

## Original Research

### Morphological assesment of TMJ spaces, mandibular condyle and glenoid fossa using cone beam computed tomography among Kanyakumari population: A cross sectional study

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#### ABSTRACT:

**Background:** The temporomandibular joint (TMJ) is a complex structure and is susceptible to structural changes caused by functional stress. Cone-beam computed tomography (CBCT) provides high-resolution three-dimensional imaging, making it ideal for precise evaluation of TMJ morphology. This study was aimed to assess the morphology of tmj using cbct analysis. **Materials and Method:** This cross-sectional study included 20 asymptomatic participants from the Kanyakumari population, divided equally by sex and age (<35 years and ≥35 years). CBCT scans, obtained for diagnostic purposes unrelated to TMJ disorders, were analyzed using standardized protocols. Participants met strict inclusion criteria for normal dentition and TMJ health, while exclusions removed individuals with systemic diseases, trauma, or developmental anomalies. Two experienced radiologists independently evaluated the scans using NewTom 3D NNT software. Measurements included condylar length, width, height, anterior, superior, and posterior joint spaces, and glenoid fossa roof thickness. Inter- and intra-examiner reliability was assessed. Data were analyzed with SPSS v26, using t-tests and chi-square tests, with statistical significance set at  $p < 0.05$ . **Results:** The sample included equal numbers of male and female participants. The younger group had a mean age of  $23.20 \pm 1.32$  years, while the older group averaged  $39.60 \pm 5.46$  years. Condylar dimensions showed minimal age-related variation, though superior joint space was slightly larger in older individuals, and left condylar width was marginally reduced. No significant differences were observed for other parameters, aside from clear age group separation ( $p = 0.029$ ). **Conclusion:** This retrospective study with CBCT provides accurate evaluation of condylar morphology and joint spaces, thus supporting its application in diagnosis and treatment planning

**Keywords:** Temporomandibular Joint Morphometry, Condylar Morphometry, Cone Beam Computed Tomography, Temporomandibular Joint Disorders

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#### INTRODUCTION

The temporomandibular joint (TMJ) is a synovial joint essential for chewing and proper occlusion. Cone-beam computed tomography (CBCT) enables helps in the visualization of condylar shape and joint spaces and evaluates bony changes relevant to temporomandibular disorders (TMDs) [1]. Both age and gender have an impact on the TMJ dimensions and the occurrence of degenerative alterations, while CBCT provides constant measurements in symptomatic and asymptomatic cases [2]. Studies

have shown that in people with normal occlusion natural variations in condylar size and joint space offer baseline morphometric information for comparison [3]. CBCT in specific populations have demonstrated osteoarthritic changes and have provided normative reference data [4]. High-resolution imaging helps in the detection of early degenerative alterations, thus supporting clinical and orthodontic evaluation [5]. Bone changes correspond with TMD classifications and help in differentiating the involvement of muscle, disc, and joint [6].

Radiographic analyses document normal variations and age- or function-related remodeling [7,8]. Condylar shape shows associations with TMJ conditions, underlining the importance of morphometric evaluation [9]. Retrospective CBCT research demonstrates its usefulness in identifying structural remodeling and degenerative changes [10,11].

Cone-beam computed tomography (CBCT) provides clear multiplanar views of the TMJ, showing condylar shape and joint spaces with lower radiation than conventional CT and without the overlap seen in 2D imaging [10]. Conventional CT detects degenerative TMJ changes with 87.5–96% accuracy [11], but CBCT is more sensitive than orthopantomograms for early bony changes, exceeding 90% [12]. Physiological tooth changes happens from normal chewing or parafunctional habits, may reflect adaptive or degenerative TMJ alterations [13,14].

This study examined TMJ morphology in the Kanyakumari population using CBCT. The imaging enabled precise evaluation of condylar length, width, height, joint spaces (anterior, superior, posterior), and glenoid fossa roof thickness. The research aimed to establish baseline morphometric data, analyze variations by age, sex, and laterality, and explore associations with functional dominance. Specific objectives included comparing morphometric features between younger (<35 years) and older ( $\geq$ 35 years) groups, identifying sexual dimorphism, evaluating right–left asymmetry. This study integrates clinical assessment with CBCT measurements to provide reference data for clinicians, clarify TMJ variation, and demonstrate CBCT as an effective diagnostic tool for detecting early degenerative changes, enabling timely intervention and accurate treatment planning.

