

Morphometric Assessment of Temporomandibular Joint Using Cone Beam Computed Tomography

Vaishnavi P¹, Sreekanth P. Kunjumon^{2*}, Laipubam Fabina Sharma³, Pavan Kumar Reddy⁴
Sujatha S⁵, N. Rakesh⁶, Shwetha V⁷

¹Private Practitioner, Coimbatore, Tamil Nadu, India.

²Consultant, Department of Oral Medicine and Radiology, Aster Whitefield Hospital, Bengaluru, Karnataka, India.

³Private Practitioner, Manipur, India.

⁴Assistant Professor, Department of Oral Medicine and Radiology, Faculty of Dental Sciences, Ramaiah University of Applied Sciences, Bengaluru, Karnataka, India.

⁵Senior Professor and HOD, Department of Oral Medicine and Radiology, Faculty of Dental Sciences, Ramaiah University of Applied Sciences, Bengaluru, Karnataka, India.

⁶Professor and HOD, Department of Oral Medicine and Radiology, Faculty of Dental Sciences, Ramaiah University of Applied Sciences, Bengaluru, Karnataka, India.

⁷Assistant Professor, Department of Oral Medicine and Radiology, Faculty of Dental Sciences, Ramaiah University of Applied Sciences, Bengaluru, Karnataka, India.

*Corresponding Author: Dr. Sreekanth P. Kunjumon, Consultant, Department of Oral Medicine and Radiology, Aster Whitefield Hospital, Bengaluru, Karnataka, India.

<https://doi.org/10.58624/SVOADE.2026.07.040>

Received: July 16, 2026

Published: October 07, 2026

Citation: Vaishnavi P, Kunjumon SP, Sharma LF, Sujatha S, Rakesh N, Reddy PK. Morphometric Assessment of Temporomandibular Joint Using Cone Beam Computed Tomography. *SVOA Dentistry* 2026, 7:5, 314-326. doi: 10.58624/SVOADE.2026.07.040

Abstract

Background: The temporomandibular joint (TMJ) is one of the most fascinating and complex synovial systems in the human body. The mandibular condyle, which articulates with the craniofacial complex, is an important part of the TMJ. As a result, the evaluation and assessment of condylar morphology is critical.

Aim: The aim of this study was to use cone beam computed tomography (CBCT) imaging modality to evaluate the morphology of the mandibular condyle from the radiographic archives.

Material and Methods: It is an retrospective observation study. A retrospective analysis was performed on CBCT images of 100 patients from the radiographic archives. The morphometric changes of the condyle, articular eminence thickness, glenoid fossa thickness were evaluated on both the left and right sides in both males and females.

Results: The morphometric changes of the condyle were seen more in the elderly population with a slightly higher predilection for females. However, the overall amongst the parameters were similar to the previous studies.

Conclusion: CBCT can be a useful diagnostic tool in assessing various dimensions, joint spaces, and condylar volume in different planes, and thus can be a useful predictor in assessing treatment outcomes of TMJ disorders.

Keywords: Temporomandibular joint, Mandibular condyle, Cone beam computed tomography, Condylar morphology

Introduction

The temporomandibular joint (TMJ) is one of the most fascinating and complex synovial systems in the human body. It's the part of the mandible that attaches to the cranium. Mastication, speech, and deglutition are all performed by the masticatory system, which is made up primarily of bones, muscles, ligaments, and teeth. All of these movements are governed by a complex neurological control system, which is critical for the system's normal and efficient operation.

Lack of such harmony may lead to disruptive muscle behavior or structural damage to any of the components. Temporomandibular disorders (TMD) are a broad category of disorders that affect the temporomandibular joints, masticatory muscles, or both. It is the most common jaw disorder, with 28 percent to 86 percent of adults and adolescents displaying one or more clinical signs or symptoms. The etiology of the TMD is unknown. Occlusal disharmony and psychological distress are the two hypotheses which have dominated the literature. The psychological hypothesis proposes that the disorder evolves as a consequence of psychological distress that is usually due to the individual's stressful environment. As a result of the psychological distress, parafunctional habits (tooth clenching and grinding) develop, resulting in muscle pain. TMJ dysfunction manifests itself in a variety of ways. To supplement the information gathered during the clinical examination, TMJ imaging may be required. When an osseous abnormality or infection is suspected, when conservative treatment has failed, or when symptoms are getting worse, it's especially useful. The main aim for TMJ imaging includes evaluation of the integrity of the structures when disease is suspected, determination of the extent of disease and its progression, and finally evaluation of the effects of treatment. Even though, a large number of imaging modalities are available for imaging of TMJ, each one has its own advantages and disadvantages starting from the conventional 2D imaging to advanced 3D imaging. Due to the disadvantages of thick image layers and superimpositions of anatomical structures providing a distorted view of the joint, the screening projection used for TMJ only shows an overall view of the teeth and jaws without any detail, severely limiting the image quality.

