

Association Between Chronic Periodontitis and Condylar Morphological Changes Using Cone Beam Computed Tomography: An Observational Study

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ABSTRACT

Background: Chronic periodontitis is a widespread inflammatory condition that can progress, resulting in destruction of periodontal supporting structures, tooth loss and morphological changes of the condyle. The study aimed to assess the relationship between chronic periodontal (PD) conditions and condylar morphological changes in patients with and without temporomandibular joint disorders (TMDs) using CBCT. **Methodology:** This cross-sectional study examined 216 condyles using cone beam computed tomography (CBCT), scans were divided into Group I (control) and Group II (TMD). Each condyle was assessed for the presence of condylar morphological changes as flattening, erosion, osteophyte and sclerosis. PD conditions were categorized into mild, moderate, and severe based on radiographic bone loss. Comparison between group I and II regarding baseline and clinical data was performed using Chi square test. The association between different PD conditions, condylar morphological changes, and age was assessed using Fisher's Exact test. **Results:** Moderate PD was more prevalent in TMD patients 66.7%. Condylar changes were more observed in Group I (34.3%) compared to Group II (22.2%). No significant difference was noted for flattening, osteophytes, erosion, or sclerosis. Moderate periodontal disease was more prevalent in the TMD group and was also more common among older patients in both groups. In Group II, condylar changes were significantly more common in older age group (31.8%) compared to younger group (15.6%). **Conclusion:** No correlation was found between TMD related symptoms and condylar morphological changes in patients with chronic periodontitis.

Key Words : Chronic periodontitis, Condylar morphological changes, TMD, CBCT

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INTRODUCTION

Periodontitis is a chronic, irreversible condition that affects the periodontium and the supporting structure of the teeth, its severity and prevalence tend to increase with age [1,2]. Many predisposing factors may lead to periodontitis, including bad oral hygiene, smoking and overhanging restorations. Diseases such as diabetes, systemic disorders as well as genetic factors may also attribute to periodontitis [3,4,5]. In its early stages, periodontitis is painless, allowing unnoticed progression of the disease [4]. Overtime, bone loss may occur due to increase osteoclastic activity which may lead ultimately to tooth

loss [6]. That in turn may result in occlusal instability, negatively impacting quality of life by impairing mastication and causing future temporomandibular joint (TMJ) problems [7]. Periodontal treatment in its early stage along with good oral hygiene, can help decrease or slow down the progression of periodontal disease [6]. TMJ is a synovial joint connecting the mandibular condyle with the glenoid fossa in the temporal bone of the skull, with the articular disc separating both structures [8]. It connects upper and lower jaws through the teeth, with the muscles acting as motors that moves the mandible [9].

Accordingly, any stimulus affecting this articular system could impact swallowing, chewing, and speaking causing temporomandibular disorders (TMDs)^[9,10]. TMDs affect 5 to 12% of populations^[8], and refer to a group of musculoskeletal disorders affecting masticatory muscles, TMJ, and associated anatomical structures causing pain and dysfunction^[11]. Morphological changes in the condyle lead to TMJ dysfunction with osteoarthritis being among the most common joint disorder. It is characterized by flattening of the condyle, osteophyte formation, erosion, sclerosis and bone resorption^[12,13]. Accurate and precise diagnosis of TMD is essential examination and imaging^[14]. Various imaging modalities are used in dental fields for diagnosis of condylar morphological changes including panoramic radiography, computed tomography (CT), magnetic resonance imaging (MRI) and cone beam CT (CBCT). Among these, three dimensional CBCT has become widely used in dentistry, due to its ability to visualize the condyle in various cross-sectional views. Compared to CT, CBCT offers the benefit of lower radiation dose and lower cost^[11]. Additionally, CBCT enables greater reliability and better accuracy in evaluating condylar morphology compared to panoramic radiography^[15]. Many studies have examined the prevalence of degenerative changes in the TMJ regarding age and sex. However, the association between chronic periodontal condition and condylar morphological changes remains unexplored. As a result, the present study aimed to evaluate the association between chronic periodontal conditions and condylar morphological changes using CBCT, and to compare the periodontal condition between patients with and without TMDs.

