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Assessment of Morphological Variation of the Mandibular Condylar Process, Coronoid Process, and Sigmoid Notch in Temporomandibular Joints of Adult Population Using Digital Orthopantomogram Based on Age and Gender –A Cross-sectional Study

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Abstract

Introduction: Orthopantomogram, a form of radiography that uses X-ray technology and is used in the diagnosis and treatment planning in various fields of dentistry, has been found to be less expensive than other advanced imaging modalities such as computed tomography or magnetic resonance imaging. **Objective:** The aim of the study was to evaluate the shape of mandibular condylar process, coronoid process, and sigmoid notch in various age groups and among the gender. **Methods:** A study was conducted using 150 digital orthopantomograms of patients. The different shapes of condylar process, coronoid process, and sigmoid notch were traced in computer using Galileos software. Statistical analysis was performed on the data obtained. A Chi-square test was performed to evaluate the *P*-value which was ascertained to be significant if <0.05. **Results:** The condylar shapes commonly observed among males and females were round, coronoid process shapes were triangular in shape and round, and sigmoid notches were wide. These variations in condylar process, coronoid process, and sigmoid notch are most commonly seen in the age group of 20–30 years. When compared between gender-wise and age-wise, there were no statistical significance differences found with these variations. **Conclusion:** In the present study, morphological variation in the shape of the condylar process, coronoid process, and sigmoid notch was observed among the adult population. Knowing these variations can help detect gender, age, and diagnoses of pathologies.

Keywords: Condylar process, Coronoid process, Sigmoid notch

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Introduction

The human mandible, the largest and strongest bone in the face, consists of two rami that run from side to side and bear the coronoid process and condyle. The coronoid process is a flat triangular plate projecting upward and slightly forward; whereas, the condyle is a rounded projection that articulates with the glenoid fossa of the temporal bone.[1] The mandibular condyle of an individual may vary greatly in appearance, depending on the person's age, sex, and other factors. Morphologic changes may also be caused by developmental variability or malocclusion, trauma, and other causes.[2] The mandible has a thin and triangular process that projects upward and slightly forward. It has a top border and is concave in shape, while its lower part is convex in shape. The margins and medial surface give attachments to the temporalis muscle.[3] Sigmoid notch is the deep notch between the coronoid and the condylar process. The shape of the notch depends on the shape of these processes.[4] The condyle, coronoid process, and sigmoid notch are all important structures. They provide the expression of mandibular growth in relation to each other and with age, gender, facial type, occlusal force, and functional load. Degenerative changes in TMJ lead to morphologic changes of elderly persons. Studies in the past demonstrated that even the coronoid process and sigmoid notch varies in shape in different individuals. In panoramic images, different shapes of these structures can often be appreciated; this radiographic data when available as ante mortem records and correlated with the post-mortem records can thereby aid in the identification of a person either living or dead.

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Materials and Methods

Study Design

This is a cross-sectional study.

Study Area

The study were conducted in the Department of Oral Medicine and Radiology in our dental institution located in the city of Maharashtra.

Methods

This cross-sectional and orthopantomogram (OPG) study was conducted in the department of oral medicine and radiology after obtaining the approval from institutional ethical committee. The patients were explained about the objectives of the study and informed consent was obtained before enrolling them in the study. Digital OPG radiograph of patients who required radiographs of diagnostic purposes was included in study. OPG radiograph of patient with history of temporomandibular joint (TMJ) pain, arthritis, history of trauma in TMJ region, patient with systemic diseases such as rheumatoid arthritis, psoriasis OPG radiograph showing fracture of condylar process or coronoid process was excluded from study. All OPGs were captured using SIDEXIS Version 1.9.4497.23802(ID7) software. (a) Model designation: ORTHOPHOS XG 3D/CEPH, (b) Nominal voltage: 200v–240v, (c) Rated current: 12 mA, (d) Tube voltage: 77 kVp, and (e) Tube current: 14 mA (at 16 mA max. 66kV).

A single observer analyzed the OPG and traced in the condylar region, condylar region, and sigmoid notch region. The various shapes of condylar process and sigmoid notch were interpreted as given by Hegde *et al*.[2] and Shakya *et al*.[4] [Figures 1-4]. The data obtained were tabulated and subjected to statistical analysis.

