

Morphometric Study of Mandibular Condyles – a Dry Bone Analysis

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ABSTRACT

Introduction: the mandible consists of horse-shoe shaped body and two rami. Each rami presents two processes: coronoid and condylar. The condylar process of the mandible is the rounded protuberance, and it articulates with the mandibular fossa forming the temporomandibular joint (TMJ). In the early stage of development of mandible, coronoid and condylar process cannot be distinguishable. In adults, their shape and size differ in each population and also differs in same given subject. Mandible being sexually dimorphic bone of the skull which also resists postmortem changes, helps in identification of race, process of evolution and demographic profile. Bones play a major role in identification of a person. Various temporomandibular joint disorders (TMDs), such as hypoplasia, hyperplasia, bifid mandibular condyle or irregular condyle, osteoarthritis, and tumours of the TMJ are characterized by morphological changes of the mandibular condyle.

The precise knowledge of mandibular condyle with regard to its shape and size help in surgical procedures, TMJ disorders, occlusal disorders and mandibular condyle fractures and to design population-specific condylar prostheses.

Method: the present study was conducted on 210 adult human mandibles, irrespective of age and gender. This study was taken to study the different shapes of mandibular condyles and to assess symmetry and to assess the dimensions of mandibular condyles. Mandibles with the intact condyles were included. Mandibles that were eroded, broken and deformed were excluded from the study. The shapes of the mandibular condyles were observed in different views i.e. anterior, lateral and superior views and were assessed. Morphometric parameters; anteroposterior length and mediolateral (transeverse) width were measured in digital vernier calipers, tabulated and analysed.

Result: the most common type prevalent was round, followed by plane variety. The antero-posterior length of the mandibular condyle was ranging between 3.1 mm – 10.39 mm on right side and on left side 4.69 mm – 11.14 mm. The mediolateral width on mandibular condyle ranged between 11.67 mm – 22.45 mm on right side and 9.74 mm – 23.13 mm on left side.

Conclusion: the morphological and morphometric features of the mandibular condyles affect the functional activity of the temporomandibular joint (TMJ). Various temporomandibular joint disorders (TMDs), such as hypoplasia, hyperplasia, bifid mandibular condyle or irregular condyle, osteoarthritis, and tumours of the TMJ are characterized by morphological changes of the mandibular condyle. The mandibular condyle is the most common site of a mandibular fracture. Condylar prosthesis is used to rectify traumatic injuries and in surgical procedures related to disarticulation that may be caused by tumours, congenital malformations and degenerative diseases.

Keywords: Condylar process; Evolution; Malocclusion; Prostheses; Temporomandibular joint.

Introduction

The largest and strongest bone in the human face is the Mandible, lower jaw bone. The mandible is horseshoe shaped and consists of horizontally oriented anterior part called body and two vertically oriented posterior parts called rami. The ramus presents two processes – condylar process which is a strong upward projection from posterosuperior parts, and coronoid process – a flattened triangular projection from the anterosuperior part. The condylar process present in the mandible is the rounded protuberance, and it articulates with the mandibular fossa forming the temporomandibular joint (TMJ)¹.

The shape and size of mandibular condyle is different among one another. The various conditions like fractures, benign or malignant lesions alters normal anatomy of mandibular condyle. These conditions result in TMJ dysfunction and facial asymmetry. The relationship between the condyle and the mandibular fossa of the temporal bone affects the occlusal properties of the mandible^{2,3}.

Materials and Methods

The present study was conducted on 210 adult human mandibles, irrespective of age and gender. This study was taken to study the different shapes of mandibular

condyles and to assess symmetry and to assess the dimensions of mandibular condyles. Mandibles that were eroded, broken and deformed were excluded.

The shapes of the mandibular condyles were observed in different views i.e. anterior, lateral and superior views and were assessed, according to the classification of Wedel *et al.* (1978)⁴.

Morphometric parameters; anteroposterior length and mediolateral width were measured in digital vernier calipers and tabulated, adapted from Matsumoto & Bolognese (1995)⁵.

Anteroposterior condyle length: the distance between the most prominent points on the anterior and posterior surfaces of the mandibular condyle.

Mediolateral condyle width: the distance between the most prominent medial and lateral points of the mandibular condyle. (Figure 1 and Figure 2)



Figure 1. Measurement of the mandibular condyle on dry bone specimens- mediolateral width.



