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TMD, CBCT, CONDYLE, RDC, ARTICULAR EMINENCE

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Evaluation of Mandibular Condyle Morphology and Articular Eminence Inclination in Non-Muscular Temporomandibular Disorder Patients Using CBCT: A Cross-Sectional Study

Abstract

Background: Temporomandibular disorders (TMDs) are complex disorders with various etiologies.Cone-beam computed tomography (CBCT) provides precise information on TMJ anatomy, articular eminence, and condyle morphology. Factors like age, genetics, and functionals influence condyle changes, crucial for diagnosis and treatment.

Aims: To evaluate morphological variations of mandibular condyle and articular eminence inclination in non-muscular TMD and non- TMD patients using CBCT.

Settings And Design: cross –sectional study

Material & Methods: Condyle morphology and articular eminence inclination were measured in a sample of 30 patients who were grouped under (TMD =15) and (non –TMD =15) in coronal and sagittal view on both sides of the joint respectively

Statistical Analysis: Independent t-test used for comparison between groups

Result: A statistically significant difference was observed in condylar morphology and articular eminence inclination between the TMD and non-TMD groups. However, no significant differences were noted between the right and left temporomandibular joints within each group.

Conclusion: This study demonstrates increased condylar morphological changes and reduced articular eminence inclination in TMD patients compared to non-TMD individuals. These alterations may predispose to TMDs, and CBCT is a valuable tool for their diagnosis and treatment planning.

INTRODUCTION

The temporomandibular joint (TMJ) belongs to the category of ginglymoarthrodial synovial joint and consists of an articular disk, fibrous capsule, articular eminence, synovial membrane, synovial fluid, and associated ligaments[1]

TMDs, a group of disorders, affect the TMJ's soft tissue and bony components [2,3,]. Symptoms include pain, clicking, popping, limited mouth opening, mandible deviation, and muscle tenderness. Diagnosis is based on clinical examination and imaging, with the RDC/TMD being the most widely used protocol [4].

Morphological changes in the temporomandibular joint (TMJ) including condyle morphology, joint space, and articular eminence, are linked to TMDs. The mandibular condyle can be affected by developmental variations, remodelling, diseases, trauma, hormonal imbalances, and radiation therapy [5,6].

The articular eminence is described as the anterior limit of the glenoid fossa. The quantitative evaluation of the articular eminence can be assessed using the inclination, length, and height [7, 8].

The articular eminence is convex in the sagittal plane and inclination varies between 30 degrees and 60 degrees [9]. Using tomograms, Atkinson and Bates determined the articular eminence's slope and hypothesized that the TMD might be caused by the angle's steepness [10].

The Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) recommends CT as the preferred modality for evaluating TMJ osseous changes, for both research and diagnosis but due to high cost and radiation dose the use has been limited. Two-dimensional projections have low sensitivity in evaluating condyle, articular eminence, and structural distortion so Cone beam computed tomography (CBCT) is often recommended as a dose sparing and effective technique for TMJ imaging offering multiplanar views and shorter scanning time than conventional CT [11].

In the present study CBCT was used to evaluate the morphological shape of the condyle and the articular eminence inclination in non-muscular TMD and non-TMD patients.

Material And Methods

This study included a total of 30 CBCT images. CBCT scans obtained from patients presenting with complaints in the temporomandibular joint (TMJ) region were considered as the case group (Group 1). CBCT images taken for other diagnostic purposes, in which the TMJ region was incidentally included within the field of view, were considered as the control group (Group 2). All images were acquired using the Planmeca ProMax Mid CBCT unit with Planmeca Romexis software (Version 3.8.3.R). Ethical clearance for the study was obtained from the Institutional Ethical Committee of Yenepoya University prior to the commencement of the study.

Inclusion Criteria:

CBCT Images of clinically diagnosed cases of non-muscular TMD based on RDC

Exclusion Criteria:

Patients having a positive history of:

- Temporomandibular surgery
- Trauma and fracture of condyle
- Congenital abnormality.
- Systemic diseases
- Scans with artifacts will be excluded from study

Methodology:

The study samples were selected from the outpatients who visited the department of Oral Medicine and Radiology, Yenepoya dental college with the pain in the TMJ area. The clinical evaluation and diagnosis were done by using RESEARCH DIAGNOSTIC CRITERIA RDC/TMD and patients grouped under non –muscular category

CBCT images were taken in field of view with a size of 20X17 cm,90 kvp ,8ma.

The morphology of condyle and articular eminence inclination were studied in coronal and sagittal view in TMD and non -TMD patients.