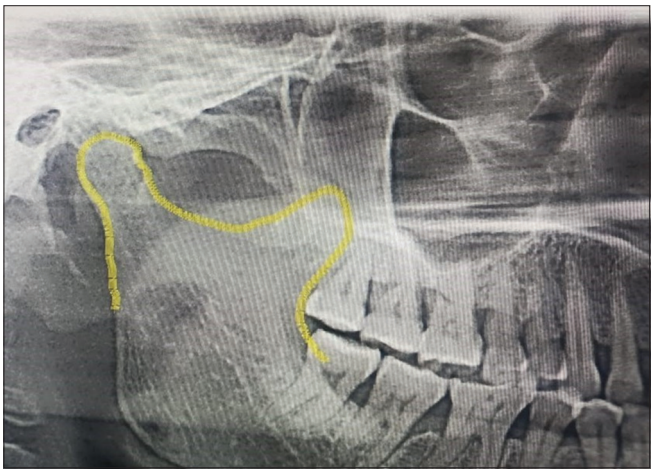

Figure 1: Orthopantomogram showing round condylar process

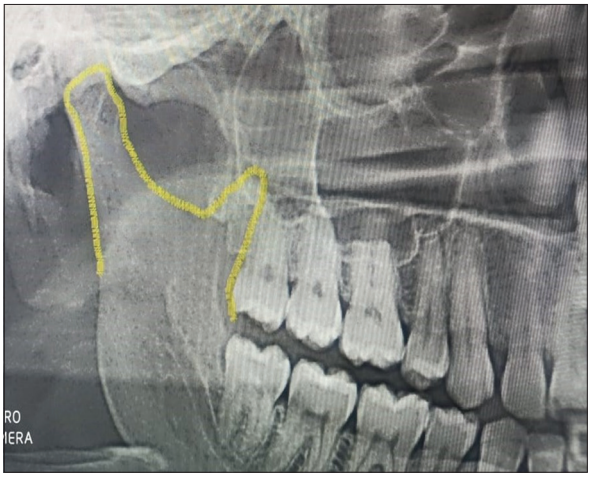

Figure 2: Orthopantomogram showing triangular coronoid process

Results

Total 150 OPGs were obtained, 81 of which were male and 69 female. The most common shape observed in the OPGs of condylar process was round, out of which 32 were male and 24 female. The second most common shape was angled, out of which 23 were in males and 22 female. The distribution between males and females did not show any statistical significance differences between the two groups [Table 1]. The most common shape of the sigmoid notch was a wide form out of which 34 were present in males and 26 were there in females. The second most common shape of sigmoid notch was a sloping form out of which 29 were in males and 21 were in females followed by a round form out of which 18 were in males and 22 in females. There were no significant differences found between the sigmoid notch between males and females [Table 2].

About 99% of the coronoid shapes observed were triangular, with 55 occurring in males and 44 occurring in females. The second most common shape was round, accounting for 45 cases with 25 occurring in males and 20 occurring in females. Flatness was least common type that accounted for only five occurrences in females and one occurrence in males. The most common type in

