ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 4, Issue – 3, June - 2021, Page No. : 270 - 279

A CBCT Assessment of Temporomandibular Joint- A retrospective study to analyze the osseous components

[1]Dr Reema Talat Ayesha, Post Graduate, oral medicine and radiology, raja rajeswari dental college and hospital, Ramohalli Cross, Mysore Road, Raja Rajeswari Dental College and Hospital, Bangalore, Karnataka, India

[2]Dr Balaji Pachipulusu, Professor and Head of Department, oral medicine and radiology, raja rajeswari dental college and hospital, Ramohalli Cross, Mysore Road, Raja Rajeswari Dental College and Hospital, Bangalore, Karnataka, India

[3]Dr Poornima Govindaraju, Professor, oral medicine and radiology, raja rajeswari dental college and hospital, Ramohalli Cross, Mysore Road, Raja Rajeswari Dental College and Hospital, Bangalore, Karnataka, India

Corresponding Author: Dr Reema Talat Ayesha, Post Graduate, oral medicine and radiology, raja rajeswari dental college and hospital, Ramohalli Cross, Mysore Road, Raja Rajeswari Dental College and Hospital, Bangalore, Karnataka, India

Citation of this Article: Dr Reema Talat Ayesha, Dr Balaji Pachipulusu, Dr Poornima Govindaraju, "A CBCT Assessment of Temporomandibular Joint- A retrospective study to analyze the osseous components", IJDSIR- June - 2021, Vol. – 4, Issue - 3, P. No. 270 – 279.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Objective: A precise knowledge of parameters pertaining to normal anatomy, morphology, and functioning of TMJ plays an important role in diagnosing temporomandibular disorders. The objective of the study was to assess the age, gender and side-related changes in eminence inclination, eminence height, joint space, anteroposterior and mediolateral width of the condyle, condyle shape and fossa in Indian population. The bone components of the temporomandibular joint (TMJ) were examined using cone beam computed tomography (CBCT) images of asymptomatic individuals.

Methods: The CBCT scan of 40 subjects (20 females and 20 males distributed among age groups (15-25, 26-35, 36-45 and >45) were used in the present study. CBCT imaging was conducted using a SCANORA 3D unit. The maximum output of the CBCT scanner was 90 kvP and 12 mAs, with 75 x 145 field of view.

Results: The joint space (SJ, AJ, PJ) and eminence height were statistically significant among different age groups ($p > 0.005$). The eminence height and eminence inclination were increased on the right side compared to the left side and also differed in genders. Age-associated growth of condyle was evident along with sexual dimorphism. The round shape of the condyle and the oval shape of fossa was found to be most prevalent.

Discussion: Age and gender play an important role in the osseous morphology of TMJ. The current research suggests that a steeper eminence inclination might be of diagnostic value in detecting temporomandibular disorders.

Keywords: Temporomandibular Joint, Temporomandibular Joint Disorders, Cone-Beam Computed Tomography, Temporomandibular Joint Disc

Introduction

The temporomandibular joint (TMJ) is a sophisticated articular system between the temporal bone and the mandible. The condylar process forms the inferior portion of the bone and the superior portion is formed by glenoid fossa. The mandibular condyle slides over the articular eminence during mandibular movements. [1, 2]

A radiographic understanding of the TMJ components and the surrounding structure may help diagnosticians in differentiating between the variations within asymptomatic and symptomatic patients. The possible correlation between clinical parameters such as condyle position and articular eminence inclination to temporomandibular disorders (TMD) has also been investigated in previous studies. [1]

The superimposition of overlying structures is a limitation to accurate visualization of the pathological changes in conventional two-dimensional projections of the TMJ. CT machines due to their high cost and radiation exposure have certain limitations in dentistry. Cone-beam computed tomography (CBCT) a relatively newer imaging technique has been recommended due to its dose sparing advantage and overcoming other drawbacks. CBCT used in the present study allows the use of shorter scanning time while reducing radiation dose [3]. CBCT was also suggested to be a dependable indicator of linear measurements for TMJ reconstruction and imaging. [4]

The aim of the study was to investigate variation in the osseous morphology of bony components and joint space of the TMJ in asymptomatic individuals of different age groups using CBCT. This study focused on a South Indian ethnic population and intended to be the first one to include all the components surrounding the temporomandibular joint.