Morphology of the condyle were studied under following category:

- Bony shapes of condyle; flattened ,convex, concave ,angled, rounded
- Condylar surface irregularities :erosion, osteophytes
- Changes in the condyle : Ely‟s cyst (sub cortical cyst) were evaluated in non-muscular TMD Patients and non -TMD patients in sagittal, coronal, axial views

The articular eminence inclination was measured after adjusting the axial view at maximum convexity of condyle and by placing the lines perpendicular to each other and the corresponding central sagittal section was selected with a slice thickness of 0.04 mm (fig 1).

Two reference lines, labeled Line A and Line B, were established on the sagittal section (fig 2)

A; line drawn horizontally from superior most convexity of glenoid fossa

B; another line drawn parallel to posterior slope of articular eminence and their intersection makes an inclination

The inclination angle was measured between two reference lines A and B (fig 3)

Results

30 CBCT scans were taken in the study based on inclusive and exclusion criteria. The condyle morphology and articular eminence inclination were measured using the software. Among the samples, 15 are case group (group - 1) and 15 are control group (group - 2). Condylar morphology in both groups demonstrated notable differences in condylar shape between TMD and non-TMD patients. In the TMD group, concave (33%) and angled shapes (26%) were the most frequently observed, whereas round and flat forms appeared in fewer cases. In contrast, the non-TMD group showed a predominantly

concave shape (64%), with other shapes occurring less frequently, indicating a more uniform and physiologic condylar morphology in individuals without TMD.

Assessment of bony changes further supported these morphological variations. On the right side (Table 1), erosion was more commonly observed in the TMD group (n=4) compared to the non-TMD group (n=2), while osteophytes were recorded only in the TMD group (n=2). On the left side (Table 2), erosion appeared equally in both groups (n=1), while Ely's cyst was noted exclusively in the TMD group (n=1). A side-wise comparison of condylar morphology between TMD and non-TMD groups is presented in Graphs 1 and 2. These findings suggest that degenerative and pathological alterations are more characteristic of patients with TMD.

A comparison of the articular eminence inclination between groups revealed statistically significant differences on both sides of the joint. The right side (Table 3) showed a significant difference between groups ($t = -2.640$, $p = 0.013$), while the left side (Table 4) also demonstrated a significant difference ($t = -3.943$, $p = 0.001$). In both cases, the mean inclination was found to be decreased in TMD patients compared to non-TMD subjects.

Overall, the results indicate that altered condylar morphology, higher prevalence of degenerative bony changes, and significantly decreased articular eminence inclination are associated with TMD. These patterns support the role of both structural variations and functional biomechanics in the development and progression of temporomandibular disorders.

Discussion

The Temporomandibular Joint (TMJ) is challenging to examine due to its inability to accurately assess its position on conventional X-rays while CBCT as a 3D modality offers high-quality three-dimensional imaging of the TMJ region allowing for accurate assessment of condylar head and bony changes with less scanning and radiation dose than conventional tomography with high diagnostic quality of reconstruction images [12]

The appearance of mandibular condyles varies between age groups and individuals, and can be influenced by developmental changes, diseases, trauma, hormonal disorders, and radiation [13]

Female predominance can be seen in TMDs because estrogen may influence the development and metabolism of the TMJ and associated structures and may also influence the pain regulation mechanism in the female [14,15].

Changes in the shape and size of the condyles are an important factor in the diagnosis of the temporomandibular joint [16].

In the present study, condyle morphology was evaluated mainly by classifying condyle shapes in different cross-sections. We conducted the study in two groups (group 1 TMD = 15 and group 2 non-TMD = 15) under the age group (18-58 years) we found concave shape in 33%, angled -26%, followed by other round and flat shapes in 13% approx of TMD group that contradicts with previous studies that showed a more convex, round, and angular condyle shape in patients with anterior disc displacement [7].

In non –TMD group concave shape was most frequently observed in around 64 percent of samples followed by other shapes like round, oval etc

Common variations in TMD include surface erosion, sclerosis, flatness, osteophytes, and Ely's cyst.

In a study done by Zahra Vasegh et al [17] in the year 2023 in CBCT of 200 patients, the prevalence of bony changes in the TMJ were Osteophyte (63.5%), Flattening (42%), Erosion (40%) and Ely cyst (1%). which contradicts to our study in which Erosion (33%), Osteophyte (13 %), Elys‟cyst (6 %) was found in TMD group.

The slope of the eminence determines the joint's trajectory and disc rotation. Patients with prominent eminences experience wider condyle-disc movement, which can increase the risk of elongating the posterior ligament, leading to disc disorders [18].

Two main methods for measuring AE inclination are the "top-roof line method" and the "best-fit line method," both of which have similar AE angle values [19].

