A Single-Center Radiographic Study on Temporomandibular Joint Condylar Morphology in Eastern Nepal

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ABSTRACT

Introduction: The temporomandibular joint (TMJ) is a complex synovial joint critical for mastication, speech, and facial expression. Morphological variations of the mandibular condyle can influence joint function and susceptibility to disorders.

Methods: A cross-sectional study was conducted at the Department of Oral Medicine and Radiology, B.P. Koirala Institute of Health Sciences, Dharan, Nepal. A total of 441 panoramic radiographs of patients aged ≥18 years were analyzed. Condylar morphology was evaluated and recorded. Data were analyzed using Microsoft Excel 2023, and frequency distributions were calculated.

Results: The mean age was 40.31 years (177 males, 264 females). Round/oval condyles were the most common morphology (right: 297(67.3%); left: 295(66.9%)). Other variants included mixed (right: 54(12.2%); left: 32(7.3%)), bifid (right: 38(8.6%); left: 45(10.2%)), flat (right: 21(4.8%); left: 37(8.4%)), diamond (right: 22(5%); left: 23(5.2%)), crooked finger (right: 7(1.6%); left: 8(1.8%)), bulbous (1(0.2%) both sides), and condyle-in-condyle (1(0.2%) right side). Minor asymmetries were noted between sides.

Conclusion: Round/oval condyles predominate in this Nepalese population, while rare variants and asymmetries exist. Awareness of these variations is crucial for accurate diagnosis, treatment planning, and management of TMJ disorders.

Keywords: Condylar Morphology; Nepal; Panoramic Radiography; Temporomandibular Joint; TMJ Variants

INTRODUCTION

The temporomandibular joint (TMJ) is one of the most complex synovial joints in the human body, playing a crucial role in mastication, speech, and facial expression.[1] It is formed by the articulation between the mandibular condyle and the temporal bone, permitting both rotational and translational movements.[2] This unique combination of hinge and gliding actions enables a wide range of mandibular movements necessary for functional activities. The mandibular condyle serves as an important growth center and undergoes continuous remodeling throughout life in response to functional demands.[3]

Morphological variations of the condyle are well documented, with commonly observed shapes including round, oval, flat, angled, and irregular forms.[4] These variations are influenced by multiple factors such as age, sex, occlusal forces, and functional loading.[3,5] Additionally, environmental influences and parafunctional habits may further contribute to adaptive changes in condylar morphology. Furthermore, craniofacial skeletal patterns have also been shown to contribute to differences in condylar morphology.[6]

Conflict of Interest: None

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Alterations in condylar morphology hold clinical significance, as they may be associated with temporomandibular disorders, degenerative joint diseases, and developmental anomalies.[7,8] Such changes may affect joint function and can lead to symptoms including pain, restricted movement, and joint sounds. Although rare, bifid mandibular condyle has been reported in association with TMJ dysfunction.[9]

Radiographic evaluation plays a vital role in the assessment of condylar morphology. Panoramic radiography is widely utilized due to its accessibility and cost-effectiveness, whereas cone-beam computed tomography (CBCT) provides a more accurate three-dimensional evaluation.[10]

In Nepal, there is a paucity of studies investigating condylar morphology.[5,11] Therefore, the present study aimed to evaluate the morphological variations of the mandibular condyle in patients visiting a tertiary care center in eastern Nepal.

METHODS

This cross-sectional study was conducted in the Department of Oral Medicine and Radiology, College of Dental Surgery, B.P. Koirala Institute of Health Sciences (BPKIHS), Dharan, Nepal. Panoramic radiographs (Orthopantomogram, OPG) of patients visiting the department, and in whom OPG was indicated were analyzed. Radiographs were taken from the panoramic machine Rayscan alpha. Ethical approval was taken from institutional review committee, BPKIHS, Dharan (IRC/3008/025).

All patients, without the exclusion criteria, undergoing OPG examination during the study period were included. A convenience sampling technique was used, with a total of 441 patients included. The sample size was calculated using the formula: $N = (Z^2PQ) / L^2$, where $Z = 2.58$ at a 99% confidence level, $P = 79$,[1] $Q = 100 - P$, and $L = 5$.

Patients with age $\geq$ 18 years and panoramic radiograph of patients showing complete mandibular view on either side with optimal density and contrast without any image distortion, projection errors were included in the study

Radiographs having any of the following characters were excluded, any pathology (osteomyelitis, osteoporosis, etc.) in the maxilla or mandible or revealing any sign of fracture in the mandible, developmental anomalies of the jaws, syndrome of cranio-facial structures. Radiographs with or patient giving history of plating for fractures or orthognathic surgeries were also excluded. If presence of odontogenic cysts or tumors of the jaws were present then the cases were excluded. Complete denture wearer and patients with edentulous dental arches and patients with temporomandibular joint disorders (TMD) or para-functional habits related to TMD were also excluded.

