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Original Article

Assessment of Degenerative Condylar Bony Change Due to Temporomandibular Joint Disorder in Bangladeshi Population Using Cone Beam Computed Tomography – A Pilot Study

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Abstract

Background: Temporomandibular joint (TMJ) degeneration is a progressive disorder characterised by structural and functional deterioration; however, population-specific epidemiological and morphometric data based on cone-beam computed tomography (CBCT) remain limited for the Bangladeshi population. This study investigated the prevalence of degenerative bony changes in the mandibular condyle and explored their morphometric alterations and demographic (age and gender) correlations in the Bangladeshi population.

Methods: Following predefined inclusion criteria, this descriptive study included 15 patients with temporomandibular disorder (TMD) symptoms in the case group and 15 participants without TMD symptoms in the control group. CBCT was used to evaluate the following bony changes: erosion, flattening, subchondral sclerosis, osteophytes, and subcortical cysts, and their associations with age and gender. Condylar head dimensions were compared between the groups to assess morphometric alterations. Statistical analyses included chi-square tests, t-tests, and Mann-Whitney U tests.

Results: Among the 60 TMJs, erosion (93.3%) was the most common bony change, followed by flattening (53.3%), osteophytes (43.3%), subcortical cysts (43.3%), and sclerosis (40%). The linear measurements of the condylar head and glenoid fossa were found not to differ significantly between the case and control groups or between the left and right sides ($P>0.05$). Females showed a higher prevalence of sclerosis. However, no significant correlation was found between bony changes and age groups ($P>0.05$).

Conclusion: The study findings indicate that degenerative bony changes of the condyle may occur independently of clinical symptoms and age in the Bangladeshi population, highlighting the need for careful evaluation of every CBCT scan that covers the TMJ. The results may assist Bangladeshi clinicians in refining diagnostic decisions and treatment planning, as well as promoting radiation safety for patients.

Keywords: Degenerative joint disease, Condylar bony changes, Temporomandibular joint disorders, Mandibular condyle

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Introduction

The temporomandibular joint (TMJ) is a mobile articulation between the mandibular condyle and the glenoid fossa of the temporal bone, separated by the articular disc. Both bony components are covered with thin fibrocartilage. The condyle-disc complex allows translatory and rotational movements, facilitating essential jaw functions such as chewing, swallowing, and speaking[1,2] The TMJ and its associated structures are crucial for guiding mandibular movement and distributing the stresses generated by daily activities.[3]

In contrast, temporomandibular disorder (TMD)

encompasses conditions characterised by pain and tenderness in the TMJ or masticatory muscles, often accompanied by limited or deviated mouth opening, clicking sounds, and preauricular pain.[4,5] Degenerative bone changes affecting the TMJ structures, including flattening, erosion, osteophytes, subchondral bone sclerosis, and subcortical cysts, may frequently be associated with TMD.[6] Accordingly, diagnosing degenerative changes involves clinical examinations and imaging.[7] Imaging techniques include Magnetic Resonance Imaging (MRI), Computed Tomography (CT), cone-beam computed tomography (CBCT), ultrasonography, and conventional radiography. Conventional radiography is limited by its two-dimensional nature, while CBCT and CT effectively detect bony changes. MRI and ultrasonography are preferred for evaluating the articular disc.[8,9]

On the other hand, CBCT provides detailed multi-planar images with high resolution and minimal radiation exposure. With a smaller field of view and voxel size, CBCT can provide more accurate images than CT for assessing osseous alterations of the TMJ.[10] However, its use in Bangladesh remains limited compared to CT, possibly due to the absence of comprehensive studies utilising this technology to investigate TMJ degeneration in the local population. To our best knowledge, there is no published consensus on the prevalence of condylar bony changes or their relationship with age and gender for the Bangladeshi population. Furthermore, research on morphometric alterations associated with TMD in this population is also lacking[3]

Therefore, this study aimed to fill these gaps by using CBCT to assess the prevalence of degenerative alterations in the condylar head, including erosion, flattening, subchondral sclerosis, osteophytes, and subcortical cysts, and to examine their morphometric and demographic correlations within the Bangladeshi population. This study was conducted to provide population-specific CBCT-based evidence on degenerative condylar changes in the Bangladeshi population, thereby improving diagnostic accuracy and clinical management of degenerative TMJ disorder.