Materials and Methods:

This cross-sectional observational study was approved by the Research ethical committee of the faculty of Dentistry, Cairo university, under approval number of 55-7-24. CBCT scans from a large pool of patients were initially reviewed; however, for the purpose of this study, a total of 216 condyles (108 for each group) from both right and left sides, were selected and included in the current study. All the scans were performed in the Oral and Maxillofacial Radiology department at the Faculty of Dentistry, Cairo University. The patients were referred for 3D imaging for various dental purposes.

Sample size calculation:

The predicted sample size was a total of (103) per group according to the results of a previous study by Jeevitha et al 2021^[16] in which the prevalence was (7.2%) by adopting a confidence interval of (95%), a margin of error of (5%) with finite population correction. Sample size was calculated by using EPI INFO version 7.2.5.0.

Eligibility criteria:

The inclusion criteria for this study were adult patients aged from 18 to 60 years, who had undergone closed mouth CBCT scans of both arches, with optimal diagnostic quality, and clearly showing condylar area, along with fully presence of posterior teeth. Exclusion criteria included patients over the age of 60, those with badly decayed carious teeth that prevent chewing on the affected side. Patients with history or signs of surgery, any congenital disorders that might affect TMJ were also excluded from the research. Additionally, patients were excluded if they had any dental implant, had severe malocclusion, undergone periodontal treatment within the previous three months, and who had received any orthodontic treatment potentially affecting the TMJ.

Patient preparation and scanning

The patients were scanned using a Planmeca ProMax 3D mid CBCT machine (Planmeca Oy, Helsinki, Finland)) with their mid-sagittal plane positioned perpendicular to the floor. The scanning parameters included a 16×10 cm field of view, a matrix size of 400×400×225, a 400 µm voxel size, and exposure parameters of 90 kVp, 8 mA, and 13.5 seconds. Participants were asked to complete a questionnaire to determine if they are suffering from any TMD related problems^[17], which included the following:

- Do you experience any pain related to TMJ area? Yes/No
- Do you hear a clicking sound while eating or on opening the mouth? Yes/No
- Do you suffer from any limitations in mouth opening? Yes/No
- Do you feel any muscle pain on chewing? Yes/No
- Do you experience chronic ear pain or headache? Yes/No
- Do you have any grinding or clenching habits? Yes/No

Based on the questionnaire results the scans were categorized into 2 groups, which are: Group I (Control group): Patients with no signs and symptoms suggestive of TMD, who answered "No" to all questions. Group II (TMD group): Patients who reported any symptom of TMD, who answered "Yes" to one or more questions in questionnaire. The scans were then coded with numbers by an independent researcher, and the radiologists assessing the cases were blinded to whether the scans belonged to control or TMD group. Clinical and demographic information about the patients was not available during assessment to ensure blinding.

Condylar morphology evaluation:

DICOM images were exported to computer running windows 10, and viewed using Planmeca Romexis viewer software version (6.4.2.49). The condyles of each side were assessed in the corrected sagittal images, generated perpendicular to the condylar long axis on axial view. Sagittal images were scrolled in slice thickness of 0.4 mm to evaluate condylar shape, which was categorized as either normal or abnormal condyles. Normal condyles were identified by its typical convexity, normal bone density and intact cortication. Abnormal condyles, were further classified according to previous studies [18,19] into: (figure 1)

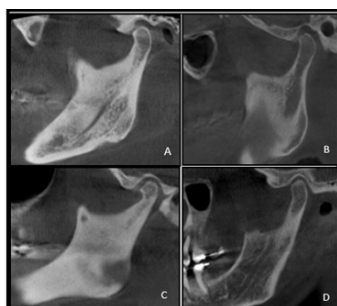


Figure 1. Corrected sagittal CBCT cuts showing the classification of abnormal condylar morphology: (A), Flattening, (B), Erosion (C) Osteophyte, and (D) Sclerosis.

1. Flat: loss of condylar contour or convexity
2. Erosion: loss of condylar cortical plate cortication or decreased bone density
3. Osteophyte: localized bony outgrowth at the edge of mandibular condyle

Sclerosis: increased bone and/or cortical plate radiopacities Other abnormalities as Ely cyst, generalized sclerosis, ankylosis, and any TMJ anomalies were not included in the study as their

causes are not related to our research focus.

