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Original Article

Assessment of Condylar Position and Dimensions in Symptomatic TMD Patients and Asymptomatic Individuals Using Cone Beam Computed Tomography

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Abstract

Aim: to assess the effect of temporomandibular disorder (TMD) on the condylar position and dimensions by examining symptomatic TMD patients and comparing it with controls without TMD symptoms using CBCT.
Subjects and Methods: 32 patients (64 TMJs) were enrolled in this study. They were divided into symptomatic TMD group and control group without TMD symptoms; 16 of each. Corrected coronal and sagittal cuts were used to measure the anterior joint space (AJS), posterior joint space (PJS), vertical diameter (VD), and mediolateral diameter (MLD). Anterior/posterior ratio (A/P) ratio was calculated to detect the condylar position.
Results: comparing right and left sides each group; showed no statistical difference in MLD, VD, AJS, PJS and A/P ratio ($P > 0.05$). The comparison of both studied groups revealed that no statistical difference in MLD, VD, AJS and PJS ($P > 0.05$). Also, no statistical difference in anterior displacement (p-value = 0.784) between studied groups and there was a statistical difference in posterior and concentric condylar positions (p- value = 0.005) (p- value = 0.012) respectively. Controls showed 65.6% concentric position while anterior and posterior displacements were 28.10% and 6.3% respectively. Whereas, TMD patients showed concentric position and posterior displacement in an equal percentage 34.4%.
Conclusion: No statistical difference in joint space and condylar dimensions between controls and TMD patients. Nevertheless, there was a statistical difference in posterior and concentric condylar positions between studied groups. Controls showed concentric condylar position whereas, TMD group presented concentric position and posterior displacement in an equal percentage.
Keywords: Cone-beam computed tomography; Mandibular condyle; Temporomandibular disorder; Temporomandibular joint.

Introduction

Temporomandibular disorders (TMD) are a group of musculoskeletal and neuromuscular conditions causing pain and dysfunction in the masticatory muscles, temporomandibular joints (TMJ) and associated structures with a peak incidence at 20 to 40 years of age. It is the most common type of non-odontogenic orofacial pain **(Gauer and Semidey, 2015; Kaposa et al., 2020).**

TMD have a wide variety of causes; parafunctional habits, occlusal disharmony, anxiety, stress, trauma and microtrauma, mandibular instability and postural imbalance **(Bitiniene et al., 2018).** Signs and symptoms of TMD include painful joint sounds, restricted mouth opening, deviating mandible and cranial and/or muscular pain **(Murphy et al., 2013).**

Diagnosis is most often based on history and physical examination. In addition, diagnostic imaging modalities are valuable when intra-articular abnormalities are expected **(Gauer and Semidey, 2015**). Several radiographic techniques have been used to evaluate the TMJ including plain radiography, conventional tomography, arthrography, magnetic resonance imaging (MRI), computerized tomography (CT) and cone beam computed tomography (CBCT). CBCT is ideal for imaging the bony components of TMJ, owing to its high resolution, low dose, short scanning time, and low cost when compared with medical CT **(Incesu et al., 2004; Shokri et al., 2019; Ravelo et al., 2022).**

Although the condylar position and dimensions could be a valuable diagnostic assistance in TMD as joints with internal derangement have a tendency to have a posterior condyle position, there is a controversial results about that **(Gorucu-Coskuner et al., 2019).** Thus, the purpose of this study is to assess the effect of TMD on the condylar position and dimensions by examining a group of TMD patients and comparing it with a control group of patients without TMD.

Subjects and methods

The study was approved by the ethic committee, faculty of Dentistry, Cairo university. All methods were performed in accordance with the relevant guidelines and regulations. A total of 32 subjects (64 TMJs) were enrolled in this prospective study. The subjects were divided into two groups; TMD group consisted of sixteen symptomatic patients (5 men and 11 women) with mean age 31 years. Normal (control) group consisted of sixteen asymptomatic individuals (4 men and 12 women) with mean age 35.5 years. The subjects of the control group had already been referred for a CBCT examination to evaluate complaints not related to or affecting the TMJ; such as; evaluation of impactions, evaluation of maxillary sinus, or lesions not related to TMJ. Informed consent was obtained from each patient before the research. The inclusion criteria were healthy physical condition, no sex predilection, > 20 years old, and no degenerative joint disease. For the control group, no TMD symptoms were reported. Exclusion criteria were the presence of positive history of trauma of head and neck, orthognathic surgery, skeletal anomalies such as craniofacial synostosis and facial cleft and severe bruxism or attrition.