As a result, advanced radiographic imaging for TMJ is required. Recent imaging technology for TMJ is Cone beam computed tomography (CBCT). In comparison to traditional imaging systems, which are limited by distortion, magnification changes, restricted clarity, lack of accuracy in measurements, and 3D reconstruction; CBCT at a lower cost and with less radiation to the patient, provides high definition three-dimensional digital data on precise anatomical information of all oral and maxillofacial structures. Imaging the TMJ can be difficult because the bony components are small and superimpositions from the base of the skull often result in a lack of clear delineation of the joint. Because of these disadvantages, CBCT is becoming more popular for TMJ imaging. The diagnostic potential of CBCT has been thoroughly investigated in comparison to traditional radiographic examinations. Because of CBCT's accuracy and lack of superimposition, it's possible to measure the roof of the glenoid fossa and see where the soft tissue around the TMJ is located, allowing for a more accurate diagnosis and reducing the need for MRI. In this study, we evaluated the various radiographic changes in TMJ using CBCT.

Materials and Methods

A Retrospective study was conducted in our department using the data from the CBCT archives. CBCT images were obtained with carestream 9300 premium machine. All images were taken following a standardized protocol for patient positioning and exposure parameter setting (120kVp, 3–7mA, 20 sec) and image acquisition at 0.3mm voxel size. A random sampling was done, out of the 200 tmj joints assessed, 100 CBCT scans of patients who had got their scans done (CBCT full skull scan) for evaluation of any pathology were selected randomly. The inclusion criteria were scans with a clear resolution and adequate coverage displaying bilateral TMJs and large FOV CBCT scans. Full skull CBCT scans (200 × 170 mm) of 100 patients in the age group of 15 to 80 years were obtained from the archives and assessed. For each patient, both the right and left side images were taken, therefore the total number of TMJ joints studied was 200. The study was designed to analyse morphometric changes of the condyle which included the condylar shape and size, various condylar abnormalities like condylar flattening, condylar fracture, osteosclerosis, condylar hypoplasia, osteophytes, thickness of the glenoid fossa roof, shape of the articular eminence and joint space. The whole joints were evaluated using 2mm axial, coronal and sagittal slices selected in which the condyle, glenoid fossa and articular eminence were clearly noticed. The para-sagittal and para-coronal sections perpendicular to antero-posterior and transverse long axis of condylar head, glenoid fossa and articular eminence were assessed bilaterally. The condylar surface was assessed for any bony changes. The glenoid fossa and the articular eminence were assessed in the sagittal section while the joint spaces were measured from the thinnest bone forming the roof of the glenoid fossa to the condylar head.

TMJ assessment (Alexiou et al)

Osseous changes of the condyles:

- Flattening: defined as a flat bony contour deviating from the convex form
- Erosion: Loss of continuity of the articular surface of the condyle

- Osteophytes: defined as marginal bony outgrowths on the condyle;
- Sclerosis: defined as an increased density of cortical bone extending into the bone marrow; and
- Condylar head resorption is defined as a partial loss of the condylar head.
- Osseous changes of the glenoid fossae and articular eminence
(1) Erosion, (2) Sclerosis and (3) Resorption.

Criteria for determining joint space

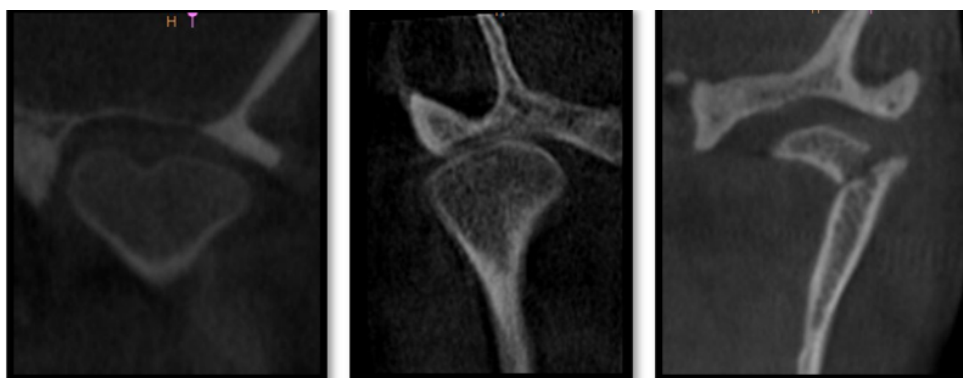
- Increased: when the distance between the condylar head and the mandibular fossa was greater than 4 mm;
- Normal: when the distance between the condylar head and the mandibular fossa was between 1.5 mm and 4 mm;
- Reduced: when the distance between the condylar head and the mandibular fossa was less than 1.5 mm; and
- Bony contact between the condyle and the mandibular fossa

Statistical analysis

The statistical analysis was performed using SPSS (Statistical Package for Social Sciences) version 20 (IBM SPSS statistics [IBM corp. released 2011]). Descriptive statistics of the explanatory and outcome variables were calculated by mean, standard deviation for quantitative variables, frequency and proportions for qualitative variables. Inferential statistics like Chi-square test was applied to check the association between age, gender and TMJ findings. The level of significance is set at 5%.