In the present study, we took the most posterior slope of articular eminence as the reference point and measured inclination in both TMD and non-TMD patients on the right and left sides of the joint in degrees.

In the TMD group mean value on the right side being 44.05 degree similarly on the left side the mean value of 42.09 degree obtained.

Some studies found a difference in eminence inclination according to gender, the present study results contraindicate this, and no significant relation was found between genders and inclination in the TMD group [20,21,].

In this present study we tried to evaluate the articular eminence inclination in non-muscular TMDs and compared with non-TMDs. The articular eminence mean inclination was found to be slightly decreased in the TMD group than in the non-TMD whereas the value within each group is statistically insignificant.

The controversies in articular eminence inclination and height could be due to differences in imaging techniques, methods of measurement, sample size, age range, and other differences between the populations.

Since our study is first of the its kind which uses RDC criteria for clinical diagnosis of TMDs and then co-relating with radiographic findings and so many more similar studies with more sample sizes should be used to get precise knowledge and can lead to identify patients with TMDs

Limitations Of Study:

- Low sample size
- Radiographic findings and clinical co-relation are not always accurate, in some cases radiographic findings were present in asymptomatic patients.

Conclusion

The present study demonstrates significant morphological differences in the mandibular condyle between individuals with temporomandibular disorders (TMDs) and non-TMD subjects. Patients with TMD exhibited a higher prevalence of degenerative condylar changes,

including erosion, osteophyte formation, and Ely's cysts, indicating ongoing structural alterations within the temporomandibular joint. In addition, a statistically significant difference in articular eminence inclination was observed between the TMD and non-TMD groups, highlighting its potential role in the pathophysiology of TMDs.

Cone-beam computed tomography (CBCT) proved to be a valuable imaging modality for the detailed assessment of osseous changes of the temporomandibular joint, enabling early detection of subtle degenerative alterations that may not be evident on conventional radiographs. Therefore, patients with clinical suspicion of TMD should be considered for CBCT evaluation to facilitate early diagnosis, appropriate treatment planning, and timely intervention, thereby preventing progression of joint pathology and improving overall patient outcomes.

inclination assessed in degrees comparing the TMD group to non-TMD group. Therefore patients with suspected TMDs should be referred for CBCT to detect any early alterations and address any potential problems as soon as possible.

Conflict of interest:

The authors have no commercial interest in any of the materials used in this study. The authors declare that they have no conflict of interest.

References

1. Pandis N, Karpac J, Trevino R, Williams B. A radiographic study of condyle position at various depths of cut in dry skulls with axially corrected lateral tomograms. Am J Orthod Dentofacial Orthop. 1991;100(2):116-122.
2. Lopes SL, Costa AL, Cruz AD, Li LM, de Almeida SM. Clinical and MRI investigation of temporomandibular joint in major depressed patients. Dentomaxillofac Radiol. 2012;41(4):316-322.
3. De Leeuw R, Klasser GD. Orofacial pain: guidelines for assessment, diagnosis, and management. Am J Orthod Dentofacial Orthop. 2008;134(1):171.
4. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet JP, et al. Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. J Oral Facial Pain Headache. 2014;28(1):6.
5. Major P, Kamelchuk L, Nebbe B, Petrikowski G, Glover K. Condyle displacement associated with premolar extraction and nonextraction orthodontic treatment of class I malocclusion. Am J Orthod Dentofacial Orthop. 1997;112:435-440.
6. Tsiklakis K, Syriopoulos K, Stamatakis HC. Radiographic examination of the temporomandibular joint using cone beam computed tomography. Dentomaxillofac Radiol. 2004;33(3):196-201.
7. Hegde S, Praveen BN, Shetty SR. Morphological and radiological variations of mandibular condyles in health and diseases: a systematic review. Dentistry. 2013;3(1):154.
8. Vemareddy S, Kannan A, Raghuram P, Kannan N. Assessment of morphological changes of articular eminence and condyle using CBCT. IP Int J Maxillofac Imaging. 2019;5(3):58-62.
9. Ayyıldız E, Orhan M, Bahşi İ, Yalçin ED. Morphometric evaluation of the temporomandibular joint on cone-beam computed tomography. Surg Radiol Anat. 2021;43(6):975-996.
10. Talaat W, Al Bayatti S, Al Kawas S. CBCT analysis of bony changes associated with temporomandibular disorders. CRANIO. 2016;34(2):88-94.
11. Sümbüllü MA, Çağlayan F, Akgül HM, Yilmaz AB. Radiological examination of the articular eminence morphology using cone beam CT. Dentomaxillofac Radiol. 2012;41(3):234-240.
12. Warren MP, Fried JL. Temporomandibular disorders and hormones in women. Cells Tissues Organs. 2001;169(3):187-192.
13. Sá SC, Melo SL, Melo DP, Freitas DQ, Campos PS. Relationship between articular eminence inclination and alterations of the mandibular condyle: a CBCT study. Braz Oral Res. 2017;31:e25.
14. Palomo JM, Kau CH, Palomo LB, Hans MG. Three-dimensional cone beam computerized tomography in dentistry. Dent Today. 2006;25(11):130.
15. Tsiklakis K. Cone beam computed tomographic findings in temporomandibular joint disorders. Alpha Omegan. 2010;103(2):68-78.
16. Vasegh Z, Safi Y, Azar MS, Ahsaie MG, Arianezhad SM. Assessment of bony changes in temporomandibular joint in patients using cone beam computed tomography: a cross-sectional study. Head Face Med. 2023;19(1):47.
17. Barghan S, Tetradis S, Mallya SM. Application of cone beam computed tomography for assessment of the temporomandibular joints. Aust Dent J. 2012;57(Suppl 1):109-118.
18. Dalili Z, Khaki N, Kia SJ, Salamat F. Assessing joint space and condylar position in the people with normal function of temporomandibular joint with cone-beam computed tomography. Dent Res J (Isfahan). 2012;9(5):607-612.
19. Boeddinghaus R, Whyte A. Computed tomography of the temporomandibular joint. J Med Imaging Radiat Oncol. 2013;57(4):448-454.
20. Ozkan A, Altug HA, Sencimen M, Senel B. Evaluación de la morfología e inclinación de la eminencia articular en pacientes con trastorno interno de ATM con MRI. Int J Morphol. 2012;30(2):740-744.