Materials and Methods

This study was carried out in the Department of Oral Medicine and Radiology in a Dental College. The measurements were performed retrospectively on CBCT images obtained randomly from the archives. The study received approval from the Ethical Committee (RRdchet/01omr/2017).

A small study group consisting of 40 individuals aged between 15-60 years (20 females and 20 males distributed among age groups 15-25, 26-35, 36-45 and >45) who underwent CBCT examination for other reasons not related to TMD was taken. The exclusion criteria were: facial trauma, maxillofacial disorders, or other conditions affecting the TMJ obtained from past records.

After categorizing the subjects in accordance with the selection criteria, all measurements were carried out in a blinded manner.

Imaging procedures

CBCT imaging was performed using a SCANORA® 3D CBCT unit. The maximum output of the scanner was 60-90 kVp and 12.5 mA, with field of view of 75 x 145. For imaging, the subject was positioned in a seated posture with the head held upright, the eyes focused on a point straight ahead, and the teeth in centric occlusion (maximum intercuspation). The time taken for each scan was 15s.

Measurements

Using OnDemand software, the slice thickness for axial view was set at 0.5mm. The slice showing the maximum mediolateral dimension of condyle was selected as the reference slice for measurements. **(Fig. 1)** Subsequently, sagittal slices were created with a thickness of 1mm from medial condyle to orbitale. These reconstructed sagittal image were used for measuring the joint spaces and eminence inclination. (**Fig. 2**) Two methods were used for measurement of eminence inclination. The angle measured between BFm and FH was using best-fit line method **(Fig 3a)** and the angle measured between TRm and FH was using top roof line method **(Fig 3b)**. The perpendicular distance from the minimum point of articular eminence (S) to the maximum point of fossa was determined as eminence height (ht). (5). **(Fig 3c)**

The sagittal images were used to also determine the position of the condyle by measuring the joint spaces ie. Superior Joint Space (SJ), Posterior Joint Space (PJ) and Anterior Joint Space (AJ). Firstly, a line was drawn from G (deepest point of fossa) to Ct (superior most point of the condylar head). The G point was then then connected to A and P. The perpendicular distance from the points A and P drawn tangentially to points on glenoid fossa were defined as AJ and PJ respectively. The measurement from the G point to Ct indicated the SJ (**Fig. 3d**).

A view containing the maximum mediolateral view of the condyle was used for evaluating the axil condylar morphology. The condyle shape was estimated from the central coronal slice, and the fossa shape was determined from the central sagittal slice. Condyle shapes were recorded as round, angled, convex, flattened, or other. The shapes of the fossa were categorized as trapezoidal, triangular, oval, angled or other. (**Fig. 3e**)

All the points and planes used in this study are illustrated in **Fig 4**.

Statistical analysis

All statistical analyses were performed using Statistical Package for Social Sciences (SPSS) for Windows software, version 16.0 (SPSS Inc., Chicago, IL, USA). Student's t test was used to measure the variations in AP (anteroposterior) and MD (mediolateral) width of condyle, AJ, PJ, SJ, AJ/PJ ratio, eminence height and inclination among difference sexes and groups. One-way ANOVA was used to evaluate differences in eminence height and inclination between different groups. Differences in fossa and condyle shapes and their distribution within the groups was evaluated by the Chi-square test. A p value < 0.05 was considered as statistical significant.

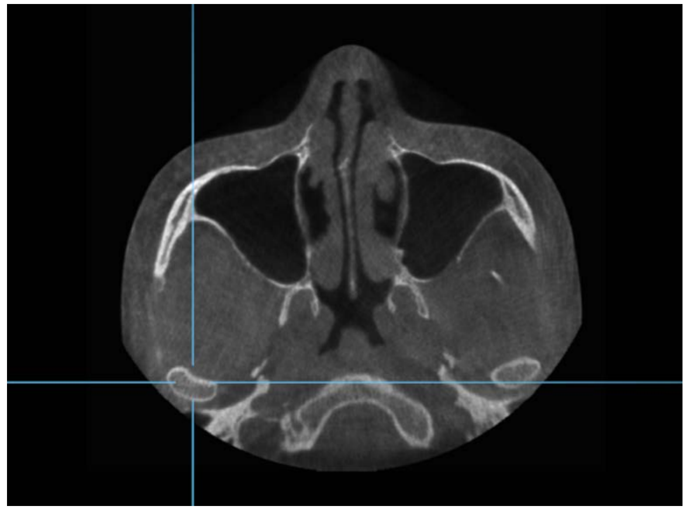

Fig. 1: The longest mediolateral length of the condyle seen on the axial view. The blue line shows the slice selected for reference view for joint space and eminence measurements.