Results

A total of 100 patients including 49 females and 51 males were evaluated in the study. All the parameters were assessed bilaterally. Evaluation of each of the parameters with age groups ie (< 25 yrs., 25 to 35 yrs., 36 to 45 yrs., 46 to 55 yrs., above 55 yrs.) was done using chi square test. On assessing the association between the selected parameters and age, it was seen that bilateral condylar flattening was seen more in the age group of 46-55 years (3%) as compared to the other age groups, left condylar flattening present in 19 % of the population was seen relatively more in younger age groups (<25 years). 4 % of the patients presented with bilateral parrot beak appearance of the condyle (age group of 46-55 years and > 55 years). A similar trend was seen with articular eminence flattening. Erosion of the glenoid fossa was seen relatively equally among all age groups (3% each) and on the right, left sides and bilaterally. Left (2%) and bilateral condylar fracture (1%) was a rare finding seen in the age groups of < 25 years and 46-55 years. Osteosclerosis, osteophytes and bony contacts was more in the elderly age groups of 46- 55 years. Condylar hypoplasia and bifid condyle were some of the rare findings seen (1%)



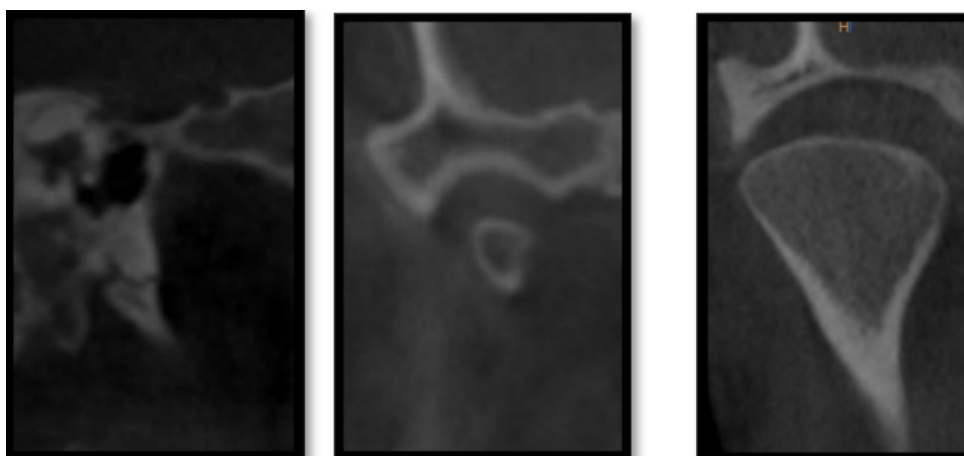


Figure 1. Morphological changes of TMJ a) Bifid Condyle, b) Flattening of condyle, c) Left condylar fracture, d) Condylar Hypoplasia e) Normal condyle

Table 1. Cross- tabulation of age and TMJ findings.

			GENDER					Total	Chi-square value	p value
			< 25 yrs	25 to 35 yrs	36 to 45 yrs	46 to 55 yrs	Above 55 yrs			
Condylar flattening	Both	N	N	0	0	0	3	1	17.27	0.14
		%	%	0.0%	0.0%	0.0%	3.0%	1.0%4.0%		
	Left	N	N	6	4	2	2	519		
		%	%	6.0%	4.0%	2.0%	2.0%	5.0%19.0%		
	Nil	N	N	15	18	12	10	1974		
		%	%	15.0%	18.0%	12.0%	10.0%	19.0%74.0%		
	Right	N	N	0	1	0	0	23		
		%	%	0.0%	1.0%	0.0%	0.0%	2.0%3.0%		
Parrot Beak appearance	Both	N	0	1	0	2	2	5	12.5	0.4
		%	0.0%	1.0%	0.0%	2.0%	2.0%	5.0%		
	Left	N	1	1	0	2	0	4		
		%	1.0%	1.0%	0.0%	2.0%	0.0%	4.0%		
	Nil	N	20	21	14	11	24	90		
		%	20.0%	21.0%	14.0%	11.0%	24.0%	90.0%		
	Right	N	0	0	0	0	1	1		
		%	0.0%	0.0%	0.0%	0.0%	1.0%	1.0%		

Table 1. Continued...