Methods

Ethical approval had been obtained from the ethical review board of Shaheed Suhrawardy Medical College Hospital (Ref: ShSMCH/Ethical/2023/008) and the Universiti Sains Malaysia (USM/JEPeM/KK/24080711).

Participants

Following Browne's (1995) recommendations on pilot study sample size, this study comprised 30 participants (60 TMJs), with 15 patients per group, a sample size considered sufficient to assess feasibility and estimate variability and preliminary effect sizes, rather than to achieve definitive statistical power.[11] The sample was selected using a non-probability sampling technique from patients who visited Shaheed Suhrawardy Medical College Hospital, and were referred for CBCT to ODC imaging center from 20 November 2023 to 20 December 2023 for the control group, and from the first 15 patients' CBCT data for the case group from the archive scanned before 20 November 2023 using predefined inclusion criteria.

Inclusion Criteria

Case Group (Clinically Symptomatic)–

Patients presenting with chronic temporomandibular noise with or without pain in the last 30 days (according to DC/TMD)[7].

1. A good quality CBCT scan covering at least both condyles, the joint cavity, and the articular eminence was taken with maximum intercuspation of the teeth.

Control Group (Clinically Asymptomatic)–

1. Patients presenting neither temporomandibular noise nor pain in their lifetime but visited Shaheed Suhrawardy Medical College Hospital for other dentoalveolar reasons, such as implant placement, impacted third molar extraction, etc.
2. A CBCT scan following the as-low-as-reasonably-achievable principle, covering at least both condyles, the joint cavity, and the articular eminence, was taken with maximum intercuspation of teeth.

Exclusion Criteria for Both Case and Control Groups

1. History of TMJ surgical interventions or radiation therapy involving the head and neck region.
2. Presence of congenital TMJ anomalies or any history of jaw trauma.
3. Pregnancy or patients younger than 21 years old.
4. CBCT scans with an insufficient field of view (FOV) or motion artefact.

Informed written consent was obtained from participants in the control group before the CBCT scan.

CBCT Image Acquisition

The CBCT scans were obtained with an Orthophos S scanner (Dentsply Sirona, North Carolina, USA). The acquisition parameters included an FOV of 8 cm x 8 cm, a tube voltage of 85 kV, a tube current of 10 mA, a voxel size of 0.3 mm, and a scan time of 4.4 seconds. The images were exported in DICOM (Digital Imaging and Communications in Medicine) format using the software program Sidexis 4 (Dentsply Sirona, North Carolina, USA) for further processing.

CBCT Image Interpretation

The DICOM files were imported into the software program Sidexis (Dentsply Sirona, North Carolina, USA) version 4, with the Galileos Implant version 1.9 add-on installed, to assess bony changes and perform morphometric analysis. A multiplanar, blinded evaluation of the CBCT scans was conducted twice by a dental surgeon with at least 5 years of experience in maxillofacial imaging, at 6-month intervals, to ensure interpretation reliability. The intraclass correlation coefficient (ICC) was calculated and found to exceed 0.9, indicating excellent intra-rater reliability.

Assessment of Bony Changes

Bony changes were assessed using a multi-planar approach to evaluate the mandibular condyle, whether visualised or not.[6,12,13] The five categories of bone changes were defined as follows (Figure 1):

- Flattening: deviation from the standard convex shape of the condyle.
- Osteophytes: bony outgrowths located on the margin of the condyle.
- Sclerosis: a region of increased cortical bone density extending into the bone marrow.
- Erosion: discontinuation of the cortical bone outline.
- Cysts: a well-defined osteolytic lesion in the subcortical area without affecting the cortical bone.