21. Krishnamoorthy B, Mamatha NS, Kumar VA. TMJ imaging by CBCT: current scenario. Ann Maxillofac Surg. 2013;3(1):80-83.

Fig-1

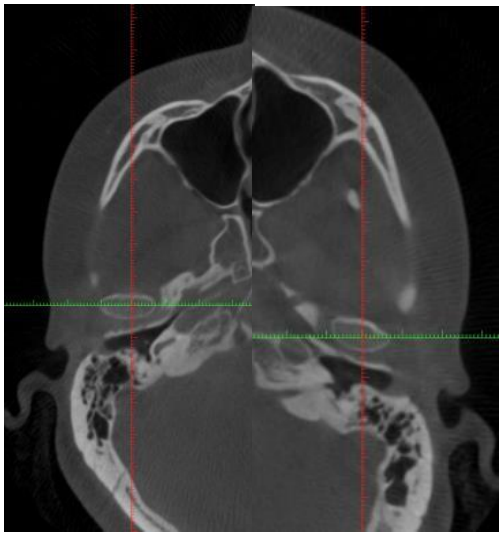


Fig-2 showing two reference lines A and B

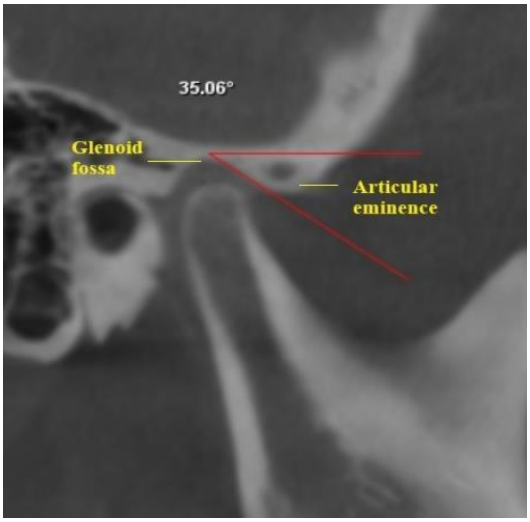
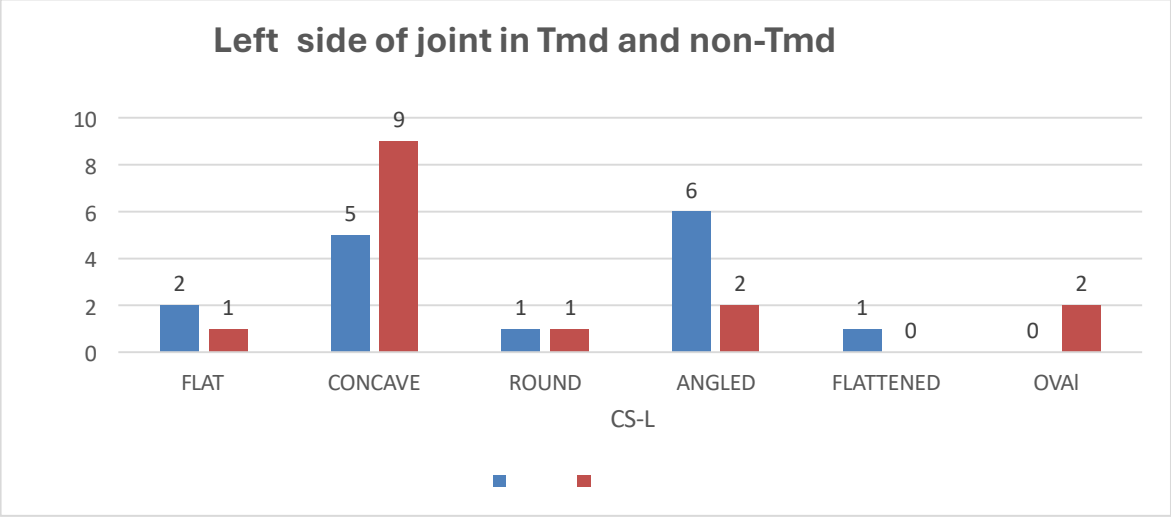