Articular eminence flattening	Both	N	0	0	0	1	2	3	7.11	0.52
		%	0.0%	0.0%	0.0%	1.0%	2.0%	3.0%		
	Left	N	0	0	0	0	1	1		
		%	0.0%	0.0%	0.0%	0.0%	1.0%	1.0%		
	Nil	N	21	23	14	14	24	96		
		%	21.0%	23.0%	14.0%	14.0%	24.0%	96.0%		
Erosion of glenoid fossa	Both	N	0	0	0	1	2	3	10.06	0.61
		%	0.0%	0.0%	0.0%	1.0%	2.0%	3.0%		
	Left	N	0	1	0	0	2	3		
		%	0.0%	1.0%	0.0%	0.0%	2.0%	3.0%		
	Nil	N	21	21	14	13	22	91		
		%	21.0%	21.0%	14.0%	13.0%	22.0%	91.0%		
	Right	N	0	1	0	1	1	3		
		%	0.0%	1.0%	0.0%	1.0%	1.0%	3.0%		
condylar fracture	Both	N	0	0	1	0	0	1	9.95	0.26
		%	0.0%	0.0%	1.0%	0.0%	0.0%	1.0%		
	Left	N	1	0	0	1	0	2		
		%	1.0%	0.0%	0.0%	1.0%	0.0%	2.0%		
	Nil	N	20	23	13	14	27	97		
		%	20.0%	23.0%	13.0%	14.0%	27.0%	97.0%		
Edentulous	Both	N	0	0	0	0	1	1	2.73	0.6
		%	0.0%	0.0%	0.0%	0.0%	1.0%	1.0%		
	Nil	N	21	23	14	15	26	99		
		%	21.0%	23.0%	14.0%	15.0%	26.0%	99.0%		

Table 1. Continued...

Osteosclerosis	Both	N	0	0	1	1	0	2	6.99	0.53
		%	0.0%	0.0%	1.0%	1.0%	0.0%	2.0%		
	Left	N	21	22	13	14	26	96		
		%	21.0%	22.0%	13.0%	14.0%	26.0%	96.0%		
	Nil	N	0	1	0	0	1	2		
		%	0.0%	1.0%	0.0%	0.0%	1.0%	2.0%		
Bifid Condyle	Bifid Condyle	N	1	0	0	0	0	1	3.8	0.43
		%	1.0%	0.0%	0.0%	0.0%	0.0%	1.0%		
	Nil	N	20	23	14	15	27	99		
		%	20.0%	23.0%	14.0%	15.0%	27.0%	99.0%		
Condylar Hypoplasia	Bifid Condyle	N	21	22	14	15	27	99	3.38	0.49
		%	21.0%	22.0%	14.0%	15.0%	27.0%	99.0%		
	Nil	N	0	1	0	0	0	1		
		%	0.0%	1.0%	0.0%	0.0%	0.0%	1.0%		
Bony contact	Both	N	0	1	0	0	1	2	4.83	0.77
		%	0.0%	1.0%	0.0%	0.0%	1.0%	2.0%		
	Left	N	21	22	14	15	25	97		
		%	21.0%	22.0%	14.0%	15.0%	25.0%	97.0%		
	Nil	N	0	0	0	0	1	1		
		%	0.0%	0.0%	0.0%	0.0%	1.0%	1.0%		
Osteophytes	Both	N	0	0	0	1	0	1	15.89	0.19
		%	0.0%	0.0%	0.0%	1.0%	0.0%	1.0%		
	Left	N	0	2	0	0	0	2		
		%	0.0%	2.0%	0.0%	0.0%	0.0%	2.0%		
	Nil	N	21	21	13	14	26	95		
		%	21.0%	21.0%	13.0%	14.0%	26.0%	95.0%		
	Right	N	0	0	1	0	1	2		
		%	0.0%	0.0%	1.0%	0.0%	1.0%	2.0%		

On analysing the association between gender and TMJ changes, females had a higher rate of bilateral condylar flattening (3%) compared to males in which left condylar flattening was more prevalent. Parrot beak appearance of the condyle was prevalent equally in both males and females. A similar pattern was seen in glenoid fossa erosion. Bilateral articular eminence flattening was seen in males (3%) with only 1% in females on the left side. Condylar fracture was a rare finding which was seen in both the sexes (1%). Osteosclerosis of the right condyle was more common in males compared to osteophytes which was equally seen in both the sexes. Males had a higher rate of bony contact in the joint space (2%) while condylar hypoplasia and bifid condyle were rare findings seen 1% each amongst females and males respectively.

Table 2. Cross-tabulation of gender and TMJ findings.

			GENDER		Total	Chi-square value	p value
			Females	Males			
Condylar flattening	Both	N	3	1	4	4.01	0.26
		%	3.0%	1.0%	4.0%		
	Left	N	9	10	19		
		%	9.0%	10.0%	19.0%		
	Nil	N	37	37	74		
		%	37.0%	37.0%	74.0%		
	Right	N	0	3	3		
		%	0.0%	3.0%	3.0%		
Parrot Beak appearance	Both	N	2	3	5	1.16	0.76
		%	2.0%	3.0%	5.0%		
	Left	N	2	2	4		
		%	2.0%	2.0%	4.0%		
	Nil	N	45	45	90		
		%	45.0%	45.0%	90.0%		
	Right	N	0	1	1		
		%	0.0%	1.0%	1.0%		
Articular eminence flattening	Both	N	0	3	3	3.96	0.13
		%	0.0%	3.0%	3.0%		
	Left	N	1	0	1		
		%	1.0%	0.0%	1.0%		
	Nil	N	48	48	96		
		%	48.0%	48.0%	96.0%		
Erosion of glenoid fossa	Both	N	1	2	3	1.05	0.78
		%	1.0%	2.0%	3.0%		
	Left	N	2	1	3		
		%	2.0%	1.0%	3.0%		
	Nil	N	44	47	91		
		%	44.0%	47.0%	91.0%		
	Right	N	2	1	3		
		%	2.0%	1.0%	3.0%		

Table 2. Continued...