## MATERIALS AND METHOD

**Study Design, Population, and Ethics:** This cross-sectional study was carried out in the Department of Oral Medicine and Radiology at Rajas Dental College and Hospital, Kavalkinaru, Tirunelveli, to assess the morphological features of the TMJ in individuals from the Kanyakumari population. The study included 20 participants, equally divided between males and females (10 each). They were grouped by age into two categories: Group I, participants under 35 years, and Group II, participants over 35 years. All participants had undergone CBCT imaging for diagnostic purposes unrelated to TMJ disorders, ensuring that the scans reflected normal, asymptomatic TMJ anatomy. Imaging was performed at the same institution using standardized protocols to maintain uniformity and reduce technical variability. Before enrollment, each participant was informed about the study's purpose, procedures, benefits, and risks, and written informed consent was obtained. The institutional ethics committee of Rajas Dental College and Hospital approved the study protocol, and all procedures

followed national and international ethical guidelines for research involving human participants.

**Selection Criteria:** The study included only individuals with healthy temporomandibular joints and normal functional parameters. Participants showed no clinical signs or symptoms of TMJ disorders, had normal jaw opening without deviation or deflection during extraoral examination, and had no history of oral pathology. All included individuals had intact dentition adequate for normal masticatory function. Exclusion criteria removed factors that could affect TMJ morphology, such as gross facial asymmetry, systemic diseases like arthritis, pregnancy, ongoing or completed orthodontic treatment, partial or complete edentulism, and any history of trauma, tumors, fractures, or orthognathic or TMJ reconstructive surgery. Participants with developmental anomalies such as condylar hyperplasia or hypoplasia were also excluded. These criteria ensured a healthy baseline sample for accurate assessment of morphometric parameters and minimized bias from pathological or structural variations.

**Clinical Examination and Imaging Protocol:** A comprehensive clinical evaluation included extraoral and intraoral assessments of the jaw movement, range of motion, presence of pain, joint sounds, and symmetry of function. Only those who met all clinical inclusion criteria proceeded to CBCT imaging. The imaging was performed using the NewTom GO 3D NNT (NewTom Verona, Italy), a cone-beam computed tomography system known for its high spatial resolution and low radiation dose. Standardized scanning protocols were applied to all participants, with consistent positioning and exposure settings (e.g., 90 kVp, 5–8 mA, exposure time of 18 seconds, field of view centered on the TMJs) to ensure uniformity and reproducibility of the images. High-resolution axial, coronal, and sagittal reconstructions were generated for detailed anatomical assessment.

**Morphometric Evaluation and Measurement Technique:** All morphometric analyses were conducted using the NewTom 3D NNT software, which allows precise linear measurements in multiplanar reformatted views. Two trained maxillofacial radiologists independently evaluated the CBCT images under optimal lighting conditions on calibrated diagnostic monitors to minimize observer bias. The inter-rater reliability between the two observers was statistically assessed using Kappa statistics to ensure measurement consistency. Bilateral assessments were performed for both the right and left TMJs. The parameters measured included: condylar length (from anterior to posterior pole of the condyle in sagittal view), condylar width (distance between medial and lateral poles in coronal section), condylar

height (perpendicular distance from the superior most point of the condyle to the lowest point of the sigmoid notch in the sagittal plane), roof thickness of the glenoid fossa (measured from the outer to inner cortical table at its thinnest point), and joint spaces specifically anterior, superior, and posterior joint spaces measured as the shortest perpendicular distances between the articular surfaces of the mandibular condyle and the glenoid fossa. Standard anatomical landmarks were used to ensure accuracy, including the superior pole of the condyle (SC), inferior sigmoid notch (IS), medial and lateral poles of the condyle (MC, LC), and the superior aspect of the glenoid fossa (SF). Measurements were repeated after a two-week interval for a subset of cases to assess intra-examiner reliability. (Figure 1 and Figure 2)

**Statistical Analysis:** Data were compiled and coded in Microsoft Excel 2019, and statistical analysis was performed using IBM SPSS Statistics version 26.0. Descriptive statistics (mean ± SD) were calculated for all morphometric parameters. Independent samples t-tests compared measurements between age groups (<35 and ≥35 years), while chi-square tests and t-tests assessed gender differences. Right and left side measurements were directly compared to evaluate asymmetry. A p-value <0.05 was considered statistically significant.