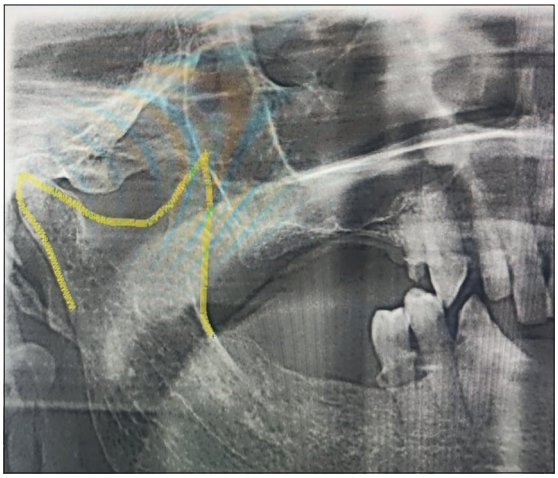

Figure 3: Orthopantomogram showing wide sigmoid notch

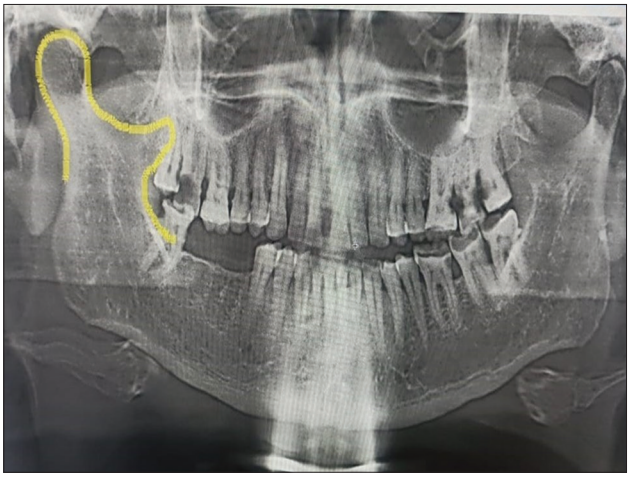

Figure 4: Orthopantomogram showing round condylar process with wide sigmoid notch

Table 1: Comparison of gender-wise distribution of condylar process

Gender	*Round (n=56) (%)*	*Angled (n=45) (%)*	*Convex (n=34) (%)*	*Flat (n=15) (%)*
Male (*n*=81)	32 (39.5)	23 (28.4)	18 (22.2)	8 (9.9)
Female (*n*=69)	24 (34.8)	22 (31.9)	16 (23.2)	7 (10.1)
Total (*n*=150)	Chi-square test=1.371, *P*=0.417 (no statistical significant difference)			

Table 2: Comparison of gender-wise distribution of sigmoid notch

Gender	*Wide (n=60) (%)*	*Sloping (n=50) (%)*	*Round (n=40) (%)*
Male (*n*=81)	34 (41.2)	29 (35.8)	18 (22)
Female (*n*=69)	26 (37.7)	21 (30.4)	22 (31.9)
Total (*n*=150)	Chi-square test=2.692, *P*=0.285 (no statistical significant difference)		

Table 3: Comparison of gender-wise distribution of coronoid process

Gender	*Triangular (n=99) (%)*	*Round (n=45) (%)*	*Flat (n=6) (%)*
Male (*n*=81)	55 (67.9)	25 (30.9)	1 (1.2)
Female (*n*=69)	44 (63.8)	20 (29)	5 (6.2)
Total (*n*=150)	Chi-square test=1.982, *P*=0.342 (no statistical significant difference)		

Table 4 : Comparison of age-wise distribution of condylar process

Age	*Round (n=56) (%)*	*Angled (n=45) (%)*	*Convex (n=34) (%)*	*Flat (n=15) (%)*
20–30 years (*n*=49)	17 (34.7)	15 (30.6)	11 (22.5)	6 (11.2)
31–40 years (*n*=43)	17 (39.5)	12 (27.9)	9 (20.9)	5 (11.7)
41–50 years (*n*=34)	13 (38.2)	9 (26.5)	9 (26.5)	3 (8.8)
51–60 years (*n*=24)	9 (37.5)	9 (37.5)	5 (20.9)	1 (4.1)
Total (*n*=150)	Chi-square test=3.867, *P*=0.178 (no statistical significant difference)			

Table 5: Comparison of age-wise distribution of sigmoid notch

Age	*Wide (n=60) (%)*	*Sloping (n=50) (%)*	*Round (n=40) (%)*
20–30 years (*n*=49)	20 (40.8)	16 (32.6)	13 (26.6)
31–40 years (*n*=43)	17 (39.5)	14 (32.5)	12 (28)
41–50 years (*n*=34)	13 (38.2)	11 (32.4)	10 (29.4)
51–60 years (*n*=24)	10 (41.6)	9 (37.5)	5 (20.9)
Total (*n*=150)	Chi-square test=4.712, *P*=0.092 (no statistical significant difference)		