Condylar fracture	Both	N	0	3	3	1.05	0.59
		%	0.0%	3.0%	3.0%		
	Left	N	1	0	1		
		%	1.0%	0.0%	1.0%		
	Nil	N	48	48	96		
		%	48.0%	48.0%	96.0%		
Edentulous	Both	N	1	0	1	1.05	0.3
		%	1.0%	0.0%	1.0%		
	Nil	N	48	51	99		
		%	48.0%	51.0%	99.0%		
Osteosclerosis	Left	N	1	1	2	1.96	1.37
		%	1.0%	1.0%	2.0%		
	Nil	N	48	48	96		
		%	48.0%	48.0%	96.0%		
	Right	N	0	2	2		
		%	0.0%	2.0%	2.0%		
Bifid Condyle	Bifid condyle	N	0	1	1	0.97	0.32
		%	0.0%	1.0%	1.0%		
	Nil	N	49	50	99		
		%	49.0%	50.0%	99.0%		
Condylar Hypoplasia	Nil	N	48	51	99	1.05	0.3
		%	48.0%	51.0%	99.0%		
	Right	N	1	0	1		
		%	1.0%	0.0%	1.0%		
Bony contact	Left	N	0	2	2	2.97	0.22
		%	0.0%	2.0%	2.0%		
	Nil	N	48	49	97		
		%	48.0%	49.0%	97.0%		
	Right	N	1	0	1		
		%	1.0%	0.0%	1.0%		
Osteophytes	Both	N	0	1	1	0.97	0.8
		%	0.0%	1.0%	1.0%		
	Left	N	1	1	2		
		%	1.0%	1.0%	2.0%		
	Nil	N	47	48	95		
		%	47.0%	48.0%	95.0%		
	Right	N	1	1	2		
		%	1.0%	1.0%	2.0%		

The mean joint space varied between 1 mm to 7 mm (mean-3.29mm) and 1mm to 8 mm (3.31mm) on the right and left sides respectively in age groups between 14 to 85 years with a mean age of 42 years. The joint space was more or less the same in all the age groups from <25 years to >55 years with a mean value of 2.91 to 3.75 mm. On analysing the gender differences in joint space, it was seen that females had a slightly reduced joint space in both right and left sides (mean of 3.20 and 3.12 respectively) as compared to males (mean of 3.38 and 3.51 respectively).

Table 3. Mean Age, Joint Space in Right and Left Region.

	N	Minimum	Maximum	Mean	S.D
Age	100	14	85	42.00	17.512
Joint space - R	97	1	7	3.29	1.398
Joint space - L	92	1	8	3.31	1.599

Table 4. Mean joint space based on age.

Age-classified	Joint Space	N	Minimum	Maximum	Mean	S.D
< 25 yrs	Right	20	1	5	3.08	1.02
	Left	19	1	5	3.20	1.23
25 to 35 yrs	Right	23	1	7	3.68	1.47
	Left	22	2	8	3.75	1.60
36 to 45 yrs	Right	13	2	5	3.55	1.31
	Left	13	1	6	3.06	1.48
46 to 55 yrs	Right	15	1	7	2.91	1.65
	Left	13	1	6	3.02	1.40
Above 55 yrs	Right	26	1	7	3.21	1.47
	Left	25	1	8	3.30	1.99

Table 5. Mean joint space based on gender

Gender	Joint Space	N	Minimum	Maximum	Mean	S.D
Female	Right	47	1	7	3.20	1.26
	Left	46	1	8	3.12	1.60
Male	Right	50	1	7	3.38	1.52
	Left	46	1	7	3.51	1.59

Discussion

CBCT has been recognized as a reliable method for examination of osseous components of TMJ, this technique is easy to perform, is reproducible and delivers relatively low dose to the patients. Its usefulness has been previously described in literatures.