TMD patients showed signs and symptoms consistent with TMD, including joint pain, joint click/crepitation, mouth-opening limitation, muscle pain, and non-harmonic movements of the joint. They were diagnosed at - Maxillofacial Surgery Department, faculty of Dentistry, Cairo University - according to the RDC/TMD criteria, which is an international diagnostic system and is widely used as a valid and reliable system **(Ahmad et al., 2009)**. Then, referred to Oral and Maxillofacial Radiology Department, faculty of Dentistry, Cairo University for imaging and accurate treatment planning.

CBCT of the TMJ was performed for each patient using a Planmeca® Promax3D Mid (Planmeca Oy, Helsinki, Finland). The exposure parameters were FOV of 20×10 cm, a voxel size of 0.4 mm, 90 kVp, and 10mA. CBCT image analysis was performed using the Planmeca Romexis viewer software version 6.1.0.997.

The measurements were performed on corrected sagittal and coronal views to guarantee an accurate visualization of the TMJ from the anteroposterior and the mesiolateral aspect. To create these corrected views, the axial view showing the widest mediolateral diameter of the condyle is selected for determination of the long axis of the condyle and formation of the corrected sagittal and coronal views. A single examiner performed all of the measurements twice with one week interval.

The measurements were analyzed on the coronal and sagittal planes with the following orientations: (Fig.1)

Mediolateral diameter of the condyle (MLD): The measurement was obtained from a transverse line of the condyle, from the most medial to the most lateral cortical point. It was measured on coronal view.

Vertical diameter of the condyle (VD) mm: The measurement was obtained from a vertical line that begins at the highest cortical point to the lowest point of the condylar head (the beginning of condylar neck constriction). It was measured on coronal view.

Anterior joint space (AJS) mm: The shortest distance between the posterior wall of the tubercle and the most anterior point of the condylar head and was measured on sagittal view.

Posterior joint space (PJS) mm: The shortest distance between the posterior wall of the mandibular fossa and the most posterior point of the condylar head and was measured on sagittal view.

The anterior/posterior (A/P) joint space ratio: it was calculated according to **Fraga et al. 2013** by dividing the anterior joint space by the posterior joint space. A/P ratio of 1.0 indicated a concentric condyle. A/P ratio of greater than 1.0 represented a posterior condylar position, while A/P ratio of less than 1.0 represented an anteriorly displaced condyle.

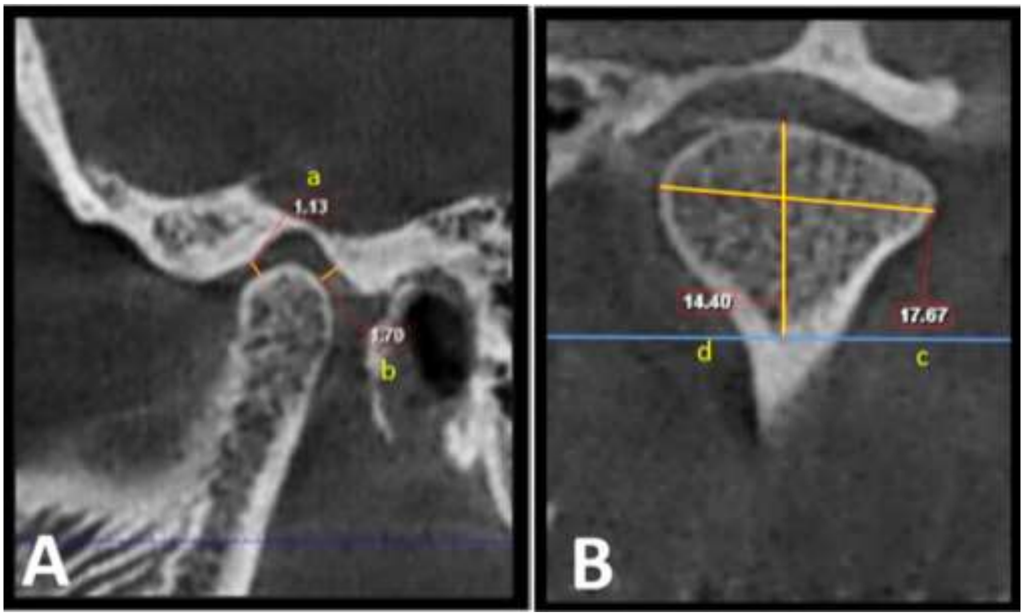
Statistical methods:

Data were coded and entered using the statistical package for the Social Sciences (SPSS) version 28 (IBM Corp., Armonk, NY, USA). Data was summarized using mean and standard deviation for quantitative variables and frequencies (number of cases) and relative frequencies (percentages) for categorical variables. Comparisons between groups were done using unpaired t test (Chan, 2003a). For comparing categorical data, Chi square ($\chi 2$) test was performed. Exact test was used instead when the expected frequency is less than 5 (Chan, 2003b). *P*-values less than 0.05 were considered as statistically significant.