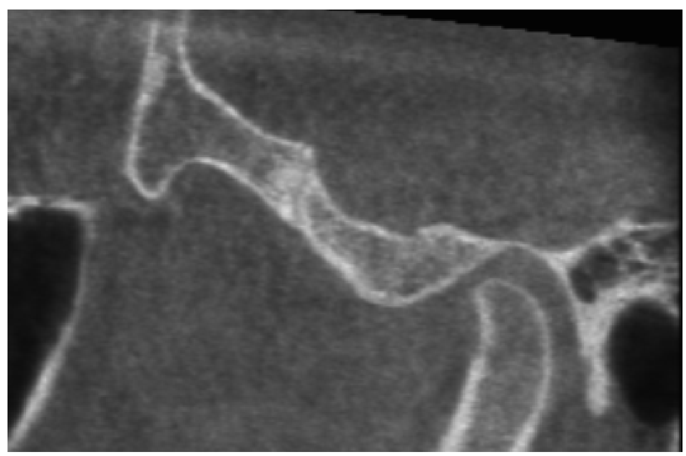

Fig 2: The reconstructed sagittal cross sectional image corresponding to the blue line as shown in Fig .1.

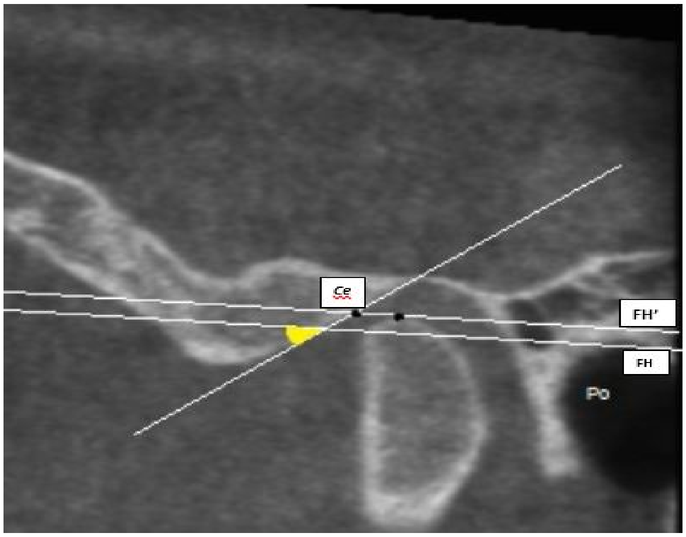

Fig. 3a: Eminence inclination using best-fit line

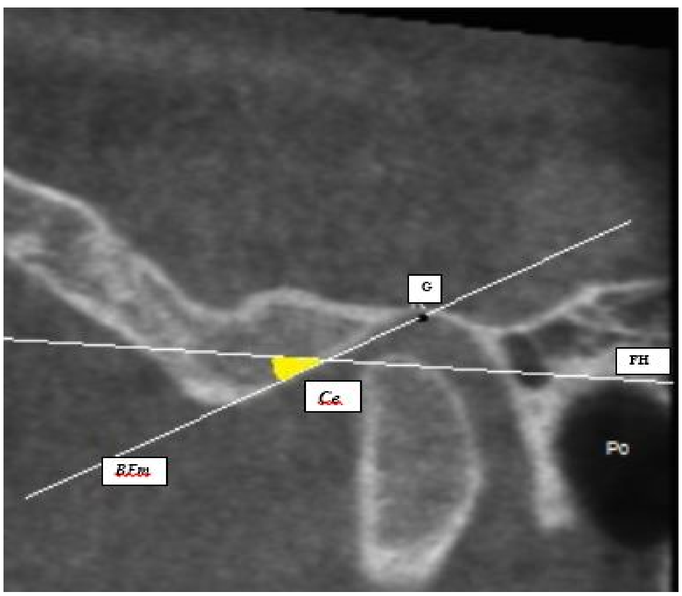

Fig 3b: Eminence inclination using top-roof line method

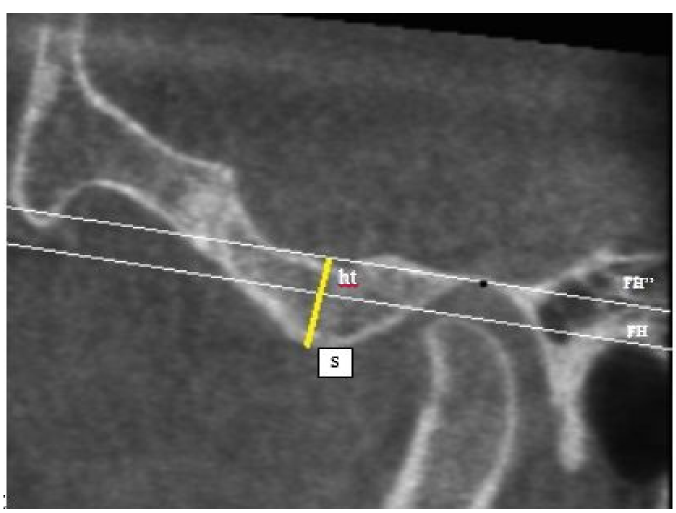

Fig 3c: Measurement of eminence height

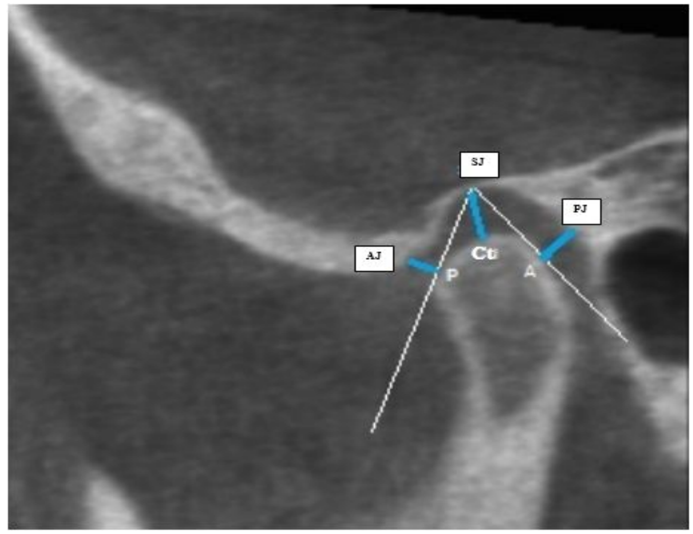

Fig 3d: Joint space measurement