Figure 2. Measurement of the mandibular condyle on dry bone specimens- antero-posterior length.

Results

In the present study, morphology of the condyle was analysed on three different views viz. anterior; lateral; superior.

a) Morphology of the mandibular condyle;

I - Anterior view - The most common type prevalent was round with 168, followed by plane variety with 30 on right side. On left side, most common was round 159, followed by plane type. (Figure 3)

II- Lateral view - The most common type prevalent was round with 192, followed by triangular variety with 12 on right side. On left side, most common was round 171, followed by triangular type. (Figure 4)

III- Superior view - The most common type prevalent was oval with 159, followed by pear lateral variety with 24 on right side. On left side, most common was oval 138, followed by pear lateral with 33. (Figure 5)

The various types of shapes of condyles are shown in the Table 1.

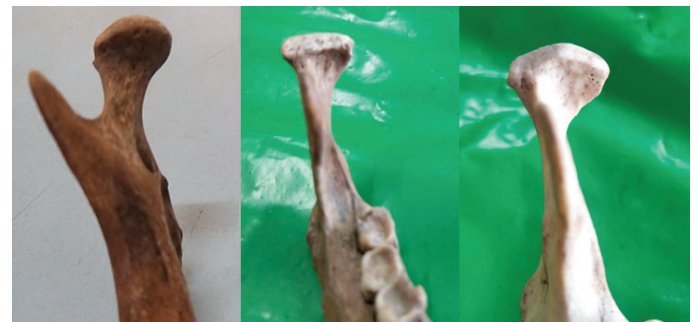


Figure 3. Different shapes of Condyles from Anterior view - Round, Plane, Triangular

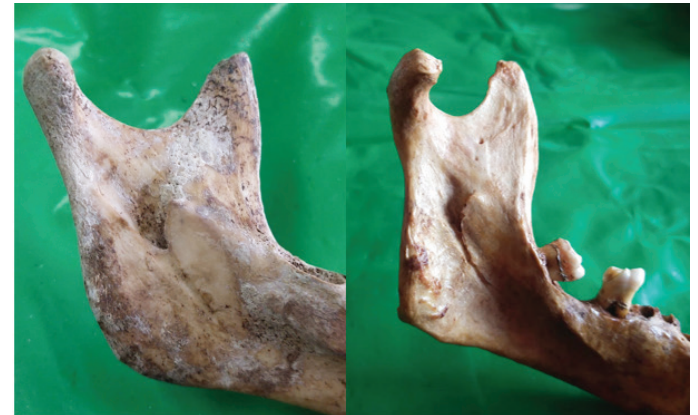


Figure 4. Different shapes of Condyles from Lateral view - Round, Triangular



Figure 5: Different shapes of Condyles from Superior view - Oval, Pear

Table 1. Morphology of mandibular condyles in different views.

Shapes	RIGHT			LEFT		
	Anterior	Lateral	Superior	Anterior	Lateral	Superior
Round	168	192	-	159	171	-
Plane	30	6	-	36	15	-
Oval	-	-	159	-	-	138
Triangle	12	12	-	15	24	-
Pear lateral	-	-	24	-	-	33
Pear medial	-	-	18	-	-	24
Hourglass	-	-	09	-	-	15

b) Morphometry of mandibular condyle;

I- The antero-posterior length of the mandibular condyle was ranging between 3.1 mm – 10.39 mm on right side and on left side 4.69 mm – 11.14 mm.

II- The mediolateral width on mandibular condyle ranged between 11.67 mm – 22.45 mm on right side and 9.74 mm – 23.13 mm on left side.

The morphometric measurements of condyles and comparison with the right and left is shown in the Table 2.

Discussion

Variations in the normal morphology of the mandibular condyle occur due to age, gender, ethnicity, facial type, occlusal force, functional load, and malocclusion, and can also differ between the right and left sides⁶.

The condylar process consists of cancellous bone/spongy bone covered by a thin layer of compact bone and the intra-articular surface is covered by a layer of thick fibro-cartilaginous tissue formed by collagen and a small number of elastic fibers. This cover is much thicker in areas that receive heavier loads during mastication. The cartilage of the mandibular condyle acts as an important center for the endochondral growth of the mandible during morphogenesis¹. Any amount of traumas to this region may delay the developmental process which may later may results in facial malformation and also consequently leading to mechanical damage to the articular surface^{7,8,9}.