According to Anuna Laila Mathew et al the prevalence of change in condylar morphology was more in individuals above 40 yrs (90%) as compared to those below the age of 40 (64%). It was also observed that, as the age increased, the number of condyles affected also increased. Huuonen et al. and Takayama et al. stated that absence of morphologic variation was much more common in the younger age group and age is a factor that determines the degree of remodelling, though there is no direct linear relationship. As the adaptive or degenerative changes in the temporomandibular joints appear over a long period of time, it is understandable that the condylar changes increase with advancing age. In our study the bilateral condylar flattening was observed more in the age groups above 40 years while unilateral (left) condylar flattening was observed in the younger age groups. The findings of our study was in accordance with the observations of a few studies which showed condylar changes to be more prevalent in younger age groups or showed condylar changes in all age groups (G. V. Packota et al 1989). The asymmetry between the two sides observed in our study could be due to the presence of a preferred chewing side among malocclusion patients, contributing to altered morphology. Several studies have attempted to evaluate the morphology and position of the condyle but not much emphasis has been laid on the shape of the condyle. The abnormal shape of the condyle identified incidentally may be due to developmental defect which got aided with trauma (Anusha et al 2018). In this study, 4 % of the patients in elderly age group presented with bilateral parrot beak appearance of the condyle. This variation of the condylar head seen in our study may be the anatomic variation of condyle with aided age changes like erosion, flattening, sclerosis etc. Studies by Ahmad and Schiffman et al indicated that articular eminences flattening must be taken into consideration as a risk factor for osteoarthritis and would require long term thorough observations. According to Bakke et al, articular eminence flattening was the most commonly diagnosed osseous change in elderly population, similar observations were presented by shahidi et al who also found articular eminence flattening as most common osteoarthritic change. In the current study, a similar pattern was observed with the articular eminence. In our study, erosion of the glenoid fossa was seen relatively equally among all age groups (3% each) and on the right, left sides and bilaterally. According to Honda et al an increase in bone thickness in glenoid fossa may be caused by mechanical stimulation because of incomplete shock absorption function resulting from the disc perforation or altered retro discal connective tissue. However, there is no significant difference between the various age group and thickness of glenoid fossa in our study. The prevalence of bifid condyle varies from 0.31 – 1.82% as per previous studies, and the cause for bifid condyle is due to developmental abnormality although it has been related to infection, trauma, condylar fractures or condylectomy. While majority of bifid condyle has coincidentally been diagnosed with panoramic radiography during routine exam, CBCT is considered to be the best of choice for appropriate diagnosis. According to Sampaio et al, the prevalence of 1.1% of bifid condyle is seen using CBCT amongst which half of them could be diagnosed by checking panoramic images. One case of unilateral bifid condyle was seen in this study. Condylar hypoplasia is characterized by unilateral or bilateral underdevelopment of mandibular condyle and usually occurs as a part of some systemic condition originating in the 1st and 2nd brachial arch such as treacher collin syndrome, goldenhar syndrome etc. Several authors confirmed that mandibular deficiency can occur without any define aetiology, however condylar hypoplasia without any facial malformation is an extremely rare condition, one case of unilateral condylar hypoplasia was seen in the current study. According to Renato et al, young adults had higher prevalence for condylar fractures as they were involved in most of the road traffic accidents which was considered as the main cause of condylar fractures, the findings of this study was in agreement with the Renato et al with 2% of unilateral condylar fractures in younger age groups.

In the present study, no significant differences in osseous changes of condyle were found in males and females which is similar to the results of studies by Ikeda, Kawamura et al (2009) who had found no significant sex differences in condylar morphology using CBCT. According to Priyanka et al, one of the most common findings in patients with degenerative arthritis is reduced joint space. In this study the mean joint space varied between 1 mm to 7 mm (mean-3.29mm) and 1mm to 8 mm (3.31mm) on the right and left sides respectively in age groups between 14 to 85 years with a mean age of 42 years. The joint space was more or less the same in all the age groups from <25 years to >55 years with a mean value of 2.91 to 3.75 mm. These findings are similar to previous study by priyanka et al. On analysing the gender differences in joint space, it was seen that females had a slightly reduced joint space in both right and left sides (mean of 3.20 and 3.12 respectively) as compared to males (mean of 3.38 and 3.51 respectively) which may be explained by the hormonal influences.

In our study, the TMJ changes were seen in the following order- condylar flattening (9.5%), parrot beak condyle (7.5%), erosion of glenoid fossa (6%), articular eminence flattening (3.5%), osteophytes (3%), condylar fracture and osteosclerosis (2%), bony contact (1.5%), bifid condyle and condylar hypoplasia (0.5 %). Our findings were consistent with the literature, with Alxeiou et al. stating in 2009 that flattening and erosion of the condyle were the most common radiographic findings. Flattening was observed in 59 percent of the cases by Dos Anjos Pontual et al in 2012. Flattening and osteophytes are the most common degenerative bony changes, according to him. He also discovered that the high prevalence of flattening could be explained by the possibility that this bone change is an adaptive change as a first sign of progressive disease caused by internal derangement.

Multiple authors in literature have reported study results that support the superiority of CBCT over OPG in assessment of TMJ changes. Shetty et al. (2014) in a comparative study of OPG and CBCT in the assessment of TMJ morphology proposed that the common condylar bony changes seen in both OPG and CBCT in the assessment of TMJ morphology were erosion, flattening, and osteophyte, the study included 100 temporomandibular joints from 62 patients who complained of temporomandibular joint pain. For each of the 100 joints, CBCT and OPG radiographs were taken. The study concluded that there was a significant difference in detecting erosion and osteophytes between OPG and CBCT, and that CBCT provides more valid and accurate information on condylar bony changes than OPG. Kohli et al. compared the efficacy of CBCT and OPG in evaluating osseous changes of the condyle in 10 patients with Temporomandibular Joint Disorders. The presence of erosion ($P=0.000$), the thickness of the roof of the glenoid fossa ($P=0.000$), deformed contour ($P=0.001$), joint space ($P=0.011$), subchondral sclerosis ($P=0.011$), irregularity of the articular surface and eminence ($P=0.000$), and flattening ($P=0.050$) were all found to be significant differences between OPG, transcranial, and CBCT. In comparison to conventional radiographic techniques, CBCT as an imaging technique effectively detects osseous changes in the TMJ, according to the study. In another study, HC Crow et al 2005 compared panoramic radiography with tomography as the gold standard, specificity was high for the presence or absence of osteophytes (0.90) and condylar flattening (0.85), while sensitivity was unacceptable (0.29 and 0.33, respectively). In addition to this, Sabine Ruf et al 1995 stated that Changes in head position during orthopantomography can affect the condyle and fossa images to a marked extent, leading to anterior condylar flattening, simulation of osteophytes, joint-space narrowing, and left/right condylar asymmetry. Thus, orthopantomography has potential limitations from a TMJ diagnostic standpoint in this aspect too in comparison to a CBCT.