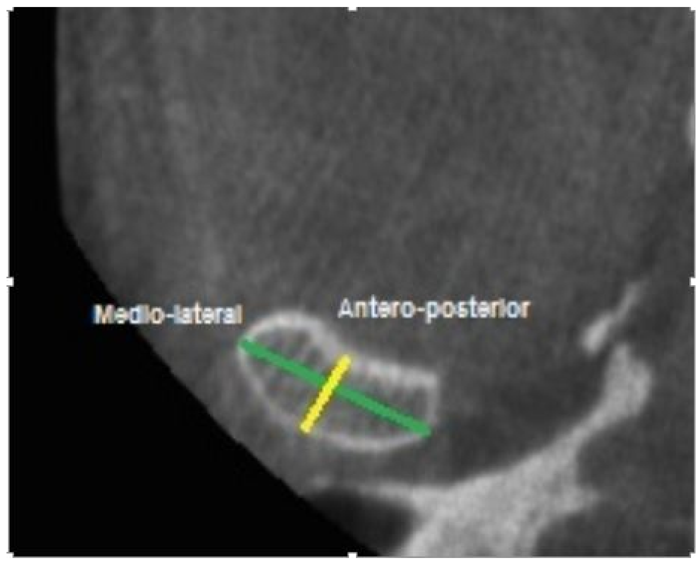

Fig 3e: Condyle shape

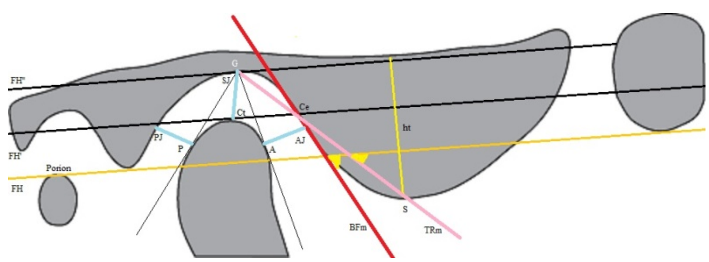

Fig 4: Points and planes used in this study. (Courtesy: Yasa Y, Akgül HM. Oral Radiol. 2018; 34: 31) **FH:** Frankfurt Horizontal Plane; **FH':** Line parallel to FH plane passing through Ct; **FH'':** Line parallel to FH' passing through G; **ht:** Eminence Height; **AJ,PJ** : Tangents drawn from points A and P **Ct:** Superior most point of condyle head; **G:** Deepest point of glenoid fossa;