Periodontal (PD) condition evaluation

The periodontal condition of the tooth with the most bone loss was observed and evaluated in each side for any bone loss and categorized based on a previous study (20) (figure 2), into: Mild, defined as bone loss more than 2 mm and less than 20 % of root length; Moderate, characterized by bone loss more than 20 % but less than 50% of root length; and severe; indicating bone loss more than 50% of the root length. The periodontal conditions were correlated to the condylar classification of the same side to evaluate possible association between PD conditions and the presence or absence of TMD

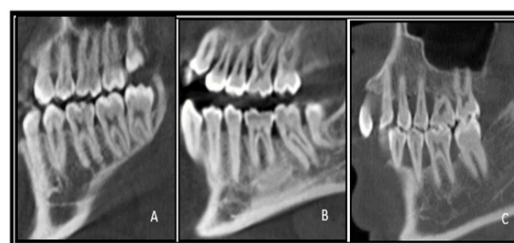


Figure 2. Corrected sagittal CBCT cuts showing the classification of periodontal bone loss: (A), Mild, (B), Moderate (C), Severe.

All the scans were examined and evaluated by two qualified oral and maxillofacial Radiologist of 15 years' experience independently for interobserver reliability. In case of conflicting findings, both observers discussed the case together to reach an opinion.

Statistical analysis:

The comparison between Group I (control group) and Group II (TMD group) regarding baseline and clinical data was performed by using Chi square test. The association between different PD conditions, condylar morphological changes, and age was assessed using Fisher's Exact test. Interobserver agreement for image quality assessments of both PD condition and condylar morphology was evaluated using intraclass correlation coefficients (ICC) in Groups I and II.

Results:

A statistically significant difference was found between Group I and Group II in assessing the PD conditions. Group I, mild and moderate periodontitis were almost equally distributed at 38.9%

and 39.8%, respectively, while severe periodontal involvement was found in 21.3% of cases. In contrast, Group II showed a higher prevalence of moderate periodontitis, accounting for 66.7% of cases, compared to mild (16.7%) and severe (13.0%) (table 1) (figure 3). In terms of condylar morphology, a significant difference was also noted, with a higher prevalence of condylar changes observed in Group I compared to Group II (34.3% vs. 22.2%) (table 1).

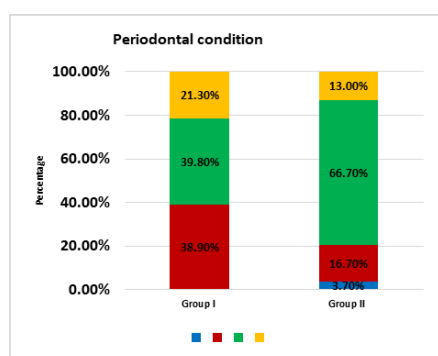


Figure (3): Stacked chart showing PD condition in each Group I and Group II.

		Group				Chi square test		
		Group I		Group II		Chi square	P value	
		Count	Column N %	Count	Column N %			
Periodontal condition	Normal	0	0.00%	4	3.70%	23.1	0.0001*	
	Mild	42	38.90%	18	16.70%			
	Moderate	43	39.80%	72	66.70%			
	Severe	23	21.30%	14	13.00%			
Condylar morphology	Normal	No	71	65.70%	84	77.80%	3.86	0.04*
		Yes	37	34.30%	24	22.20%		
	Flattening	No	59	54.60%	62	57.40%	0.17	0.68
		Yes	49	45.40%	46	42.60%		
	Osteophyte	No	91	84.30%	82	75.90%	2.35	0.13
		Yes	17	15.70%	26	24.10%		
	Erosion	No	99	91.70%	90	83.30%	3.43	0.06
		Yes	9	8.30%	18	16.70%		
	Sclerosis	No	93	86.10%	88	81.50%	0.85	0.36
		Yes	15	13.90%	20	18.50%		

prevalence of condylar changes observed in Group I compared to Group II (34.3% vs. 22.2%) (table 1).