**RESULTS**

**Table 1** shows the demographic distribution and descriptive statistics of the study participants. The sample consisted of 20 individuals, evenly divided into two age groups: 10 participants below 35 years (mean age 23.20 ± 1.32 years) and 10 participants aged 35 years or older (mean age 39.60 ± 5.46 years). The younger group demonstrated a narrow age range (20–25 years) with a slightly negative skewness, while the older group showed a broader range (35–50 years) and moderate positive skewness, reflecting variability in age distribution. Gender was equally distributed, with 10 males and 10 females, ensuring balanced representation for comparative analysis. Table 2 shows the morphometric

measurements of the right temporomandibular joint (TMJ) in participants below and above 35 years of age. Condylar dimensions, including length, width, and height, were comparable between both age groups, suggesting minimal age-related variation in condylar size. Joint space measurements demonstrated a slight increase in the superior joint space among participants aged 35 years and older (4.05 ± 0.95 mm) compared to the younger group (3.26 ± 1.08 mm), possibly reflecting adaptive changes in the articular surface over time. Other parameters, such as anterior and posterior joint spaces and the thickness of the roof of the glenoid fossa, showed only minor differences, indicating overall morphological symmetry and stability of the right TMJ across age groups. **Table 3** shows the morphometric measurements of the left temporomandibular joint (TMJ) across both age groups. Condylar length and height were similar in participants below and above 35 years, indicating no significant age-related differences in these dimensions. Older individuals demonstrated a slight reduction in condylar width (15.18 ± 0.95 mm) compared to younger participants (17.66 ± 1.30 mm), suggesting mild remodeling with age. Superior joint space measurements were slightly larger in older participants, while posterior joint space showed a small decrease. Glenoid fossa roof thickness remained stable, reflecting overall bilateral symmetry and minimal structural variation between age groups. **Table 4** summarizes the Chi-square analysis comparing morphometric parameters of the temporomandibular joint (TMJ) between participants below and above 35 years of age. A significant association was observed only between age and group classification (p = 0.029), confirming clear separation of participants based on the predefined age groups. No statistically significant differences were found for any of the measured condylar dimensions, joint spaces, or glenoid fossa thickness (p > 0.05), suggesting that TMJ morphology remains largely consistent across age categories and between sexes. These findings highlight that structural TMJ features demonstrate minimal age-related variation in this population sample.

**Table 1: Demographic distribution and descriptive statistics of study participants**

Group	n	Mean Age (years)	SD	Range	Skewness	Kurtosis
Group I (<35 years)	10	23.20	1.32	20–25	-1.548	39.60
Group II (≥35 years)	10	39.60	5.46	35–50	1.459	0.676
Male	10	–	–	–	–	–
Female	10	–	–	–	–	–
Total	20	–	–	–	–	–

**Table 2: Right TMJ morphometric measurements (mean ± SD)**

Parameter	<35 years	≥35 years
Condyle Length (CL- Right)	7.71 ± 1.15	7.56 ± 1.03
Condyle Width (CW - Right)	16.17 ± 3.09	15.27 ± 1.78
Condyle Height (CH - Right)	12.71 ± 3.89	12.45 ± 4.12
Anterior Joint Space (CAS - Right)	2.40 ± 0.49	2.48 ± 0.79
Superior Joint Space (CSS - Right)	3.26 ± 1.08	4.05 ± 0.95

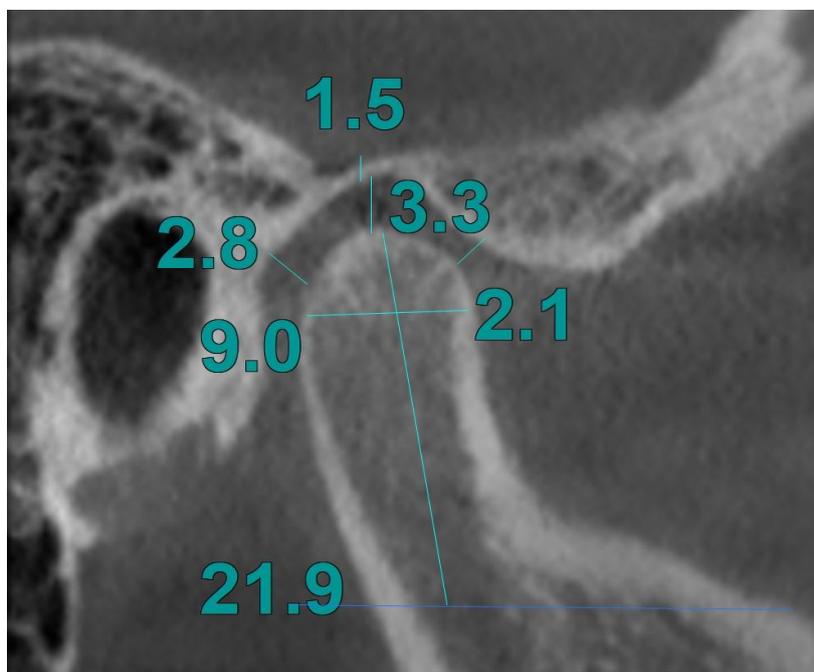
<b>Posterior Joint Space (CPS - Right)</b>	3.06 ± 0.39	3.07 ± 0.37
<b>Roof of Glenoid Fossa (RGF - Right)</b>	1.97 ± 0.22	2.13 ± 0.74