Ce; Point at which FH' plane intersects articular eminence; **S**: Inferior most point of articular eminence; **BFm** : Plane using Best-fit line method; **TRm :** Plane using Top-roof line method

Results

The interobserver and intraobserver error rate was evaluated which had moderate reliability.

The following variables were measured on right and left side; Eminence inclination (using top roofline and best fit line method), joint space (Superior, posterior and anterior), ratio of AJ/PJ, width of condyle (AP and MD) and eminence height. All the values were increased on right side except for superior joint space and AJ/PJ ratio **(Table 1).**

An age wise comparison of variables amongst the four groups (I, II, II and IV) revealed significant difference for SJ, PJ, AJ, AJ/PJ, and eminence height ($p > 0.005$). **Table 2** summarizes the mean values in different age groups.

Condyle shape when compared amongst different age groups revealed convex/round shapes in younger age groups and became angular /flat as the age increased. **(Table 3**) Amongst fossa shapes, oval was most predominant in Groups I, II and IV while triangular was seen in Group III on both right and left side. The comparison of the shape of condyle revealed a higher prevalence of round shape on both right and left side, followed by convex, flat and angled. The oval shape was the predominant shape of fossa on right and left side followed by triangular, trapezoidal and angular with no statistical significance for both parameters.

A gender wise comparison of variables among males and females revealed, higher eminence inclination in females with both the methods. Whereas the joint space and eminence height was increased in males which was not statistically significant (**Table 4**). In females, the predominant shape of condyle was convex followed by round. In males, it was round followed by flat. In females, oval was common fossa shape, followed by triangular. In males, triangular was followed by oval. No statistical Significance was seen for both.

Discussion

The functional portion of TMJ is constituted by its bony components. The use of specialized technique allows imaging of complex anatomical structures such as TMJ with increased accuracy. The articular eminence is a part of the temporal bone on which the condylar process slides during mandibular movements. The varying posterior inclinations of articular eminence dictates the path of condylar movement. The morphological shape of the slope maybe affected by the functional load arising from chewing forces, and the articular eminence may become susceptible to displacement of the disc relative to development of TMJ disorder [1].

The articular eminence inclination completes 90-94% of its growth by the age of 20 years [6]. Studies have shown that with advancing age, there is flattening of eminence in long term [6, 7]. Our results are consistent with these studies, showing significant difference related to measurements of articular eminence and eminence height in different age groups.

The highest inclination in the present study using best fit line method is 67.48 ±10.51 and using top roof line is 46.04±7.96 seen in Group II. The values are not in agreement with the study conducted by Chaurasia et al. who found steeper values in age group of 31-40 years using best fit line and in age group of 21-30 years using top roof line [8]. The decrease in the eminence inclination seen in the current study maybe due to the flattening of eminence with advanced aging [7].

An increase in the eminence inclination although not statistically significant is noted in females as compared to males using both top roof line and best fit line method which is not in accordance to the values found by Ilguy et al. [9]. These differences may be attributed to the intensity of masticatory forces loaded over the TMJ and a possible influence of sex hormones [10].

The eminence height was found to be maximum in Group III which is significant statistically. The values are significantly lower compared to other studies but the variation in age are similarly seen in a study conducted by Ilguy et al. They have also reported a lower eminence height in females as compared to males, which is not consistent with our results. This difference may have risen due to the size of sample taken [9]. The values are higher on the right side compared to the left side though the differences were not significant.

The values for anterior joint space (AJS) observed in the present study showed no significant difference on two sides ($p < 0.05$) with wider values on left side. Kaur et al. found a significant difference in AJS in their study which is increased on right side compared to the left side [11].