Morphometric Analysis

The metric analysis of condylar head and glenoid fossa morphology included linear measurements of the condylar head (length and width) and the thickness of the roof of the glenoid fossa. The anteroposterior diameter of the condyle was measured as the length from the corrected mid-sagittal slice. The superior-most point of the mandibular condyle was denoted as the superior condylar point (SCp). Two points, one posterior and one anterior, at 4 mm below the SCp, were identified as the posterior-most condylar point (PCp) and the anterior-most condylar point (ACp). By adding ACp and PCp, we found the length of the mandibular condyle (Figure 2a). Furthermore, in the coronal section, the areas of maximum convex curvature on either side of the condyle were identified as the medial-most condylar point (MCp) and the lateral-most condylar point (LCp). The mesiodistal diameter (condylar width) was measured as the linear distance between the lateral and medial points of the mandibular condyle (Figure 2b). In the sagittal plane, the thickness of the glenoid fossa (TGF) was defined as the distance between the outer cortical outline and the inner cortical outline at the thinnest portion (Figure 2c).[12]

Statistical Analysis

The statistical analysis was performed using SPSS (version 26.0; Armonk, NY: IBM Corp). Normality was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. A chi-square test was used to compare the case and control groups by gender. On the other hand, morphometric changes related to bony changes were assessed using independent t-tests for normal data, and Mann-Whitney U tests for non-normal data. Additionally, the correlation of bony changes within different age groups was evaluated. The level of significance was set at $P = 0.05$.

Results

In this study, the gender ratio was 40% (n = 15) for males and 60% (n = 15) for females in the case group and 40% (n = 15) for females and 60% (n = 15) for males in the control group. The age range was found to be (21 – 50) years for both groups. Subsequently, the patients were divided into three age groups (21-30 years, 31-40 years,

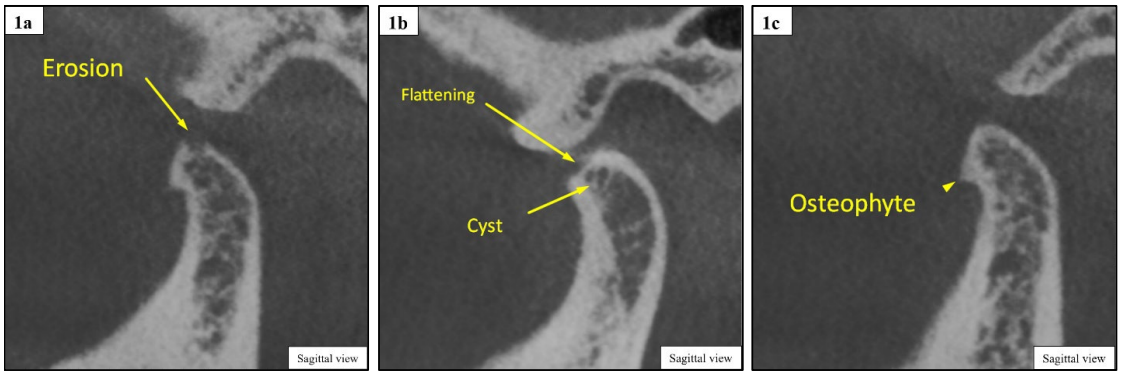

Figure 1. Sagittal section of CBCT image showing: a) erosion, b) osteophyte, c) flattening and subcortical cyst

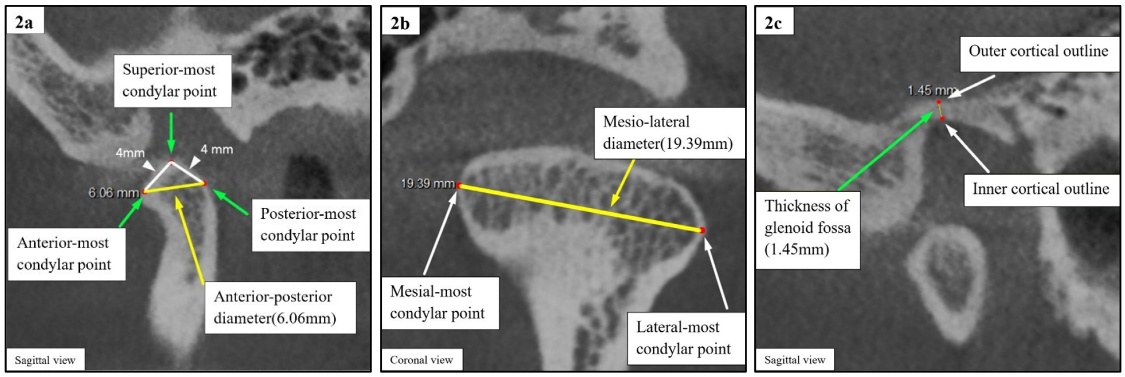

Figure 2. CBCT image showing how the measurements were done: a) The anteroposterior diameter of the condyle, b) The mesiodistal diameter, c) The thickness of the glenoid fossa

