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IP International Journal of Maxillofacial Imaging

Journal homepage: https://www.ijmi.in/

Original Research Article

Radiological study of curvature of mandibular condyle at tertiary level hospital

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ARTICLE INFO

Article history:
Received 08-11-2024
Accepted 29-11-2024
Available online 12-12-2024

Keywords:
Tempromandibular joint
Mandibular Condyle
OPG

ABSTRACT

Background: Temperomandibular joint is the articulation between the condyle of the mandible and the squamous portion of the temporal bone. It is the most important and complex part of the body and masticatory system. The mandibular condyle plays a crucial role as an anatomical reference point for facial growth, exhibiting an upward and backward orientation. The configuration of the mandibular condyle varies significantly across age groups and among individuals. These morphological differences are influenced by developmental variations and undergo condylar remodeling to adapt to conditions such as malocclusion, trauma, and other pathological and developmental abnormalities.

Aim & Objective: To evaluate the morphological variations in mandibular condylar shapes using panoramic radiographs in the Indian population across different age and gender groups. 1. To classify and analyze the different shapes of mandibular condyles (oval, bird beak, diamond, and crooked finger) observed in orthopantomograms (OPGs). 2. To examine the prevalence of these morphological variations based on age groups (18–35, 36–55, and 56+ years). 3. To assess the gender-based distribution of condylar morphological types. 4. To contribute to the understanding of condylar morphological characteristics specific to the Indian population for better clinical and diagnostic reference.

Materials and Methods: The sample comprised 125 females and 125 males. The participants were categorized into three age groups: Group 1: Young Age(18-35 years), Group 2: Middle Age(36–55 years), and Group 3: Older Age(56 years or above). A total of 250 OPGs were meticulously reviewed to determine condylar morphology.

Results: Most common shape condyle found in this study was bird beak followed by oval. Least common condyle shape was crooked finger followed by diamond.

Conclusion: In conclusion, this study unveiled a spectrum of condylar morphologies within the Indian population, with bird beak, oval, diamond, and crooked finger types identified. Notably, the oval condylar shape emerged as the most prevalent among both genders and across all age groups.

1. Introduction

The temporomandibular joint is a unique complex joint which executes both hinge and sliding movements. It is also called as the ginglymoarthroidal type of joint. It is formed by the mandibular fossa (glenoid fossa), the inferior surface of the temporal bone and the condylar process of the mandible.[1] This masticatory apparatus is a specialized unit that performs multiple functions, including those of suckling, cutting and grinding food, swallowing, and communication.

The TMJs constitute two separate joints anatomically, they function together as a single unit. Each condyle articulates with the mandibular fossa of the temporal bone.[2]

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https://doi.org/10.18231/j.ijmi.2024.036

A disk composed of fibrocartilage is interposed between the condyle and mandibular fossa. A fibrous capsule lined with a synovial membrane surrounds and encloses the joint. Ligaments and muscles restrict or allow movement of the condyle.[3–5]

The mandibular condyle constitutes the mandibular element of the temporomandibular joint (TMJ). This bony ellipsoid process emerges superiorly from the mandibular ramus through a slender neck. Measuring approximately 20 mm in mediolateral width and 8 to 10 mm anteroposteriorly, the condyle showcases considerable variation in its shape. The superior surface may exhibit flat, round, or markedly convex profiles, while the mediolateral contour typically presents a mild convexity.[6–8] These morphological variations in condylar shape can pose challenges in radiographic interpretation, underscoring the critical importance of comprehending the spectrum of normal appearances for accurate clinical assessments.[2,9–11]

Anatomical variations in condylar shape, size, and positioning, are influenced by factors like gender, age, genetics and developmental processes. Additionally, the condyle undergoes adaptive changes in response to external factors such as trauma, malocclusion, and various pathological conditions. Understanding the shape and structure of the condyle is key because problems with the temporomandibular joint (TMD) often show up as jaw pain, clicking sounds, or difficulty moving the jaw. Recognising these signs can help manage and treat the condition effectively.[11]

While some studies have explored the correlation between joint characteristics and facial morphology,[12,13] available data are limited, with most investigations concentrating primarily on the condyle's position in the mandibular fossa, neglecting its morphology. In 1961, Yale et al. pioneered the documentation of various shapes of the mandibular condyle. Initially, Yale classified the condylar head into three categories based on a superior view: concave, convex, and flat. However, he later streamlined the classification into four categories: convex, flattened, angled, and rounded.[14]