FIG-3 showing measurement of articular eminence inclination in TMJ



GRAPH -1and 2: Different Shapes of condyle on the Right and left side of the joint in TMD and non-TMD patients

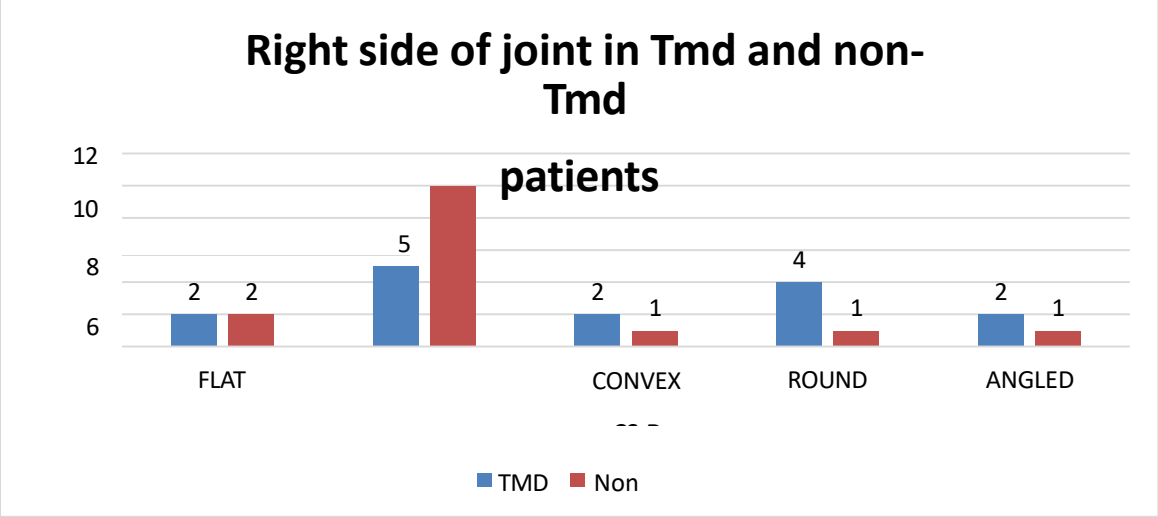


Table 1: Morphological Changes In Right Side Of Joint In Both Tmd And Non –Tmd Group

Morphological Changes-Right Side Of Joint	Frequency	
	Tmd	Non-Tmd
EROSION	4	2
OSTEOPHYTE	2	0

Table 2: Morphological Changes In Left Of Joint In Both Tmd And Non –Tmd Group

Morphological Changes-Left Side Of Joint	Frequency	
	Tmd	Non-Tmd
EROSION	1	1
ELYS CYST	1	0

Table 3 – Comparison Of Articular Eminence Inclination Between Both Groups On Right Side Of Joint (Tmd Vs Non Tmd)

	t	df	P value	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
AE-R	-2.640	28	0.013	-4.63467	1.75576	-8.23117	-1.03816

Table 4- Comparison Of Articular Eminence Inclination Between Both Groups On Left Side Of Joint (Tmd Vs Non Tmd)

	t	df	P value	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
AE-L	-3.943	28	0.001	-6.93800	1.75972	-10.54262	-3.33338

Table shows statistically significant difference in the mean of the AE-R and AE-L between the.
Group 1(TMD) Group 2 (non-TMD)