and 41-50 years).

After analysing 60 TMJs, with 30 TMJs in each group, this study found bony alterations of the condylar head in the case group: 93.3% erosion, 53.3% flattening, 43.3% osteophytes, 43.3% subcortical cysts, and 40% sclerosis. Though the asymptomatic control group also showed few bony changes, these were less frequent: 46.7% erosion, 26.7% flattening, and 20% sclerosis. The asymptomatic control group did not demonstrate any skeletal deformity, such as osteophyte formation or subcortical cysts.

On the other hand, according to the chi-square test results (Table 1), bony changes such as erosion, osteophytes, and subcortical cysts were significantly ($P=0.001$) more prevalent in the case group than in the control group. In a nutshell, patients with TMD symptoms showed significantly greater bony alterations, and erosion was the most prevalent change in both groups.

Moreover, the comparison of morphometric deviations between the case and control groups revealed minimal differences in linear measurements. The anterior-posterior diameters of the condylar head were nearly identical on both sides, with a mean difference of 0.06 mm on the right and 0.02 mm on the left. Similarly, the mesial-lateral diameters showed slight differences, with a mean difference of 1.02 mm on the right and 0.22 mm on the left. The thickness of TGF varied slightly between the groups, with differences of 0.20 mm on the right and 0.15 mm on the left. Overall, the morphometric dimensions were consistent between the case and control groups (Table 2).

The correlation between bony changes and age groups showed varying distributions across the three age groups. Flattening was most common in the 31–40-year-old group (50%), with a moderate positive correlation (r = 0.4). Erosion was distributed fairly evenly among age groups, with a weak correlation (r = 0.24). Osteophytes and subcortical cysts showed similar distributions, with the highest prevalence in the younger two age groups (37.5%) and negligible correlations (r = 0.09) between them. Sclerosis was most prevalent in the 21–30-year-old group (66.67%), with a moderate positive correlation (r = 0.446). Overall, age had a limited effect on the distribution of bony changes (Table 3).

The comparison of bony changes by gender showed differences in distribution. Flattening, erosion, osteophytes, and subcortical cysts were present in both males and females with no significant gender differences. However, sclerosis was significantly more prevalent in females (66.67%) compared to males (0%), indicating a gender-specific pattern ($P=0.028$). Other bony changes demonstrated similar proportions between genders, suggesting limited gender influence on their occurrence.

Table 1. Contingency table for bony changes in case and control groups.

Bony changes	Category	Case	Control	Chi-square	*P*-value
Flattening	Exposed	15	8	3.45	0.063
	Not Exposed	15	22		
Erosion	Exposed	28	13	17.33	0.001
	Not Exposed	2	17		
Osteophytes	Exposed	13	0	16.59	0.001
	Not Exposed	17	30		
Sclerosis	Exposed	12	6	2.85	0.090
	Not Exposed	18	24		
Subcortical Cyst	Exposed	13	0	16.59	0.001
	Not Exposed	17	30		

Discussion

This study investigated the prevalence of degenerative bony changes in the mandibular condyle among participants with and without TMJ disorder symptoms. It also examined morphometric alterations of the condylar head between case and control groups, as well as the correlation between age, gender, and the occurrence of degenerative changes within the case group.

TMJ disorders have become a concern worldwide, and their prevalence varies significantly across different countries and populations, with reported rates ranging from 30% to 50%.[14] Degenerative changes frequently lead to alterations in the morphology of the bony component of TMJ. These alterations can be found in the condylar head, articular eminence, and the roof of TGF. [15] Several studies evaluated degenerative disease located in the TMJ radiographically, stating CBCT as a superior, reliable, and recommended imaging modality to assess TMJ bony alteration.[16-18] This study used CBCT to evaluate the degenerative changes of the mandibular condyle.