Eligible radiographs were assessed for inclusion/exclusion criteria. Written informed consent was obtained from the patient, and a pro-forma was used to record demographic details and condylar morphology, classified according to Gupta et al.[1] Single investigator performed all the evaluations. Data were entered in Microsoft Excel version 2023 and analysis was done. Frequencies and percentages were calculated.

RESULTS

A total of 441 participants were included, comprising 177 males (40.1%) and 264 females (59.9%), with a mean age of 40.31 years. A total of 882 condyles were evaluated. On the right side, the most common condylar morphology was round to oval, observed in 297 cases (67.3%). This was followed by mixed morphology in 54 cases (12.2%) and bifid condyles in 38 cases (8.6%). Diamond-shaped condyles were seen in 22 cases (5.0%), while flat condyles were observed in 21 cases (4.8%). Less frequent variants included crooked finger morphology in 7 cases (1.6%), and rare forms such as bulbous and condyle-in-condyle morphology, each were seen in 1 case (0.2%) (Table 1).

On the left side, round to oval morphology was again the most prevalent, seen in 295 cases (66.9%). Bifid condyles were observed in 45 cases (10.2%), followed by flat morphology in 37 cases (8.4%) and mixed morphology in 32 cases (7.3%). Diamond-shaped condyles were present in 23 cases (5.2%), while crooked finger morphology was observed in 8 cases (1.8%). Bulbous morphology was noted in 1 case (0.2%) (Table 1).

Overall, round to oval morphology predominated on both sides. Minor asymmetry between right and left condyles was observed, particularly in bifid, flat, and mixed categories. Rare morphological variants were infrequent. The morphological types which were found in the population sample have been represented in Figure 1 (A–H).