**Table 3: Left TMJ morphometric measurements (mean ± SD)**

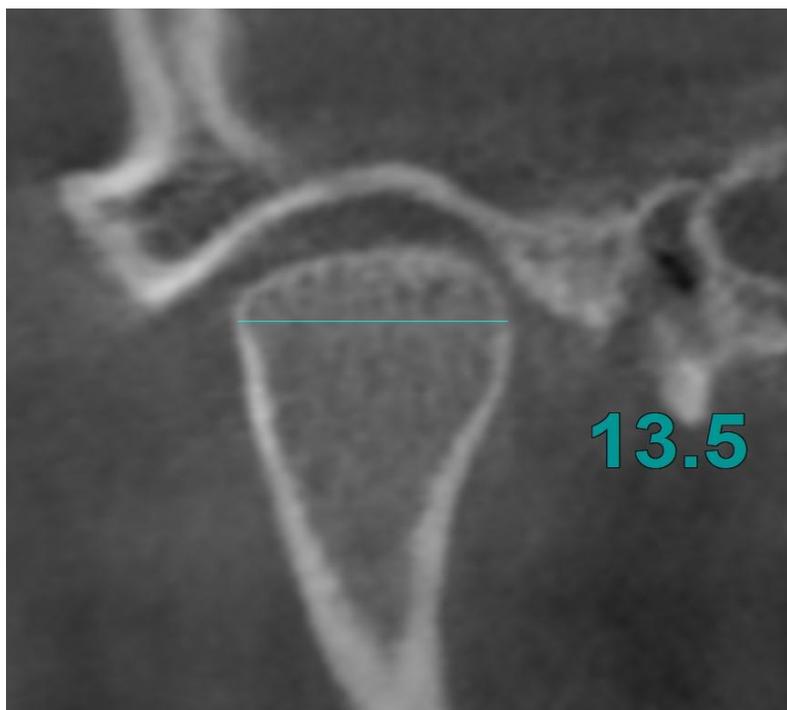
Parameter	<35 years	≥35 years
<b>Condyle Length (CL - Left)</b>	7.83 ± 1.37	8.03 ± 1.43
<b>Condyle Width (CW- Left)</b>	17.66 ± 1.30	15.18 ± 0.95
<b>Condyle Height (CH - Left)</b>	13.43 ± 4.44	13.47 ± 4.85
<b>Anterior Joint Space (CAS - Left)</b>	2.69 ± 0.96	2.89 ± 1.14
<b>Superior Joint Space (CSS - Left)</b>	3.58 ± 0.78	3.99 ± 1.03
<b>Posterior Joint Space (CPS - Left)</b>	2.83 ± 0.78	2.35 ± 0.53
<b>Roof of Glenoid Fossa (RGF - Left)</b>	2.35 ± 0.83	2.26 ± 0.81

**Table 4: Chi-square analysis of morphometric parameters by age group**

Variable	χ <sup>2</sup> Value	df	p-value
<b>Age vs Group</b>	20.000	10	0.029
<b>Sex vs Group</b>	0.000	1	1.000
<b>CL Right</b>	14.000	14	0.450
<b>CW Right</b>	16.000	15	0.382
<b>CH Right</b>	18.000	16	0.324
<b>CAS Right</b>	14.333	11	0.215
<b>CSS Right</b>	14.667	11	0.198
<b>CPS Right</b>	8.667	10	0.564
<b>RGF Right</b>	12.667	12	0.394
<b>CL Left</b>	17.333	16	0.364
<b>CW Left</b>	20.000	16	0.220
<b>CH Left</b>	20.000	18	0.333
<b>CAS Left</b>	18.000	18	0.456
<b>CSS Left</b>	20.000	16	0.220
<b>CPS Left</b>	15.333	14	0.356
<b>RGF Left</b>	8.667	12	0.731