Results

In this study, CBCT images of 32 patients (64 TMJs) were assessed (16 with TMD and 16 without any history of TMD). The intra-observer error rate was evaluated by the intraclass correlation coefficient, and it was > 0.95. Comparing right and left sides each group; showed no statistical difference between both sides in MLD, VD, AJS, PJS and A/P ratio ($P > 0.05$) (Tables: 1-4). Concerning the comparison of both studied groups, there was no statistical difference in MLD, VD, AJS and PJS ($P > 0.05$) (Table: 5).

Both groups revealed no statistical difference in anterior displacement (*p*-value = 0.784). Conversely, there was a statistical difference in posterior and concentric condylar positions (*p*-value = 0.005) (p- value = 0.012) respectively (Table: 6).



(Fig.1): Showing the measurements on corrected sagittal (A) and coronal (B) reformatted cuts; a) Anterior joint space (AJS), b) Posterior joint space (PJS), c) Mediolateral dimension (MLD), d) Vertical dimension (VD).

Table (1): Mean and S/D of measured parameters in control group.

	Control group				
	Right		**Left**		**P value**
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	
MLD	17.88	2.32	16.66	4.18	0.316
VD	12.93	2.06	12.88	2.35	0.958
AJS	1.83	0.33	1.91	0.37	0.503
PJS	2.11	0.53	1.98	0.51	0.502
A/P ratio	0.92	0.33	0.98	0.24	0.571

Table (2): Numbers and percentages of condylar position in control group.

		Control group				
		Right		Left		P value
		Number	%	Number	%	
Condylar position	Anterior displacement	5	31.3%	4	25.0%	1
	Posterior displacement	1	6.3%	1	6.3%	
	Concentric condyle	10	62.5%	11	68.8%	

Table (3): Mean and S/D of measured parameters of TMD group.

	TMD group				
	Right		Left		P value
	Mean	S/D	Mean	S/D	
MLD	19.48	1.85	18.02	4.66	0.254
VD	13.46	2.13	13.50	2.38	0.957
AJS	1.80	0.63	1.79	0.39	0.955
PJS	1.95	0.52	1.78	0.48	0.333
A/P ratio	0.97	0.38	1.13	0.58	0.351

Table (4): Numbers and percentages of condylar position in TMD group.

		TMD group				
		Right		Left		P value
		Number	%	Number	%	
Condylar position	Anterior displacement	5	31.3%	5	31.3%	0.913
	Posterior displacement	5	31.3%	6	37.5%	
	Concentric condyle	6	37.5%	5	31.3%	

Table (5): Mean and S/D of measured parameters in both studied groups.

	TMD group		**Control group**		
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	**P value**
MLD	18.75	3.57	17.27	3.38	0.093
VD	13.48	2.22	12.91	2.18	0.301
AJS	1.80	0.52	1.87	0.35	0.486
PJS	1.86	0.50	2.05	0.52	0.155
A/P ratio	1.05	0.49	0.95	0.29	0.349

Table (6): Numbers and percentages of condylar position in both studied groups.

		TMD group		**Control group**		**P value**
		Count	**%**	**Count**	**%**	
Condylar position	**Anterior displacement**	10	31.3%	9	28.1%	0.784
	Posterior displacement	11	34.4%	2	6.3%	0.005
	Concentric condyle	11	34.4%	21	65.6%	0.012

Discussion

Condylar dimensions and its relationship with the glenoid fossa may provide some reference for diagnosis and treatment of TMJ disorders **(Li et al., 2015).** Thus, in this study 32 patients (64 TMJs) were examined to assess the effect of TMD on the condylar position and dimensions. Patients were divided into two groups; 16 TMD patients and 16 patients without TMD signs and symptoms. The TMD patients were diagnosed using the diagnostic criteria for TMD research (RDC/TMD). CBCT was used in this study owing to its ability to provide 3D images of the condylar dimensions and position and precise analysis and diagnosis of bone dimensions and joint space **(Zhang et al., 2012).**