Various imaging techniques are employed for temporomandibular joint (TMJ) imaging, with panoramic radiographs serving as the primary screening modality for the detection of TMJ abnormalities. This routine imaging modality, widely prescribed by dentists,[15] offers valuable insights into the anatomical variations of the maxilla and mandible, as well as potential osseous changes or flattening that may occur over time within the TMJ structures. The extensive use of panoramic radiography is justified by its established cost-benefit relationship, and it presents a relatively lower radiation exposure dose compared to computed tomography.[6,16] Additionally, the American Academy of Oral and Maxillofacial Radiology recommends the routine use of panoramic views for the comprehensive assessment of the structural components of the temporomandibular joint (TMJ).[17]

The majority of studies focusing on the morphological assessment of the temporomandibular joint (TMJ) have been carried out on international populations and often lack comprehensive inclusion of all morphometric measurements of the condylar head. There is a notable scarcity of research specifically conducted on the Indian population. Given these circumstances, our current study is dedicated to the morphological evaluation of the TMJ in the Indian population.

2. Materials & Methods

This cross-sectional study was conducted between November 2023 and February 2024 at Ziauddin Ahmad Dental College Aligarh, involving the radiographic evaluation of 250 orthopantomograms (OPGs) from a diverse group of individuals.

No ethical certificate is needed as the study on radiograph of taken for the patient for their diagnosis & treatment. However consent had been taken for study.

2.1. Inclusion criteria

OPGs of participants aged 18 to 80 years, with a complete and clear view of both condyles, showing optimal density and contrast, and free from projection errors, were included.

2.2. Exclusion criteria

1. OPGs of individuals with a recorded history of temporomandibular joint (TMJ) dysfunction or disorders.
2. OPGs showing clear evidence of pathological or developmental abnormalities in the TMJ region.
3. OPGs with poor imaging quality, including incomplete views of the condyles, suboptimal density or contrast, or projection errors.
4. OPGs lacking sufficient clinical information or documentation to verify participant eligibility.

The sample comprised 125 females and 125 males, The participants were categorized into three age groups: Group 1: Young Age (18-35 years), Group 2: Middle Age(36–55 years), and Group 3: Older Age(56 years or above).

The OPGs were acquired using Villa Rotograph EVO 3D with exposure parameters set at 10 mA and 82 kV, ensuring optimal imaging quality free of projection errors.

A total of 250 OPGs were meticulously reviewed for routine investigation by the maxillofacial radiologist to determine condylar morphology. The participants were stratified into the specified age groups, and descriptive statistics were employed to estimate the frequency of normal morphological variations of the condyles. Furthermore, the chi-square test was applied to evaluate differences in the

frequency of normal condylar morphological variations concerning both age and gender. The statistical analysis was executed using SPSS version 23, ensuring a comprehensive examination of the morphological variations within the TMJ across different demographic categories.

3. Results

The study examined 500 condyles extracted from 250 orthopantomograms (OPGs) to explore condylar morphological variations across different age groups and genders. The participants were categorized into three age groups: Group 1: Young Age (18-35 years), Group 2: Middle Age (36–55 years), and Group 3: Older Age(56 years or above).

Middle-aged subjects comprised the maximum participants, followed by older age and young age individuals. The gender distribution was evenly divided, with 50% of radiographs belonging to females and the remaining 50% to males. (Table 1)

Condylar morphological variations were classified into four types: bird beak, oval, diamond, and crooked finger. The most prevalent condylar morphology identified was oval, constituting 50% of the cases. Following oval, bird beak, diamond, and crooked finger morphologies were observed, with percentages of 40%, 4.8%, and 4.8%, respectively. Males exhibited a higher frequency of oval condylar morphology (57.6%) compared to females (42.4%).(Table 2)

Across all age groups, oval condylar morphology remained the most prevalent, with frequencies of 36%, 44%, and 20% in age groups 1, 2, and 3, respectively. Analysis of condylar morphological types concerning gender revealed no significant difference (Chi Square = 0.41, $p = 0.94$). Specifically, among male participants, oval condylar morphology did not significantly differ from other morphologies ($p > 0.05$), while among females, the prevalence of diamond condylar morphology was not significantly higher ($p > 0.05$).(Table 3)

Further analysis comparing condylar morphological types with age groups revealed distinct patterns. In age group 1, the frequency of diamond condyles was not significantly lower compared to other age groups ($p > 0.05$). However, in age group 2, the frequency of crooked finger condyles was significantly higher ($p = 0.002$) compared to other age groups. Among participants in age group 3, bird beak condyles were significantly lower ($p = 0.001$) compared to other age groups, while diamond condylar morphology was significantly higher ($p = 0.0001$) compared to other age groups (Table 3). Oval condylar shape was most commonly found in middle age group while bird peak was revealed more in younger age group. No significant difference was found among different age groups w.r.t. shape of condyle. These findings provide valuable insights into the prevalence of different condylar morphologies, emphasizing gender and age-related variations.