In the present study, the most common shaped condyle in anterior view was round on both the sides similar to the study done on Brazilian population by Fonseca et.al in 2018¹⁰. In the superior view, most

common shaped was oval similar to the studies done by Wangai et al.² and Ishwarkumar et al.¹¹ on Kenyan and South African population respectively. In the lateral view, oval shaped was most common and was very much similar to the results of Wangai et al.².

In the present study, the range of measures in the anteroposterior length was 6.45 mm to 7.39 mm, and mediolateral width dimensions was between 10.78 mm and 13.39 mm which is larger in measurements compared to study done on Brazilian population by Fonseca et al.

In the study done by Ishwarkumar et.al, the antero-posterior length of the male mandibular condyle was recorded to be 9.23 mm and 9.57 mm on the right and left side, respectively, while in females with a length of 8.73 mm and 8.66 mm on the right and left side, respectively¹². The medio-lateral width on the right side was found to be 18.10 mm in males and 17.66 mm in females, while on the left side a width of 18.11 mm and 17.81 mm was recorded in males and females, respectively which is much higher than our present study (Tabels 3 and 4).

These variations of the mandibular condyles with regards to morphology and morphometry varies with age, gender and ethnic groups. All these parameters help us understand biomechanical and functional behaviour of mastication, speech and occlusion.

The precise knowledge of the anatomy of the mandibular condyle may help in clinical and surgical procedures, viz. TMJ disorders and mandibular condyle fractures, as well as in the designing the population-specific condylar prostheses and to collaborate dentists with physiotherapists for the rehabilitation procedures.

Table 2. Morphometric measurements of mandibular condyles.

	Anteroposterior – Right	Anteroposterior – Left	Mediolateral Width – Right	Mediolateral Width – Left
Minimum	3.10 mm	4.69 mm	11.67 mm	9.74 mm
Maximum	10.49 mm	11.14 mm	22.45 mm	23.13 mm
Mean	7.15 mm	6.96 mm	17.82 mm	17.92 mm
Median	7.23 mm	6.76 mm	17.84 mm	17.97 mm
Range	7.39 mm	6.45 mm	10.78 mm	13.39 mm

Table 3. Comparison of morphology in different studies with the present study.

Views	Shapes	Wangai <i>et al.</i> 2012 kenyan	Ishwarkumar <i>et al.</i> 2015 South african	Roberta <i>et al.</i> 2018 Brazilian	Present Study
Anterior	Round	26.2	31.5	36	77.8
	Plane	71.4	62	14	15
	Triangle/ inverted V	2.9	6.5		6.4
Superior	Oval	73.1	56.5	---	70.7
	Pear medial	4.8	15.7	---	10
	Pear lateral	2.4	---	---	13.6
	Hourglass			---	5.7
Lateral	Round/convex	80.2	13		86.4
	Plane	3.2	69.4		5
	Inverted v	16.7	17.6	11	8.6

Table 4. Comparison of morphometry - mean in different studies with the present study.

Parameters (Mean)	Ishwarkumar <i>et al.</i> 2016		Fonseca <i>et al.</i> 2018		Present Study	
	Right	Left	Right	Left	Right	Left
Anteroposterior length	9.08	9.2	5.0	4.5	7.15	6.96
Mediolateral width	17.92	17.99	11.0	10.9	17.82	17.92

Conclusion

The morphological and morphometric features of the mandibular condyles affect the functional activity of the temporomandibular joint (TMJ). Various temporomandibular joint disorders (TMDs), such as hypoplasia, hyperplasia, bifid mandibular condyle or irregular condyle, osteoarthritis, and tumours of the TMJ are characterized by morphological changes of the mandibular condyle. The surface morphology, mandibular condyle symmetry on both sides influences occlusal force and plays an important role in the stability of long-term treatment results of orthognatic and orthodontic treatments.

The mandibular condyle is the most common site of a mandibular fracture. Condylar prosthesis

is used to rectify traumatic injuries and in surgical procedures related to disarticulation that may be caused by tumours, congenital malformations and degenerative diseases.

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Ethical Statement

The authors state that every effort was made to follow all local and international ethical guidelines and laws that pertain to the use of human cadaveric donors in anatomical research (Iwanaga *et al.*, 2022).

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