In the current study the values for SJS and PJS showed statistical significance when compared among different age groups. Both SJS and PJS were greatest in Group III with average values of 4.45±0.65 and 2.79±0.65 respectively. Manjula et al. found average values of 2.4±0.58 mm in SJS and 2.1±0.65mm in PJS which are lower compared to our values [12]. Kaur et al. found higher values of SJS and PJS in age group of 31-40 years which is closely similar to the current study [11]. The observations for SJS and PJS showing non-significant difference on two sides is in agreement with earlier reports [13, 14, 15]. SJS, AJS and PJS were increased in males compared to females in the current study, although not statistically significant which is similar to other studies [11].

The mean values for anteroposterior (AP) diameter of condyle in the present study are 6.18± 1.27 and 6.06 ± 1.13 on right and left side respectively. Similar values were found by other investigators [14, 16, 17]. No significant difference was found in terms of side which has been similarly reported previously [13, 15, 16].

In the present study, the mean value for mediolateral diameter (ML) is 17.66 ± 2.22 on right side and 17.90±2.51 on left side. These values are lower as compared to those put by other investigators [13, 15]. This may be due to the difference in sample size taken. According to Neto et al., the ML dimension showed a positive correlation with age which is noted to be similar in the present study [18].

The mean values for AP diameters of the mandibular condyle are significantly higher in females, whereas the ML diameters are higher in males indicating sexual dimorphism. The observation is substantiated partially by the reports put forth by other investigators [19, 20]. Fabian and Mpembian [21] observed higher though statistically non-significant values for AP and ML diameter in males. A number of investigators have associated the higher values for condylar diameter in males with their larger cranial size and intensive dental loading.

In the present study, carried out on CBCT scans, the mandibular condyle is observed to be round in the majority of subjects and the second higher incidence is that of the convex form. This observation is in accordance with the reports put forth by earlier investigations [3, 5]. The flat shape of the condyle was observed in subjects of Group IV which may arise due to degenerative changes in bone or remodeling. The discrepancy in the reports especially pertaining to the incidence of round shape could arise because of inclusion of subjects belonging to different ethnic and age groups in various study groups [22, 23].

The fossa shape observed in the present study was almost similar on two sides, i.e. Oval was predominant in all age groups and in females. This finding is in agreement with studies done by Yasa Y et al. and Elgüy D et al. Oval is most prevalent followed by triangular shape on both the sides and also the most prevalent shape among the males [5, 9].

The observations of the study strongly suggest the probability of variations in the morphometry and morphology of various components of TMJ in different age groups and genders. It stresses on importance of gathering extensive data through studies using CBCT to study TMJ parameters, which will subsequently enable us in framing appropriate management protocols.

Using the data collected from this study, we aim to compare the same parameters with a symptomatic study group, and look for potential predictors of temporomandibular disorders.

Conclusion and Future Directions

Temporomandibular disorders (TMD) are currently the most prevalent cause of non-dental pain in the orofacial complex. Awareness regarding the anatomical features of TMJ plays an important role in treatment planning. Age and gender influence the eminence height and inclination significantly. This anatomical data might assist in understanding the anatomy of articular eminence in asymptomatic patients of South Indian ethnicity. Additional studies can be done using a larger sample size which will allow us to use the obtained values as reference data for control population. This data can be consequently used to compare in a study population that has undergone occlusal correction or splint therapy. Any shift in these values can be used as a predictor of suspected temporomandibular disorders. Further evidence of morphological variations in the condylar head as age increases opens up possibilities of forensic implications.