Comparing right and left sides each group; showed no statistical difference between both sides in MLD, VD, AJS, PJS and A/P ratio ($P > 0.05$). Our results are close to **Li et al., 2015** who investigated bilateral TMJ in patients with unilateral TMJ pain or joint sounds and controls without TMJ complaint using CBCT. The study showed that, no statistical difference between both sides except in radius value of TMJ in the control group and vertical 60° joint space in unilateral TMD group. This may be due to the linkage nature of TMJ and chewing habits that affects condylar dimensions and joint space. Conversely, **Tecco et al., 2010** and **Ahmed et al., 2021** found that, there was a significant difference in joint spaces and the volume of the condyle between the right and left side. It could be explained by the presence of a preferred side for mastication in the studied subjects **(Ahmed et al., 2021).**

In this study, there was no statistical difference in MLD, VD, AJS, PJS and A/P ratio (P > 0.05) between studied groups. likewise, **Shokri et al., 2019; Okur et al., 2012; Shahidi et al., 2018** investigated the TMJ space in TMD patients and controls using CT and CBCT respectively. They reported that, no significant difference in joint space between both studied groups. As well, **Kattiney de Oliveira et al., 2022; Lelis et al., 2015** compared the measurements of the joint space and condylar positions in centric relation and maximum intercuspation positions using CBCT in controls and TMD patients. They found no significant differences of values between both groups.

On the contrary, **Yasa et al., 2018** reported significant differences in the Ajs, Pjs and A/P ratio between the asymptomatic group and the TMD group. **Imanimoghaddam et al., 2016** revealed that PJS was not significantly different between the normal and TMD groups whereas, AJS was larger in the TMD group.

Regarding measurements of condyles between controls and TMD subjects, **Okur et al., 2012** found a significant difference in AP and ML. Also, a study by **Yasa et al., 2018** revealed that, the condylar width was greater in the asymptomatic group than TMD group.

In this study no statistical difference was revealed in anterior displacement (p-value = 0.784) while, there was a statistical difference in posterior and concentric condylar positions (p- value = 0.005) (p-value = 0.012) respectively between controls and TMD patients. Controls showed 65.6% concentric position while anterior and posterior displacements were 28.10% and 6.3% respectively. Whereas, TMD patients showed concentric position and posterior displacement in an equal percentage 34.4% and anterior displacement was 31.3%.

The normal variations in the condylar position may be due to individual adaptive capacity **(Henriques et al., 2012).** The results of this study are consistent with **Dalili et al., 2012** who examined the condylar position in the people with normal function of TMJ using CBCT and found that the centric position of the condyle was more common than other positions. Furthermore, **Ikeda et al., 2009** evaluated the condylar position in 22 asymptomatic patients using CBCT. They reported less variability of condylar position in the fossa.

In agreement with this study, **Paknahad and Shahidi, 2015** observed that the condylar position was more posterior in severe TMD patients. Also, **Imanimoghaddam et al., 2016** concluded the decreased PJS in TMD patients indicating posterior position of the condyle. Yasa et al., 2018 examined the bone components of the TMJ in asymptomatic individuals and patients with TMD using CBCT and reported that the condyle was positioned more toward the posterior in the TMD group. **Shokri et al., 2019** evaluated the association between TMD and the condylar position by examining a group of patients suffering from TMD and controls without TMD using CBCT. They indicated that the position of the condyle was more posterior in the joints with TMD, and was more anterior and centric in the asymptomatic joints. Contrary to these studies, **Lelis et al., 2015** concluded that the presence or absence of TMD was not associated with the position of the condyles in the TMJs.

The difference in the results of the studies can be explained due to the difference in subjects' age, ethnicity, gender, the craniofacial complex morphology, and also the accuracy of clinical examinations and the methods of measurements.

The posterior condylar position in TMD patients may be related to the severity of the condition. **Paknahad and Shahidi, 2015** investigated the correlation between clinical dysfunction index and condylar position in 60 patients with TMD using CBCT. They concluded that patients with mild to moderate TMD had anteriorly and concentric condylar position whereas, posteriorly located condyles were found in patients with severe TMD.

On the other hand, the condylar position in TMD patients may be related to the disk displacements (DDs). **Rammelsberg et al., 2000** compared the posterior and anterior joint spaces in healthy TMJs with those of patients who present different forms of DDs. Patients with bilateral DD with reduction showed more posterior position of the condyle, as compared with controls and patients with bilateral DD without reduction. Also, **Almăşan et al., 2013** assessed 74 TMJs with positive clinical TMD symptoms using MRI. They revealed that the condyle was located posteriorly in 62.7% of joints with DDs.

Conclusion

The present study indicates no statistical difference in joint space and condylar dimensions between controls and TMD patients. Nevertheless, there was a statistical difference in posterior and concentric condylar positions between studied groups. The majority of controls showed concentric condylar position whereas, TMD group presented concentric position and posterior displacement in an equal percentage.

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