Among the five types of changes, previous studies have reported flattening as the most prevalent alteration: 89.3%, 77.4%, and 82.5%.[19-22] Some other studies have reported sclerosis (30.2%) and osteophyte (30.2%) as the most prevalent changes.[23,24] The most frequent condylar bony change observed in our study was erosion (93.3%) (Figure 3). This may be because the prevalence of TMD

Table 2. Comparison of morphometric deviations between the case and control groups.

Linear measurements (mm)	Side	Mean (SD)		Mean difference	*P*-value
		Case	Control		
Anterior-posterior diameter	Right	6.28(1.18)	6.34 (0.84)	0.06	0.98
Anterior-posterior diameter	Left	6.51 (0.94)	6.49 (0.66)	0.02	0.92
Mesial-lateral diameter	Right	18.31 (1.81)	19.33 (1.95)	1.02	0.14
Mesial-lateral diameter	Left	18.71 (2.63)	18.93 (2.4)	0.22	0.95
Thickness of glenoid fossa	Right	1.22 (0.77)	1.02 (0.53)	0.20	0.40
Thickness of glenoid fossa	Left	1.24 (1.00)	1.09 (0.77)	0.15	1

varies significantly across geographic regions, influenced by factors such as gender, age, and sociodemographic variables.[25]

Contrastingly, degenerative joint disorder (DJD) exhibits several significant bony changes compared with controls. TMJ studies using CBCT have shown that osteoarthritic joints exhibit significantly more condylar irregularities, osteophytes, and condylar flattening than non-TMD joints.[26] Additionally, degenerative bony changes such as osteophytes, erosion, flattening, subchondral sclerosis, and pseudocysts were prevalent, with flattening being the most frequent change observed.[20] Similarly, the current study found that erosion ($P < 0.05$), osteophytes ($P < 0.05$), and cysts ($P < 0.05$) were more commonly observed in the case group compared to the control group (Table 2).

Besides, Shahidi et al[27] compared the incidence of TMJ alteration in patients with and without TMD-related complaints. Similarly, another study using CBCT found that 39.3% of TMJs in asymptomatic adults exhibited degenerative changes, including osteoarthritic alterations, despite no ongoing orofacial pain or TMJ complaints.[10] The osseous modifications were detected in 86.7% of joints in asymptomatic groups. Consistent with previous studies, our results also noted incidental osseous changes in the asymptomatic group, including erosion, flattening, and sclerosis. These bony changes in the asymptomatic group suggest that they do not always correlate directly with clinical symptoms. The presence of these changes in asymptomatic individuals highlights the complexity of TMD and the need for comprehensive clinical and radiographic evaluation to diagnose and manage the condition accurately.[28]

Table 3. Correlation of bony changes with age groups

	Age groups			
Bony types	**21-30 years**	**31-40 years**	**41-50 years**	**Correlation (r)**
Flattening	25%	50%	25%	0.40
Erosion	38.50%	30.80%	30.80%	0.24
Osteophyte	37.50%	37.50%	25%	0.09
Sclerosis	66.67%	16.70%	16.70%	0.45
Subcortical Cyst	37.50%	37.50%	25%	0.09

Furthermore, Ahmed *et al.* reported that the length and width of the mandibular condyle are greater in males than in females in a morphological assessment of healthy TMJ.[29] Other research indicates that condylar height is smaller in TMD patients than in non-TMD individuals. At the same time, the width and length of the condyle do not show significant differences between these groups.[30] Our results also showed that the dimensions of the condylar head were relatively similar between the two compared groups (Table 2).