Source of funding: None declared

References

1. Wang X, Zhang J, Gan Y, Zhou Y. Current understanding of pathogenesis and treatment of TMJ osteoarthritis. J Dent Res. 2015; May 94(5):666–673.
2. Okeson JP. Management of temporomandibular disorders and occlusion. 7th Ed., St Louis: Elsevier Health Sciences 2014, p. 222-253.
3. Çağlayan F, Sümbüllü MA, Akgül HM. Associations between the articular eminence inclination and condylar bone changes, condylar movements, and condyle and fossa shapes. Oral Radiol. 2014 Jul; 30(1):84–91.
4. Librizzi ZT, Tadinada AS, Valiyaparambil JV, Lurie AG, Mallya SM. Cone-beam computed tomography to detect erosions of the temporomandibular joint: Effect of field of view and voxel size on diagnostic efficacy and effective dose. Am J Orthod Dentofacial Orthop. 2011; Jul; 140(1):e25–30.
5. Yasa Y, Akgül HM. Comparative cone-beam computed tomography evaluation of the osseous morphology of the temporomandibular joint in temporomandibular dysfunction patients and asymptomatic individuals. Oral Radiol. 2018 May; 34(1):31-39
6. Katsavrias EG, Dibbets JM. The growth of articular eminence height during craniofacial growth period. Cranio 2001 Jan;19(1):13-20
7. Jasinevicius T, Pyle M, Nelson S, Lalumandier J, Kohrs K, Sawyer D. Relationship of degenerative changes of the temporomandibular joint (TMJ) with the angle of eminentia. J Oral Rehabil. 2006 Sep; 33(9):638-45.
8. Chaurasia A, Katheriya G, Patil R. Morphometric analysis of articular eminence of temporomandibular joint in Indian Ethinicity- A cone beam computed tomography study. Oral Sur Oral Med Oral Pathol Oral Radiol. 2016; May 2(4):196-202.

9. Elgüy D, Elgüy M. Articular Eminence Inclination, Height, and Condyle Morphology on Cone Beam Computed Tomography. Sci World J. 2014; Feb 13;2014:761714
10. Laskin DM, Greene CS, Hylander WL. Temporomandibular disorders: an evidence-based approach to diagnosis and treatment. Hanover Park: Quintessence Publishing Company; 2006. p.157-212.
11. Kaur B, Sehgal R, Logani A, Dhar P. Morphometric evaluation of temporomandibular joint using cone beam computed tomography (CBCT) Am J Oral Med Radiol. 2015; Nov 2(4):169-176.
12. Manjula WS, Tajir F, Murali RV, Kumar SK, Nizam M. Assessment of optimal condylar position with cone-beam computed tomography in south Indian female population. J Pharm Bioall Sci 2015; Apr; 7(Suppl 1):S121-4.
13. Rodrigues AF, Fraga MR and Vitral RWF. Computed tomography evaluation of the temporomandibular joint in Class I malocclusion patients: condylar symmetry and condyle-fossa relationship. Am J Orthod Dentofacial Orthop. 2009; Aug;136(2):192-8
14. Prabhat KC, Kumar Verma S, Maheshwari S, Ahmad I, Tariq M. Computed Tomography Evaluation of Craniomandibular Articulation in Class II Division 1 Malocclusion and Class I Normal Occlusion Subjects in North Indian Population. ISRN Dent. 2012; 2012:312031.
15. Vitral RWF, Campos MJS, Rodrigues AF and Fraga MR. Temporomandibular joint and normal occlusion: Is there anything singular about it? A computed tomographic evaluation. Am J Orthod Dentofac Orthop. 2011 Jul; 140(1):18-24.
16. Krisjane Z, Urtane I, Krumina G, Bieza A, Zepa K and Rogovska I. Condylar and mandibular morphological criteria in the 2D and 3D MSCT imaging for patients with Class II division 1 subdivision malocclusion. Stomatologija. 2007; Sept; 9(3):67-71.
17. Yanez-Vico RM, Iglesias-Linares A, Torres-Lagares D, Gutierrez-Perez JL and Solano-Reina E. Association between condylar asymmetry and temporomandibular disorders using 3D-CT. Med Oral Patol Oral Ci Bucal, 2012 Sep; 1;17(5):e852-8.
18. Neto JV, Estrela C, Bueno MR and Guedes OA. Mandibular condyle dimensional changes in subjects from 3 to 20 years of age using Cone-Beam Computed Tomography: a preliminary study. Dental Press J. Orthod. 2010 Sept-Oct;15(5):172-81
19. Pokhrel R and Bhatnagar R. Sexing of mandible using ramus and condyle in Indian population: a discriminant function analysis. Eur J Anat. 2013; 17(1), 39-42.
20. Saini V. Metric study of fragmentary mandibles in a North Indian population. Bull Int Assoc Paleodont. 2013; Jul; 7(2), 157-162.
21. Fabian FM, Mpembeni R. Sexual dimorphism in the mandibles of a Homogenius Black population of Tanzania. Tanz J Sci, 2002; Oct; 28(2), 48-54.
22. Al-koshab M, Nambiar P, John J. Assessment of Condyle and Glenoid Fossa Morphology Using CBCT in South-East Asians. PLoS ONE. 2015; Mar; 24; 10(3):e0121682.
23. Brand, J.W., Whinery, J.G. Jr., Anderson, Q.N., Keenan, K.M. Condylar position as a predictor of temporomandibular joint internal derangement. Oral Surg Oral Med Oral Pathol. 1989; Apr; 67(4):469-76.