**FIGURE 1 – TMJ MORPHOLOGICAL PARAMETERS**



**FIGURE 2: CONDYLAR LENGTH**

## DISCUSSION

This study evaluated mandibular condyle morphology and TMJ spaces using CBCT, focusing on age, gender. Age significantly influenced TMJ anatomy, particularly joint space and glenoid fossa depth, while overall condylar dimensions remained relatively stable. Participants younger than 35 years exhibited slightly larger anterior, superior, and posterior joint spaces, as well as deeper glenoid fossae, whereas those aged 35 years and above showed minor reductions in condylar width and subtle remodeling of the fossa, indicating age-related structural adaptation [1,2,3,10,14]. CBCT proved reliable in detecting these bony alterations and correlating them with clinical findings, supporting its use for detailed morphometric evaluation [1,10,12,15]. CBCT offers high-resolution three-dimensional imaging with lower radiation exposure than conventional CT, making it suitable for both diagnostic and longitudinal studies of TMJ morphology [16,17]. Male participants had marginally larger condylar measurements than females, though these differences were not statistically significant, suggesting limited influence of sex on degenerative changes [2,11,18]. Increased morphological changes in older participants corresponded with narrowing of joint spaces and early signs of condylar remodeling, consistent with previous reports linking functional load and tooth wear to osseous changes in the TMJ [14,19,20]. Overall, joint space dimensions and glenoid fossa morphology emerged as the most age-sensitive parameters, highlighting their value in clinical assessment and early detection of TMJ degeneration [16,21,22].

Age-stratified analysis revealed that participants aged 35 years and above had increased superior joint space

compared to younger individuals, suggesting age-related remodeling of the articular surface. Advancing age is associated with a higher prevalence of osteoarthritic changes in the TMJ, emphasizing the need for population-specific baseline data [4,5]. Functional loading combined with aging contributes to degenerative alterations, which CBCT detects more accurately than conventional imaging.

Age related changes has significant impact on the TMJ morphology, especially in participants aged >35 years, who exhibits parafunctional habits and cumulative functional load [9,10]. Higher mechanical stress leads to changes in the condyle, like flattening, erosion, and slight reductions in width in older adults [11,12]. CBCT facilitates in the precise measurement of condylar size, joint spaces, and glenoid fossa thickness, thereby supporting early detection of degenerative changes [14]. Participants who exhibited narrower joint spaces and minor condylar adaptations revealed overall condylar dimensions stable, reflecting structural adjustment without major loss [19,20]. These findings show the combined impact of age, and functional load, emphasize the value of CBCT. Hence, it is necessary to establishing baseline morphometric data for specific populations for tracking degeneration so that proper clinical care guidance can be adopted for the patients [18].

Bone quality, including density, mineralization, and microarchitecture, plays a critical role in condylar integrity and susceptibility to TMJ degeneration [23]. Prior studies also report increased condylar flattening, erosion, and sclerosis with advancing age, especially in individuals with missing teeth [21]. In this study, condylar dimensions were largely symmetrical, with minor age-related variations. Other reports indicate

that condylar width and length correlate more closely with TMJ dysfunction symptoms, while condylar height remains relatively stable across age groups [22]. CBCT enables early detection of cortical erosions and reliably identifies degenerative changes with high spatial resolution [15]. Using CBCT as the primary tool for morphometric evaluation, subtle variations in joint space and fossa roof thickness were observed, which may not be captured by other imaging modalities. Soft tissue structures, such as the TMJ disc, were not assessed in this study, which is a limitation; future studies incorporating MRI could complement CBCT findings for comprehensive evaluation [24]. Thus, age emerged as the primary factor influencing TMJ morphology, with joint space narrowing and fossa remodeling most pronounced in older participants, while gender differences were minimal [2,3,9]. Future research including systemic factors such as osteoporosis could further elucidate the influence of bone density on TMJ degenerative changes [25].

**Strengths and Limitations:** CBCT was used to measure TMJ bone structure, condylar dimensions, and joint spaces with high accuracy and minimal radiation. Participants were grouped by age, and gender was recorded to study the effects of aging and functional load. Standardized imaging protocols ensured consistent measurements, and an equal number of male and female participants allowed balanced comparisons. Limitations include the cross-sectional design, small sample size, and absence of follow-up imaging, which prevent tracking changes over time. Soft tissues, such as the articular disc, were not evaluated, and factors like parafunctional habits, systemic conditions, and occlusal issues were only partially addressed.

## CONCLUSION

This retrospective study with CBCT provides accurate evaluation of condylar morphology and joint spaces, thus supporting its application in diagnosis and treatment planning. Larger, multicenter studies with longitudinal follow-up are essential to validate these results and improve the understanding of clinico-radiological associations. Regular CBCT examination of the TMJ can assist in early detection of degenerative changes and guide appropriate patient management.

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