On assessing the prevalence of specific condylar morphological features, no statistically significant differences were found between

the two groups in the prevalence of flattening, osteophyte formation, erosion, or sclerosis. This indicates that changes in condylar morphology are not necessarily associated with Group II patients who reported TMJ complaints, as 77.8 % of this group showed no changes. Although erosion appeared more frequently in the TMD group, this difference did not reach statistical significance (figure 4).

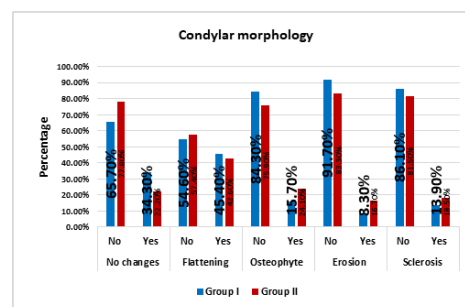


Figure (4): Bar chart showing Condylar morphology in Group I and Group II.

The association between PD conditions and condylar morphology was assessed across various PD severity. In cases with normal PD, no condylar morphological changes were found in Group I; all changes were observed exclusively in Group II (table 2). Among patients with mild PD, no significant associations were detected in either group for most condylar morphological changes. However, a significant difference was noted for sclerosis, which was more frequently absent in Group II. Flattening, osteophyte formation, and erosion were fairly evenly distributed between groups. In patients with moderate PD, erosion showed a significant association, present in 16.7% of Group II cases and absent in all Group I. Other features like flattening, osteophytes, and sclerosis showed no statistically significant differences between groups with moderate PD. No statistically significant associations were observed in severe PD. Although some variations in the distribution of flattening, osteophyte formation, erosion, and sclerosis were observed, these differences were not statistically significant. Erosion and osteophyte formation appeared slightly more frequent in Group I, but these differences did not reach significance (table 2).

Periodontal condition		Group I				Group II				P value
		No		Yes		No		Yes		
		N	%	N	%	N	%	N	%	
Normal	Normal	0	0.00%	0	0.00%	4	100.00%	0	0.00%	—
	flattening	0	0.00%	0	0.00%	2	50.00%	2	50.00%	—
	osteophyte	0	0.00%	0	0.00%	4	100.00%	0	0.00%	—
	erosion	0	0.00%	0	0.00%	2	50.00%	2	50.00%	—
	sclerosis	0	0.00%	0	0.00%	4	100.00%	0	0.00%	—
Mild	Normal	17	40.50%	26	59.50%	10	55.60%	8	44.40%	0.28
	Flattening	26	59.50%	17	40.50%	12	66.70%	6	33.30%	0.6
	Osteophyte	36	85.70%	6	14.30%	18	100.00%	0	0.00%	0.09
	Erosion	42	100.00%	0	0.00%	18	100.00%	0	0.00%	—
	Sclerosis	42	100.00%	0	0.00%	14	77.80%	4	22.20%	0.002*
Moderate	Normal	31	72.10%	12	27.90%	58	80.60%	14	19.40%	0.29
	Flattening	23	53.50%	20	46.50%	40	55.60%	32	44.40%	0.83
	Osteophyte	35	81.40%	8	18.60%	50	69.40%	22	30.60%	0.16
	Erosion	43	100.00%	0	0.00%	60	83.30%	12	16.70%	0.005*
	Sclerosis	33	76.70%	10	23.30%	58	80.60%	14	19.40%	0.63
Severe	Normal	23	100.00%	0	0.00%	12	85.70%	2	14.30%	0.06
	Flattening	11	47.80%	12	52.20%	8	57.10%	6	42.90%	0.58
	osteophyte	20	87.00%	3	13.00%	10	71.40%	4	28.60%	0.24
	erosion	14	60.90%	9	39.10%	10	71.40%	4	28.60%	0.51
	sclerosis	18	78.30%	5	21.70%	12	85.70%	2	14.30%	0.57

Table 2: Association between PD conditions and condylar morphology in Group I and Group II