Legend Tables

Table 1 : Comparison of Variables on Right And Left Side

	Right Side	Left Side	p value
	Mean±SD	Mean±SD	
Top Roof Line	44.73±9.31	44.06±9.48	0.634
Best Fit Line	61.96±12.95	60.69±12.06	0.558
SJ	3.75±0.88	4.73±7.65	0.405
AJ	2.07±0.59	2.15±0.64	0.362
PJ	2.22±0.75	2.17±0.69	0.557
AJ/PJ	1.03±0.49	1.10±0.58	0.342
ML Width of condyle	17.66±2.22	17.90±2.51	0.458
AP width of condyle	6.18±1.27	6.06±1.13	0.492
Eminence Height	3.77±0.86	3.65±0.95	0.274

Table 2 : age wise comparison of variables

Variables	15-25 Years	26-35 Years	36-45 Years	>45 Years	p value
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Top Roof Line	42.9±12.6	46.04±7.96	45.85±8.26	44.85±8.61	0.793
Best Fit Line	55.65±15.21	67.48±10.51	62.76±12.13	61.95±12.57	0.242
SJ	3.25±0.80	3.40±0.73	4.45±0.65	3.89±0.85	0.005
AJ	1.94±0.53	1.58±0.49	2.02±0.46	2.43±0.75	0.129
PJ	2.30±0.65	1.95±0.56	2.79±0.65	1.82±0.80	0.013
AJ/PJ	0.92±0.36	1.00±0.38	0.76±0.26	1.42±0.67	0.015
ML Width of condyle	16.30±2.66	17.56±1.76	18.33±1.81	18.44±2.13	0.109
AP width of condyle	5.70±1.19	6.53±1.01	6.48±1.18	5.98±1.62	0.371
Eminence Height	3.31±0.77	3.40±0.73	4.23±1.05	3.83±0.95	0.007

Table 3 : Age-Wise Distribution of Condyle Shape

	Right Side					Left Side				
	I	II	III	IV	p value	I	II	III	IV	p value
Angled	1	0	3	1	0.941	0	0	1	2	0.862
Convex	3	5	2	2		3	4	4	1	
Flat	3	2	2	4		2	2	0	4	
Round	3	3	3	3		5	4	5	3	

Table 4 : Comparison Of Variables In Males And Females			
	Males	Females	P Value
	Mean±SD	Mean±SD	
Top Roof Line	42.60±8.83	46.86±9.52	0.150
Best Fit Line	58.87±13.83	63.90±9.24	0.132
SJ	3.83±0.79	3.68±0.97	0.586
AJ	2.17±0.69	1.97±0.47	0.295
PJ	2.40±0.74	2.05±0.73	0.136
ML Width of condyle	18.25±2.36	17.08±1.95	0.096
AP width of condyle	5.96±1.27	6.17±0.99	0.563
Eminence Height	3.86±0.76	3.68±0.96	0.510

Figure Number	Figure Description
Fig. 1:	The longest mediolateral length of the condyle seen on the axial view. The blue line shows the slice selected for reference view for joint space and eminence measurements.
Fig 2:	The reconstructed sagittal cross sectional image corresponding to the blue line as shown in Fig .1.
Fig 3:	The measurements performed on OnDemand software a and b. Eminence inclination using best-fit line and top-roof line method c. Measurement of eminence height d. Condyle shape e. Joint space measurement
Fig 4:	Points and planes used in this study. (Courtesy: Yasa Y, Akgül HM. Oral Radiol. 2018; 34: 31)
	FH: Frankfurt Horizontal Plane; **FH':** Line parallel to FH plane passing through Ct; **FH'':** Line parallel to FH' passing through G; **ht:** Eminence Height; **AJ,PJ** : Tangents drawn from points A and P **Ct:** Superior most point of condyle head; **G:** Deepest point of glenoid fossa; **Ce;** Point at which FH' plane intersects articular eminence; **S**: Inferior most point of articular eminence; **BFm** : Plane using Best-fit line method; **TRm :** Plane using Top-roof line method