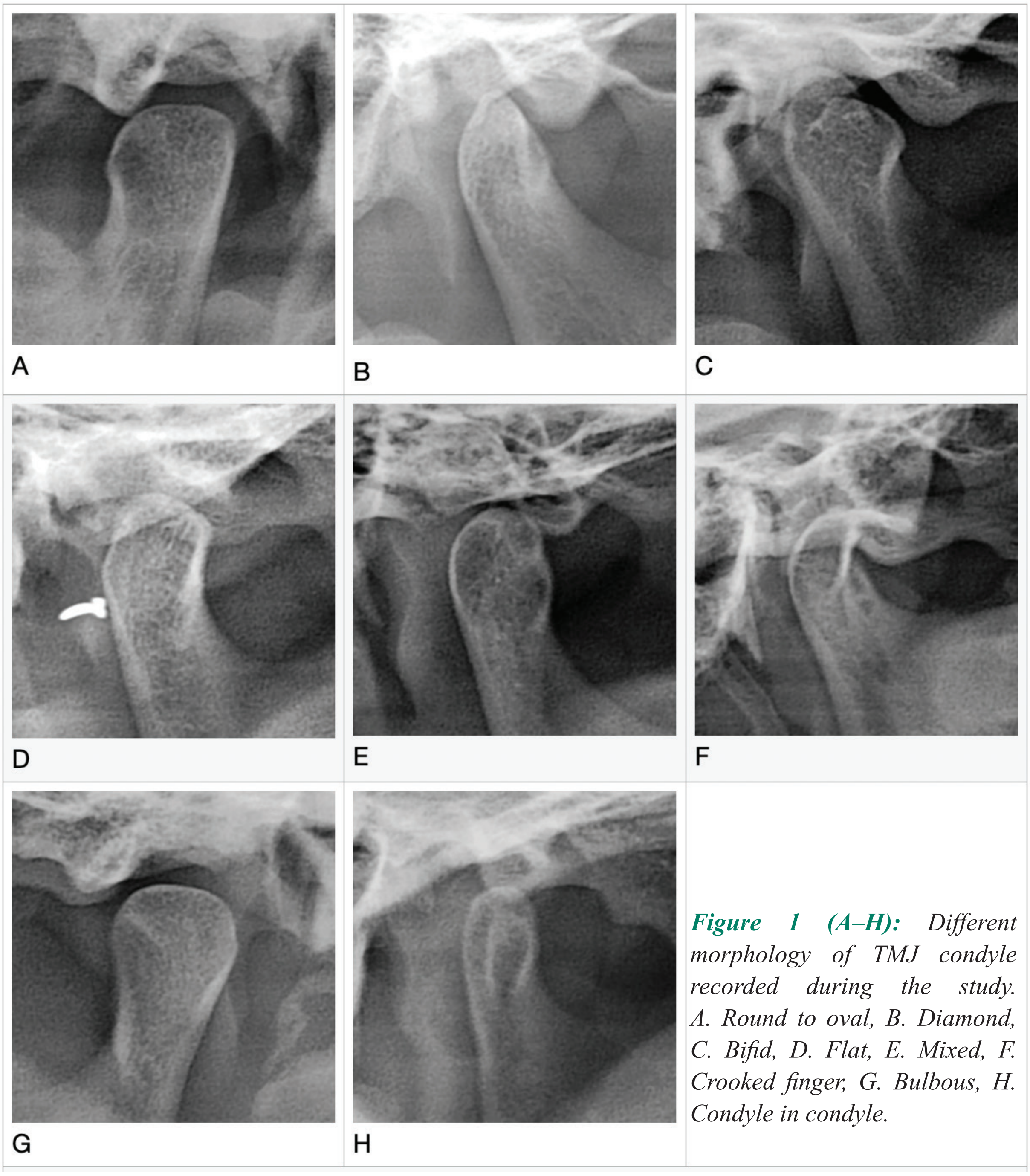

Figure 1 (A–H): *Different morphology of TMJ condyle recorded during the study. A. Round to oval, B. Diamond, C. Bifid, D. Flat, E. Mixed, F. Crooked finger, G. Bulbous, H. Condyle in condyle.*

Table 1: Distribution of condylar morphology in the right and the left side of the patients

Condylar Morphology	Right N (%)	Left N (%)
Round to oval	297 (67.34%)	295 (66.89%)
Diamond	22 (4.98%)	23 (5.21%)
Bifid	38 (8.61%)	45 (10.20%)
Flat	21 (4.76%)	37 (8.39%)
Mixed	54 (12.24%)	32 (7.25%)
Crooked finger	7 (1.58%)	8 (1.81%)
Bulbous	1 (0.22%)	1 (0.22%)
Condyle in condyle	1 (0.22%)	0 (0%)
Total	441 (100 %)	441 (100 %)

DISCUSSION

The present study demonstrated that round to oval condyles were the predominant morphology in this Nepalese population, accounting for approximately two-thirds of cases on both sides. This finding is consistent with previous radiographic and CBCT-based studies, which have reported round or oval condyles as the most common morphological type across different populations.[1,3,11] The predominance of this morphology suggests that it represents a biomechanically stable configuration of the mandibular condyle, capable of adapting to normal functional loading during mastication and other mandibular movements.

The prevalence of bifid condyles observed in this study (8.6% on the right and 10.2% on the left) was higher than that reported in global literature, where it is generally considered a rare anatomical variation. [9,12] This discrepancy may be attributed to differences in imaging techniques and diagnostic criteria. Panoramic radiography may identify subtle variations that are interpreted as bifid structures, whereas CBCT-based studies apply more stringent criteria. Clinically, bifid condyles are often asymptomatic but may occasionally be associated with temporomandibular joint dysfunction, including pain, joint sounds, or restricted movement. [9] Therefore, careful clinical correlation is essential.

Mixed morphology was also frequently observed and likely represents adaptive remodeling of the condyle in response to functional stress and occlusal forces. The mandibular condyle undergoes continuous remodeling throughout life, influenced by masticatory function and occlusal load.[3,13] Flattened condyles observed in this study may also reflect such adaptive changes rather than pathological degeneration, particularly in asymptomatic individuals.

Less common morphologies, including diamond and crooked finger shapes, were observed in smaller proportions and are considered normal anatomical variants.

Rare forms such as bulbous and condyle-in-condyle morphology were infrequent and may require advanced imaging for further evaluation. The available current literature does not discuss about these rare forms of condyle. These two forms are the new names given to the morphological types based on their appearance in the radiographs (Figure 1, G and H).

The presence of minor asymmetry between right and left condyles may be attributed to unilateral chewing habits, occlusal imbalance, or functional differences. [6] This highlights the importance of evaluating both condyles independently during radiographic interpretation.

From a clinical perspective, understanding condylar morphology is essential for accurate diagnosis and treatment planning in dentistry. Variations in condylar shape may influence joint biomechanics and affect orthodontic, prosthodontic, and surgical outcomes. [10] Furthermore, awareness of normal variations helps prevent over-diagnosis of temporomandibular disorders based solely on radiographic findings.

A few potential biases were identified in the study, including observer bias and sampling bias. Overall, this study provides important baseline data on condylar morphology in a group of Nepalese population from eastern region of Nepal and contributes to the understanding of anatomical variations relevant to clinical practice.

CONCLUSION

Round to oval condylar morphology of TMJ condyle is the most prevalent form in this Nepalese population. Variations observed are largely anatomical and should be interpreted cautiously in clinical practice. Awareness of these variations is essential for accurate diagnosis and management of temporomandibular joint conditions.

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