A significant association was identified between age and PD condition in Group I. Among patients younger than 40 years, mild PD were most prevalent, accounting for 43.0% of cases. In contrast, patients older than 40 years demonstrated a higher prevalence of moderate PD at 63.6%. A significant difference was also observed in condylar morphology which was more common in patients under 40 years (39.5%) compared to those over 40 (13.6%). No specific condylar features showed a statistically significant association with age. However, flattening, sclerosis and osteophyte tended to occur more frequently in older patients occurring in 63.6%, 27.3% and 22.7% of cases respectively, this difference was not statistically significant. In contrast, erosion occurred only in the younger group with a prevalence of 10.5% (table 3). In Group II, a significant association was observed between age and PD condition. Among patients under 40 years, moderate PD involvement was the most common, present in 65.6% of cases. In patients over 40 years, moderate PD remained predominant at 68.2% and no cases of normal PD reported in the older age group. Condylar morphological changes were more prevalent in the older age group patients (31.8%) compared to younger group (15.6%), showing a significant difference.

However, no significant age-related associations were found for flattening, osteophyte formation, or erosion. Flattening was slightly more common in younger patients at 43.8%, compared to 40.9% in older patients. Osteophyte formation was present in 21.9% of younger cases and 27.3% of older cases. Erosion was also more prevalent among younger patients at 21.9% compared to 9.1% in older group. A significantly higher prevalence of sclerosis was observed in younger patients (25.0%) than in older ones (9.1%) (table 3).

			age range				P value			
			< 40 years		>40 years					
			Count	Column %	Count	Column %				
Group I	Periodontal condition		Normal PL	0	0.0%	0	0.0%	0.02*		
			Mild	37	43.0%	5	22.7%			
			Moderate	29	33.7%	14	63.6%			
			Severe	20	23.3%	3	13.6%			
	Condylar morphology	Normal	No	52	60.5%	19	66.4%	0.02*		
			Yes	34	39.5%	3	13.6%			
		flattening	No	51	59.3%	8	36.4%	0.06		
			Yes	35	40.7%	14	63.6%			
		osteophyte	No	75	87.2%	16	72.7%	0.09		
			Yes	11	12.8%	6	27.3%			
		erosion	No	77	89.5%	22	100.0%	0.11		
			Yes	9	10.5%	0	0.0%			
		sclerosis	No	76	88.4%	17	77.3%	0.18		
			Yes	10	11.6%	5	22.7%			
		Group II	Periodontal condition		Normal PL	4	6.3%	0	0.0%	0.01*
					Mild	14	21.9%	4	9.1%	
					Moderate	42	65.6%	30	68.2%	
					Severe	4	6.3%	10	22.7%	
			Periodontal condition	normal	No	54	64.4%	30	68.2%	0.04*
					Yes	10	15.6%	14	31.8%	
	flattening			No	36	56.3%	26	59.1%	0.77	
				Yes	28	43.8%	18	40.9%		
	osteophyte			No	55	78.1%	32	72.7%	0.52	
				Yes	14	21.9%	12	27.3%		
Condylar morphol- ogy	erosion		No	55	78.1%	40	90.9%	0.07		
			Yes	14	21.9%	4	9.1%			
	sclerosis		No	48	75.0%	40	90.9%	0.04*		
			Yes	16	25.0%	4	9.1%			

Table 3: Association between PD conditions, condylar morphology and age

Both Group I and Group II demonstrated excellent interobserver reliability. In Group I, ICC for PD condition was 0.995, and for condylar morphological values ranging from 0.968 to 0.991 indicating excellent agreement. Group II similarly showed high reliability values, with 0.992 for PD condition, while condylar morphology showed ICC values ranging from 0.916 to 0.981, indicating excellent agreement.

