. The frequency distribution of degenerative changes irrespective to the left and right side has been demonstrated in Table 2, as can be observed the most frequency is related to flattening and the least related to Ely cyst.

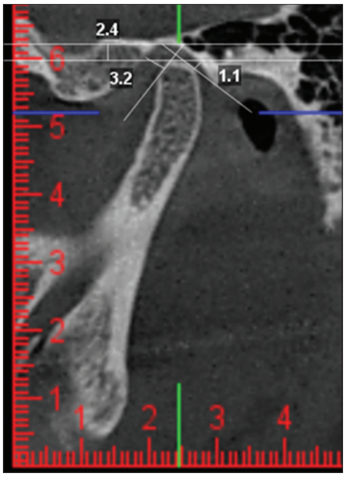

Figure 2: The superior (2.4 mm), posterior (1.1 mm), and anterior (3.2 mm) joint spaces on sagittal cone beam computed tomography cutting

Table 1: Frequency distribution of degenerative changes, based on gender

Gender	Degenerative changes (*n*=28)		Total
	Yes	No	
Female *n* (%)	17 (68)	8 (32)	25 (100)
Male *n* (%)	2 (66.7)	1 (33.3)	3 (100)
Total *n* (%)	19 (67.9)	9 (32.1)	28 (100)

All the studied patients in whom the articular spaces were measured (22 patient), showed changes in horizontal or vertical location of condyle in closed mouth position which were out of normal range, in at least one of the right or left sides. On the other hand, of all the 22 patients being observed, in six patients who were all female the vertical position of the condyle was normal on both sides. Frequency of condyle's horizontal and vertical position (as normal or abnormal) separated by gender has been demonstrated in Table 3. According to Table 3, change in condylar position tends to be higher horizontally than vertically (97.7% against 59.1%).

As Table 4 indicates, the most prevalent horizontal condylar position was the posterior position, which was higher in women compared to men. Increased superior articular space was the most prevalent vertical position of the condyle, which was higher in men compared to women. No case of decreased superior articular space was observed in men.

Discussion

Imaging is an important diagnostic part in the determination and interpretation of TMJ disorders. With the rise of CBCT and its utilization in the head and neck region, due to its lower radiation dose and higher resolution compared to CT. The use of CT in TMJ evaluation has become very limited nowadays.[6] In this study, we aimed to evaluate the position and bone changes of the condyle, using CBCT. 28 patients (56 joints) who had CBCT images because of TMJ problems entered the study.

The results of our study indicated that regarding condylar bone changes in the CBCT images, 32.1% of patients had no bone changes against 67.9% who showed at least one kind of bone changes. In a study by Pontual, it was shown that bone changes in the TMJ has a high prevalence and it is more common in women and the condyle region, and its prevalence increases with age.[11] Al-Ekrish *et al*. showed that at least one type of osteoarthritis changes exists in 78.6% of TMD patients and in 79.7% of those without TMD,[12] which is similar to the results of our study.

According to our findings, regarding bone changes the highest frequency related to flattening with a 46.4% frequency percentage, and the lowest was related to Ely cyst which was 3.6%. In a study by CÖmert Kilic, which aimed to evaluate the association between clinical signs and CBCT findings regarding TMJ osteoarthritis, it was concluded that between the evaluated changes (erosion, flattening, osteophyte, sclerosis, hypoplasia, and subchondral cyst) most were related to erosion with 94% frequency percentage and subchondral cyst had the least frequency percentage with 3.4%. It is also worth mentioning that flattening was second with 92.3% frequency percentage,[13]

Table 2: Frequency distribution of degenerative changes separated (*n*=56)

Pathologies	Sclerosis	Resorption	Erosion	Osteophyte	Flattening	Ely cyst
Number	4	3	14	8	26	2
Frequency percentage	7.1	5.3	25.0	14.3	46.4	3.6

Table 3: Frequency distribution of condyle position horizontally and vertically, in general, separated based on gender

Gender	Horizontal position (*n*=44)		Vertical position (*n*=44)	
	Normal	Abnormal	Normal	Abnormal
Female *n* (%)	1 (2.5)	39 (97.5)	17 (42.5)	23 (75.5)
Male *n* (%)	0 (0.0)	4 (100.0)	1 (25)	3 (75)
Total *n* (%)	1 (2.3)	43 (97.7)	18 (40.9)	26 (59.1)

Table 4: Frequency distribution of condyle position horizontally and vertically separated based on different conditions in two genders

Gender	Horizontal position (*n*=44)			Vertical position (*n*=44)		
	Normal	Anterior	Posterior	Normal	Decreased articular space	Increased articular space
Female *n* (%)	1 (2.5)	6 (1.5)	33 (82.5)	17 (42.5)	2 (5.0)	21 (52.5)
Male *n* (%)	0 (0.0)	2 (50)	2 (50)	1 (25.0)	0 (0.0)	3 (75.0)
Total *n* (%)	1 (2.3)	8 (18.2)	35 (79.5)	18 (40.9)	2 (4.5)	24 (54.5)

which is somewhat similar to our results. In Imani Moghaddam study, flattening had the highest prevalence in both group of patients with disk dislocation and osteoarthritis, which is also approved by the results of our study.[14] In our study, condyle's horizontal (normal, anterior, and posterior) and vertical (normal, decreased, and increased) position in closed mouth state with maximum intercuspation was evaluated. Results indicated that the most prevalent horizontal location was the posterior, with 79.5% frequency percentage which also had a higher prevalence in women. On the other hand, in the vertical dimension, there was a tendency toward increased articular space with a frequency percentage of 54.4% which was also more prevalent in men. According to our results, condylar dislocation was more horizontally rather than vertically. A study by Paknahad and Shahidi in 2015 compared the relation of condylar position (location) and clinical dysfunction in CBCT images of TMD patients. The results showed that in cases of mild-to-moderate TMD, condyle had an anterior and concentric location, whereas in patients with severe TMD, posterior position of the condyle was observed.[15] Regarding that in this study, the relation between clinical signs of the patients and radiographic features has not been evaluated, they cannot be compared or discussed on this basis.

Although CBCT provides the most complete images of TMJ and is the best alternative for assessment of TMJ osteoarthritis,[16] in a review article by Hussain *et al.*, it was concluded that specialized panoramic of the TMJ is a popular imaging method for evaluation of osteophyte and erosion in TMJ. CT does not provide any significant information compared to this method whereas CBCT is preferable to this technique, considering its radiation dose and cost. In general, for the diagnosis of erosion and osteophyte in TMJ a combination of several radiographic techniques increases the accuracy.[17]

Conclusion

In the assessment of condylar bone changes in CBCT images, most of the changes were related to flattening and the least were related to Ely cyst. In evaluating the horizontal position of the condyle, the most Prevalent position was the posterior which was more in women compared to men. In the evaluation of vertical position of the condyle, increased articular space was the most prevalent which was seen mostly in men rather than women. Dislocation of the condyle was higher in the horizontal dimension compared to the vertical (97.7% against 59.1%).

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