Limitation of the Study

This study has some potential limitations. Firstly, the sample size was relatively low in this study to have conclusive evidence, although 100 CBCTs were seen and 200 joints were assessed, it would be more valuable to examine a larger group, including more elderly individuals. Secondly, we diagnosed as the osteoarthritic changes all of the below mentioned findings including -flattening of the convex condylar head, erosion, osteophytes, sclerosis etc, however, some of the authors do not consider the articular surface flattening as an osteoarthritic change unless the condylar deformation is present. Thirdly, CBCT image artefacts reduced the quality of images thereby reducing its diagnostic potential especially in the joint region. Finally, as it was a retrospective study from the radiographic archives, we were unable to match the association between the severity of radiographic changes to the clinical symptoms that the patients present with, more such prospective studies are required in future to assess this agreement as many a times there is a weak correlation between patient's symptoms and the radiographic findings.

Conclusion

CBCT is rapidly growing as the imaging modality of choice to evaluate the osseous components of the TMJ. This modality provides high-resolution multiplanar images of the TMJ, and importantly, at a lower radiation dose compared with CT. TMJ changes were found to have a statistically weak correlation with age and gender in our study. The findings of this study revealed that condylar morphology abnormalities increased with age. There was a significant difference in the condylar morphology of the left and right sides in our study, highlighting the importance of evaluating and assessing each condyle as a separate entity prior to any treatment. The results of this study could be used as a guideline for various TMJ parameters in future research, although a larger cohort study and a detailed comparison with other imaging modalities such as CT and MRI, particularly in the evaluation of joint spaces, are desirable. The findings of our study are consistent with the literature in highlighting the superiority of CBCT over OPG in assessment of TMJ changes, CBCT has both higher sensitivity and specificity in delineating the minor anatomical changes in the TMJ in comparison to OPG.

In our study, the TMJ changes were seen in the following order- condylar flattening (9.5%), parrot beak condyle (7.5%), erosion of glenoid fossa (6%), articular eminence flattening (3.5%), osteophytes (3%), condylar fracture and osteosclerosis (2%), bony contact (1.5%), bifid condyle and condylar hypoplasia (0.5 %). Our findings were consistent with the literature, with Alxeiou et al. stating in 2009 that flattening and erosion of the condyle were the most common radiographic findings. Flattening was observed in 59 percent of the cases by Dos Anjos Pontual et al in 2012. Flattening and osteophytes are the most common degenerative bony changes, according to him. He also discovered that the high prevalence of flattening could be explained by the possible comparison to OPG.

ORCID IDs

- **Dr. Vaishnavi P.** — 0000-0002-6054-8145
- **Dr. Laipubam Fabina Sharma** — 0000-0002-0935-2542
- **Dr. Sreekanth P. Kunjumon** — 0000-0002-4174-6306
- **Dr. Sujatha S.** — 0000-0002-8648-2340
- **Dr. N. Rakesh** — 0000-0003-4388-6334

Conflicts of Interest

The authors declare no conflict of interest.

References

- Alexiou, K.E., Stamatakis, H.C. and Tsiklakis, K., (2009). Evaluation of the severity of temporomandibular joint osteoarthritic changes related to age using cone beam computed tomography. *Dentomaxillofacial Radiology*, 38(3), pp.141-147.
- Al-koshab, M., Nambiar, P. and John, J., (2015). Assessment of condyle and glenoid fossa morphology using CBCT in South-East Asians. *PloS one*, 10(3), pp 1-11
- Almeida, L.E., Zacharias, J. and Pierce, S., (2015). Condylar hyperplasia: An updated review of the literature. *The Korean Journal of Orthodontics*, 45(6), pp.333-340.
- Barghan, S., Tetradis, S. and Mallya, S.M., (2012). Application of cone beam computed tomography for assessment of the temporomandibular joints. *Australian dental journal*, 57, pp.109-118.
- Conville, R.M., Moriarty, F. and Atkins, S., (2019). The management of temporomandibular disorders: a headache in general practice. *British Journal of General Practice*, 69(687), pp.523-524.
- Cope, G. and Cope, A., (2011). Diagnosis, treatment and management of TMJ disorders. *Dental Nursing*, 7(12), pp.682-686.
- Choudhary, A., et al (2020). Association of temporomandibular joint morphology in patients with and without temporomandibular joint dysfunction: A cone-beam computed tomography based study. *Dental research journal*, 17(5), p.338.-346
- Derwich, M., Mitus-Kenig, M. and Pawlowska, E., (2020). Morphology of the temporomandibular joints regarding the presence of osteoarthritic changes. *International journal of environmental research and public health*, 17(8), pp 1-14
- dos Anjos Pontual, M.L., et al (2012). Evaluation of bone changes in the temporomandibular joint using cone beam CT. *Dentomaxillofacial Radiology*, 41(1), pp.24-29.
- Gupta, R., Luthra, R.P., Kaur, D. and Aggarwal, B., (2019). Temporomandibular disorders: A review. *International Journal of Advanced Scientific Research*, 4(2), pp.22-26.
- Gil-Martínez, A., Paris-Aleman, A., López-de-Uralde-Villanueva, I. and La Touche, R., (2018). Management of pain in patients with temporomandibular disorder (TMD): challenges and solutions. *Journal of pain research*, 11, p.571- 587