Discussion:

Chronic periodontitis has been linked to many systematic diseases, which may affect TMJ indirectly through common inflammatory pathways^[21]. The relationship between chronic periodontitis and TMD is likely multifactorial, including biomechanical, inflammatory, and behavioral factors. In absence of appropriate treatment, chronic periodontitis may progress to alveolar bone loss, leading to loosening of the teeth and subsequently altering occlusal relationship^[21]. As a result, patients will adopt unilateral mastication, to reduce discomfort, resulting in occlusal instability and increased mechanical stresses on the TMJ. These stresses may lead to condylar abnormalities including flattening, sclerosis, erosion and osteophyte formation, all of which are frequently reported in association with TMD^[11,22,23]. Nah KS^[24] et al found sclerosis to be as most common condylar abnormality followed by erosion and flattening on evaluating both TMD and healthy patients. In contrast, Almpani K et al.^[11] revealed erosion and flattening as the most common abnormalities, followed by sclerosis and osteophytes in TMD patients. Our finding showed that, flattening was the most common condylar change among TMD patients, followed by osteophyte, sclerosis and erosion. No statistically significant differences were observed. Furthermore, our findings suggest that condylar changes do not necessarily associate with the presence of TMD symptoms, as flattening was also being the most frequently observed changes in the control group. In a study by Mathew AL et al.^[25], panoramic radiographs were used for the assessment of condylar changes in TMD patients. Their findings were consistent with ours, showing no significant difference between TMD symptoms and condylar changes. In their study Flattening was the most prevalent followed by osteophyte, sclerosis and erosion. According to previous

studies^[26,27], the relation between periodontal condition and TMD showed that loss of occlusal support resulting from chronic periodontitis is associated with TMJ dysfunction, particularly with loss of molars and premolars teeth. Guo X et al.^[28] reported that condylar changes are observed more frequently in patients with chronic periodontitis, however, their study focused on examining the anatomical structures of the TMJ by measuring the joint space. These findings support the idea that periodontal bone loss along with occlusal instability, may contribute to TMD. A study by Bhoi T et al.^[22] for the association between the periodontitis severity and TMD symptoms revealed that, condylar changes were most commonly observed in patients suffering from periodontitis, particularly severe cases. This result is further supported by Jadeja et al.^[29], who also confirmed association between poor PD and TMD with a statistically significant association. Our study results demonstrated that moderate PD occurred more frequently among TMD patients, with a statistically significant association. On the other hand, Wang S et al.^[23] concluded that no direct relation exists between periodontal condition and TMD. However, they concluded that periodontitis may accelerate the progression of TMD, as it may lead to either tooth loss or chewing difficulties that will in turn contribute to increasing mechanical overload and ultimately TMD. These results align with Jeon HM et al.^[3] results, who stressed on the urgent need for early periodontitis treatment, preventing unilateral mastication and secondary TMJ related problems, and recommended TMJ examination in cases of long-term untreated periodontitis. The prevalence of chronic periodontitis has been shown to increase with age, especially in the age group of 41-60 years, as stated by different studies^[16,30]. This finding was further confirmed by a study^[31] who reported high prevalence of periodontitis in adults above 30 years. Our results concluded that moderate PD was observed more often in elder age groups (above 40 years) in both control and TMD groups. The findings of the present study also revealed that, condylar morphological changes in the control group did not correlate with age. In contrast, in TMD patients, these changes were significantly more prevalent in the older age group compared to younger group (15.6%). Flattening, erosion, and sclerosis have been more frequently observed

in the older age group compared to the younger group, whereas the prevalence of osteophytes decreased with age as reported by Mathew AL et al. [25]. Nevertheless, the current study found no age-related significant correlation in TMD patients, except for sclerosis, which was observed more frequently in younger age group.

Conclusion:

In conclusion, moderate PD was more prevalent among TMD group with a significant association. Although flattening was more common in TMD group, most condylar morphological changes didn't reach a significant association between groups. These findings indicate that, while periodontal condition may affect condylar morphology, TMD symptoms are not always related to condylar morphological changes. In terms of age influence, moderate PD was more common in older age group, while condylar changes were not age related. Maintaining good oral hygiene, and recognizing the relation between PD condition and condylar morphology, allow early intervention, effective treatment, improved patient outcomes, and prevent further complication.

Limitations:

The study did not include a clinical evaluation for periodontal condition, which might have provided a more accurate correlation.

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Authors contribution:

NA and EM developed the idea and conducted the practical work. NA drafted the manuscript, EM contributed to its editing. DA and GB critically revised the manuscript. All authors read and approved the final version of the manuscript.

Conflict of interest:

The authors declare that they have no conflict of interest.

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