4. Discussion

The temporomandibular joint (TMJ) is an important component of the masticatory system, with the mandibular condyle playing a central role in its functionality and anatomical reference.[12]

Morphological variations in the mandibular condyle, including shape, size, and positioning, are influenced by factors such as gender, age, genetics, and developmental processes. The condyle undergoes adaptive changes in response to external factors like trauma, malocclusion, and pathological conditions. Understanding the anatomy and morphology of the condyle is crucial as deviations can lead to temporomandibular disorders (TMD), presenting symptoms ranging from jaw pain to limitations in jaw movement.[18]

This study primarily focuses on the morphological evaluation of the condyle. However, it is important to acknowledge that factors such as a history of trauma, infections, TMJ-related diseases (e.g., rheumatoid arthritis, osteoarthritis), or prior surgeries may influence changes in condylar morphology, and such data, if available, will be considered for contextual understanding.

The choice of imaging techniques for TMJ evaluation is critical, and in our study, panoramic radiographs emerge as the primary screening modality.[19] Panoramic radiography, widely prescribed by dentists, offers valuable insights into the anatomical variations of the maxilla and mandible. It also provides information on potential osseous changes or flattening within the TMJ structures. The utilization of panoramic radiography is justified by its cost-effectiveness, established cost-benefit relationship, and lower radiation exposure compared to computed tomography.[7,15,19,20]

Our study's findings, with oval condyles in 50% of cases, followed by bird beak (40%), diamond (4.8%), and crooked finger (4.8%), are consistent with Shaikh et al. (2022),[8] who also identified oval as the most common morphology, followed by bird beak. This supports the prevalence of these shapes across different populations. We found round/oval shape to be the highest prevalence (50%) in our population which was similarly high in studies done by Sonal et al. (60%),[15] Anisuzzaman et al. (60%),[21] Shaikh et al. (50%),[8] In our study, males exhibited a higher frequency of oval condylar morphology compared to females, which contrasts with Gupta et al. (2022), who found no significant difference in condylar shapes between males and females. This highlights the need for further research to explore regional and demographic variations in TMJ morphology.[20]

The findings of this study, which reveal significant age-related changes in condylar morphology, align with previous research that highlights the dynamic remodelling of the mandibular condyle over time. Studies by Shaikh et al. (2022)[8] and Ashwinirani (2018)[7] also demonstrate that

Table 1: Subject distribution according to age and gender

Gender	Group 1 (Young Age)	Group 2 (Middle Age)	Group 3 (Older Age)	Total
Male	30	70	35	125
Female	28	90	57	125
Chi Square		2.71		
p value		0.26		

Table 2: Shape of condyle in OPG according to gender

Gender	Bird Beak	Diamond	Crooked Finger	Oval
Male	56	10	15	44
Female	54	12	13	46
Chi Square		0.41		
p value		0.94		

Table 3: Shape of condyle in OPG according to age

Age Group	Bird Beak	Diamond	Crooked Finger	Oval
Group 1	25	7	6	20
Group 2	60	18	12	65
Group 3	35	8	4	25
Chi Square		3.13		
p value		0.79		

older individuals exhibit a higher frequency of diamond-shaped condyles, while younger populations tend to have more oval shapes. This supports the observed trend in our study, where oval condyles predominated across age groups, with distinct age-specific patterns, such as a higher frequency of crooked finger condyles in middle-aged individuals and diamond-shaped condyles in older adult.

Despite the importance of condylar morphology, research often focuses on the position within the mandibular fossa, neglecting detailed morphometric measurements.[2] Our study addresses this gap by conducting a comprehensive morphological evaluation of the TMJ, specifically the condylar head. Importantly, this investigation is dedicated to the Indian population, filling a notable void in the existing literature.

This study's limitations include a small sample size, reliance on panoramic radiographs (OPGs) with limited detail compared to advanced imaging modalities such as CBCT and CT potential biases from the retrospective design. Excluding individuals with pathologies may have overlooked certain variations, and the findings may not be fully generalizable outside the study's region. Further research with a larger, more diverse sample and advanced imaging is needed.

5. Conclusion

In conclusion, this study unveiled a spectrum of condylar morphologies within the Indian population, with bird beak, oval, diamond, and crooked finger types identified. Notably, the oval condylar shape emerged as the most prevalent among both genders and across all age groups. The insights gained from this research contribute to our understanding of the morphological variations in the temporomandibular joint (TMJ) among Indians. Future investigations incorporating additional parameters and a larger sample size hold the potential to uncover further information, enriching our knowledge of TMJ morphology and its implications.

6. Source of Funding

None.

7. Conflict of Interest

None.

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Cite this article: Asdullah M, Shadiya C, Yadav P. Radiological study of curvature of mandibular condyle at tertiary level hospital. *IP Int J Maxillofac Imaging* 2024;10(4):175-179.