Hafez Maleki, F., Shokri, A., Hosseini Zarch, S.H., Bahraniy, A., Ebrahimpour, A. and Alimohamadi, S.M., (2019). Cone beam CT evaluation of the bony changes in the temporomandibular joint and the association with the clinical symptoms of temporomandibular joint disorders. *Journal of Dental Materials and Techniques*, 8(1), pp.25-32.

Imanimoghaddam, M., Bagherpour, A., Nasseri, S., Madani, A.S., Rezaei, M.M. and Safaee, A., (2018). Dimensional Changes of Temporomandibular Joint in Patients Affected by Temporomandibular Disorders: A Combination of Two-Dimensional and Three-Dimensional Evaluation. *JOURNAL OF RESEARCH IN MEDICAL AND DENTAL SCIENCE*, 6(5), pp.187-193.

Isomura, E.T., Kobashi, H., Tanaka, S., Enomoto, A. and Kogo, M., (2017). A Case of Bifid Mandibular Condyle. *OMICS J Radiol*, 6(278), pp 1-3

Krishnamoorthy, B., Mamatha, N.S. and Kumar, V.A., (2013). TMJ imaging by CBCT: Current scenario. *Annals of Maxillofacial Surgery*, 3(1), p.80- 84

Larheim, T.A., Abrahamsson, A.K., Kristensen, M.L.Z.A. and Arvidsson, L.Z., (2015). Temporomandibular joint diagnostics using CBCT. *Dentomaxillofacial Radiology*, 44(1), pp 1-12

Liu, F. and Steinkeler, A., (2013). Epidemiology, diagnosis, and treatment of temporomandibular disorders. *Dental Clinics*, 57(3), pp.465-479.

Ma, R.H., Yin, S. and Li, G., (2016). The detection accuracy of cone beam CT for osseous defects of the temporomandibular joint: a systematic review and meta-analysis. *Scientific reports*, 6(1), pp.1-8.

Mehdizadeh, M., Rezaei, Z. and Moghadam, F.G., (2020). Incidental Findings in Temporomandibular Joint Region Detected by Cone-beam Computed Tomography: A Retrospective Study. *The Open Dentistry Journal*, 14(1).pp 337-342

Paknahad, M., Shahidi, S., Iranpour, S., Mirhadi, S. and Paknahad, M., 2015. Cone-beam computed tomographic assessment of mandibular condylar position in patients with temporomandibular joint dysfunction and in healthy subjects. *International journal of dentistry*, pp 1-6

Ribeiro, M.C., von Meusel, L.D.Z., Gavioli, E., Silveira, A.M. and Cericato, G.O., (2018). Prevalence of TMJ pain symptom in adults and its association with predisposing factors. *Bioscience Journal*, 34(6).pp 1815 – 1823

Rosen, E., Taschieri, S., Del Fabbro, M., Beitlitum, I. and Tsesis, I., (2015). The diagnostic efficacy of cone-beam computed tomography in endodontics: a systematic review and analysis by a hierarchical model of efficacy. *Journal of endodontics*, 41(7), pp.1008-1014.

Shetty, U.S., Krishna, N.B. and Venkatesh, G.N., (2014) Assessment of condylar changes in patients with temporomandibular joint pain using digital volumetric tomography. *Radiol Res Pract*, pp 1-8

Sadat, S.A., Chowdhury, N.M., Baten, R.B.A., Uddin, A.F. and Rita, S.N., (2017). Management of temporomandibular joint dysfunction syndrome: an overview. *Journal of Bangladesh College of Physicians and Surgeons*, 35(3), pp.133-141.

Verma, P., Surya, V., Kadam, S., Umarji, H.R., Gupta, N. and Gogri, A., (2016). Assessment of joint space and arthritic changes in temporomandibular joint as visualized on cone beam computed tomography scan. *Journal of Indian Academy of Oral Medicine and Radiology*, 28(4), p.358.-363

Copyright: © 2026 All rights reserved by Kunjumon SP and other associated authors. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.