In addition, the correlation between TMD and age or gender is well documented in the literature across different geographic regions, except in Bangladesh. Adolescent females have been reported to exhibit more symptoms related to TMD than other demographic groups. A cross-sectional study conducted in the Brazilian population revealed a higher prevalence of TMD among females (66%) and young individuals (85%).[31] Similarly, Azevedo *et al.* reported that degenerative bone changes occurred more frequently among women.[22] This finding was supported by Pontual *et al.*, who observed a high prevalence of degenerative bone alterations in TMJs, particularly in women, and noted that the prevalence increased with age.[32]

Similarly, our study also reported that females were more affected by a greater number of bony changes than males (Table 2). The higher prevalence in women can be attributed to the hormonal effects of estrogen and prolactin, which can worsen the deterioration of cartilage and joint bone in the TMJ, as well as trigger a cascade of immune reactions.[33] A study analysing CBCT images of patients aged 10 to 90 years found that older patients had more common findings of osteoarthritis, such as condylar and articular erosion, osteophytes, and joint space narrowing.[34] This observation is further supported by research indicating that bone changes are more prevalent in the elderly, with significant differences in the prevalence of condylar erosion, resorption, and osteophyte formation between older and younger age groups.[35] The current study suggested that bony changes of the condylar head are not affected by age. However, flattening may occur more in the 31-40-year age group, and sclerosis in the 21-

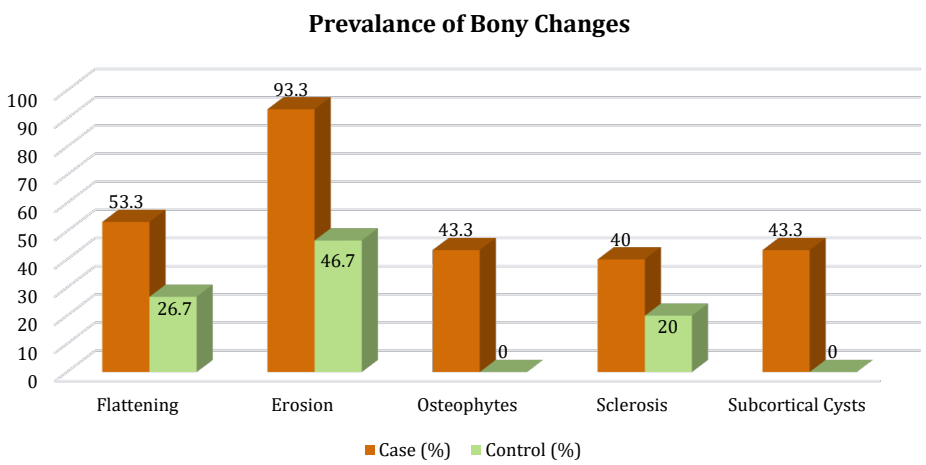

Figure 3. Clustered column chart showing the prevalence of bony changes in the study population

30-year age group.

This pilot study provides initial insight into degenerative changes in the condyles of the Bangladeshi population. However, several limitations should be considered. The small sample size and cross-sectional design may limit generalisability and preclude evaluation of disease progression over time. Because CBCT primarily assesses bony structures, soft-tissue components of the TMJ, such as the articular disc and inflammatory changes, cannot be evaluated, which may limit diagnostic interpretation. Future studies should include larger sample sizes and longitudinal follow-up to better understand the progression of TMJ degeneration. Combining CBCT with other imaging modalities, particularly MRI, may provide a more comprehensive assessment of osseous and soft-tissue changes. Further evaluation of additional parameters, including condylar volume, bone density, and age- and gender-related variations, may improve understanding of TMJ degeneration and support more informed clinical management.

Conclusion

The findings of this study indicate that degenerative condylar bony changes may occur independently of clinical symptoms and age in the Bangladeshi population, underscoring the importance of careful evaluation of all CBCT scans that include the TMJ. These results may assist Bangladeshi clinicians in refining diagnostic decision-making and treatment planning while promoting radiation safety through more judicious and indication-based use of CBCT imaging.

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Competing Interests

The authors have no financial or personal relationships that could inappropriately influence or bias the content of this paper.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical Approval

Ethical approval has been obtained from the ethical review board of Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh (No. – ShSMCH/Ethical/2023/008) and the Jawatankuasa Etika Penyelidikan Manusia Universiti Sains Malaysia (USM/JEPeM/KK/24080711).

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