Table 6: Comparison of age-wise distribution of coronoid process

Age	*Triangular (n=99)*	*Round (n=45)*	*Flat (n=6)*
20–30 years (*n*=49)	32 (65.3)	14 (28.5)	3 (6.2)
31–40 years (*n*=43)	29 (67.5)	12 (27.9)	2 (4.6)
41–50 years (*n*=34)	23 (67.6)	10 (29.5)	1 (2.9)
51–60 years (*n*=24)	15 (62.5)	9 (37.5)	0 (0)
Total (*n*=150)	Chi-square test=1.602, *P*=0.571 (no statistical significant difference)		

both genders was triangular. The distributions of coronoid shapes among males and females showed no statistical significance [Table 3]. The most common shape observed in the OPGs of condylar processes was round, in the age group of 20–30 years and 31–40 years. The second most common shape was angled, the distribution between various age groups did not show any statistical significance differences [Table 4]. The most common shape observed in the OPGs of sigmoid notch was round, with a prevalence of round in the age group of 20–30 years following sloping and round, respectively. There were statistical differences between various age groups [Table 5]. The most common shape observed in the OPGs of coronoid process was triangular, in the age group of 20–30 years following round and flat, respectively. There were no statistical differences between various age groups [Table 6].

Discussion

The mandibular condyle is a bony structure that connects the ramus of the mandible to the body of the mandible. The condyle is approximately 20 mm long mediolaterally and 8–10 mm thick anteroposteriorly. Variations in size and shape may be physiological or pathological. It has several variants: Flattened, rounded, or convex; superior aspect flat; mediolateral aspect convex; and sigmoid notch (enlarged space between condyle and body of mandible). Several studies have evaluated the morphology of this joint.[5] The coronoid process, coronoid meaning "crow," has been described as one of the bony processes of the ramus of the mandible (Field *et al*., 1947).[6]

In 1961, Yale *et al*. were the first to report about the different shapes of mandibular condyles. Initially, he classified condylar heads based on superior view into three categories — concave (rounded), convex (sharp-edged), and flat (more rounded) — but later simplified it into four categories: Convex, flattened, angled, and rounded.[7] A study published in 1980 on mandibular condyle morphology in relation to malocclusion in children found that male subjects had a larger condyle than female subjects, and midline discrepancies significantly altered the increase in condylar size during growth.[8]

In an earlier study, Sahithi *et al*. reported that the wide form of the sigmoid notch was commonly observed followed by the sloping form and the least common form was round. In a later study, they reported that the most common form was wide followed by round and sloping forms.[5] We reported that most common shape of coronoid process is triangular while round shape is least common, which is very much similar to findings of Prajapati *et al*.[3]

Triangular shape was also more common in both male and female. Similar findings were reported by Kadam *et al*.[9] The authors found 105 cases in males and 99 cases in females, among 204 total cases of triangular coronoid process. They found an even distribution of hook – like features between both sexes, with 34 cases in males and 32 cases in females. The anatomic variations in the shape of the coronoid process may narrow the vestibular space because of the close proximity of the medial aspect of the coronoid process to the distal molar teeth. This may cause impingement, which can restrict mouth opening and mandibular hypomobility.[10]

Nagaraj *et al*. conducted a study to assess the morphological types of condylar process and sigmoid notch in North Bengaluru population, using panoramic radiographs. The results showed that the sloping form was most common type followed by wide and round forms.[11] A study conducted by Shakya *et al*. found that higher prevalence was found in sloping form, followed by round form and wide form.[4]

However, in our study, the variation of sigmoid notch when compared among both the gender was not statistically significant which were similar to Nagaraj *et al*. and Shakya *et al*. studies.[4,11] In our study, the most common shape of condyle was round followed

by angled, convex, and flat shapes. This is in accordance with Nagaraj *et al.* study.[11]

Among genders, the most common type in males was angled type and in females, it was round type. These findings were consistent with Sahithi's *et al*. study.[5] The studies reported by Ribeiro *et al*.[12] and Chaudhary *et al*.[13] in Brazilian and Indian populations, respectively, have shown that round/oval shape is common in both men and women, which corresponds with our results.

Conclusion

In our study of the condylar process among adults, the most common shape was round. The coronoid process was triangular and the sigmoid notch was wide. There were no variations in shapes of the condylar process, coronoid process, or sigmoid notch among gender and age determinations. Larger sample sizes with different population studies are required to determine whether these findings hold true for all populations.

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