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MORPHOMETRIC STUDY OF CORONOID PROCESS, LINGULA OF HUMAN MANDIBLE AND THEIR CLINICAL IMPORTANCE.

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Introduction: The mandible is the largest and strongest bone in the facial skeleton, with the lingula and coronoid process serving as important landmarks for surgical procedures. Objective: The study's objective was to have significant ramifications for oral and faciomaxillary surgical procedures. Understanding the morphology of the lingula and coronoid process can help in bone grafting, reconstructive surgery, and other surgical procedures**. Materials And Methods**: : A total nmber of 63 dried adult human mandibles from the GMC Srinagar department of anatomy were examined in this observational study. Manual vernier calipers were used to record morphological parameters of the lingula and coronoid process, and morphometric measurements were taken in relation to several mandibular characteristics. **Results:** The most common lingula morphology was triangular (50.79%), followed by nodular (21.42%), truncated (15.87%), and assimilated (11.9%). The average height of the lingula was 7.48 +/- 139 mm, with an average distance of 16.33 mm from the anterior border of the ramus and 15.31 mm from the posterior border. The most common coronoid process shapes were triangular, hook-shaped, and rounded, with mean heights of 18.44+1.99mm and 18.99+1.44 mm on the right and left sides, respectively **Conclusion:** The findings of this study have important implications for faciomaxillary and oral surgical procedures. The morphological knowledge of the lingula and coronoid process can aid in reconstructive purposes, bone grafting, and other surgical interventions

Key words: Dried human mandible, coronoid process, lingual and manual vernier caliper.

Introduction: The mandible is the second bone to ossify in the body and is the largest and strongest bone in the facial skeleton system.[1] The mandibular lingula is a bony projection located on the medial aspect of the ramus of the mandible, just above its center.[2] It is located in close proximity to the mandibular foramen, which transmits the inferior alveolar nerve and artery to the mandibular foramen.[3] The lingula participates in the formation of half to two-thirds of the boundary of the mandibular foramen, and the mylohyoid line starts from its posterior border.[4] The sphenomandibular ligament is attached to the lingula.[5]

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The inferior alveolar nerve innervates the pulp of the teeth in the mandible and passes through the mental foramen as the mental nerve, which ends by supplying the lower lip and skin over the chin.[6] During dental surgical procedures or excision of nerves in facial neuralgia, the lingula serves as an important point of identification for injection of local anaesthetic drugs.[7]Structural variation in the lingula may cause approximately 10-15% of inferior nerve block failures.[8]

The lingula is an important anatomical guide for surgical procedures such as bilateral sagittal split ramus osteotomy and intra-oral vertical split ramus osteotomy used for the correction of dentofacial deformities such as laterognathia, prognathism, and orthognathia. To prevent complications such as nerve injury, the cut should be made in reference to the lingular tip.[9,10]

The mandible has a curved body and bilateral condyloid and coronoid processes. The coronoid process is triangular in shape and is directed upwards and a bit forward. On its posterior border, it has an incisura, and the anterior border of the ramus is continuous with the anterior border of the coronoid process. The coronoid process gives attachment to the temporalis muscle. Rarely, major displacement of the coronoid process occurs as it is reinforced by the attachment of the temporalis tendon.[11]

Different shapes of the coronoid process have been reported previously, including triangular, rounded, and hooked shapes.[12,13] In bony defects of oral and facio-maxillary surgeries, the coronoid process has been used as a graft for repair.[14] After surgical removal of the coronoid process, no working impairment was observed.[15]

The rationale for this study is to provide a detailed morphometric analysis of the coronoid process and lingula of the human mandible and to determine their clinical significance. Understanding the anatomical features and variations of these structures is crucial for surgical procedures in the maxillofacial region, especially those involving the correction of dentofacial deformities or the treatment of facial neuralgia. Additionally, identifying any structural variations in these areas can help prevent complications, such as nerve injury, during these procedures. This study aims to contribute to the existing literature on the topic and provide valuable information for clinicians and researchers in the field of maxillofacial surgery.

Material Methods:

Over a period of four months, an observational study was conducted on 63 dried human mandibles of unspecified sex that were used for teaching purposes in the Department of Anatomy at the Government Medical College in Srinagar, Jammu and Kashmir, India, from October 2022 to January 2023.

The inclusion criteria involved only mandibles with intact coronoid processes and lingulae, while those with fractures or congenital abnormalities were excluded from the study.

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The shape of the mandibular lingula on both sides was observed and classified into four types, as designated by Tuli et al.[16] which are illustrated in Figure 1 and listed in Table 1:

Triangular shape - having a wide base and a pointed or round apex.

Truncated shape - featuring a quadrangular bony extension.

Nodular shape - with the entire lingula blended into the ramus except for the tip.

Assimilated shape - with the lingula fully merged into the ramus.

The measurements of lingula parameters were conducted bilaterally using a manual vernier caliper. The following parameters were measured:

The height of the lingula was measured from its tip to the lower edge of the mandibular foramen.

The location of the lingula was measured with respect to various parameters of the mandible as shown in Figure 3 and Table 2.

a. The horizontal distance between the apex of the lingula to the anterior and posterior border of the mandibular ramus.

b. The distance between the apex of the lingula to the mandibular notch and base of the mandible.

The shapes of the coronoid process, according to Prajapati et al.[13], Issac and Holl[17], and Khan and Sharieff[18], were noted, recorded, and classified as shown in Figure 2.

To determine the various parameters of the coronoid process, a reference point (O) was identified at the lowermost point of the condyloid process where its quadrangular shape terminates. A horizontal line was then drawn at the same level to the anterior border of the ramus, and a point (R) was marked on this line. Another point (P) was marked in alignment with the lowest point of the mandibular notch on this horizontal line. A third point (Q) was marked at the top of the coronoid process, and the points PQ and QR were connected to form a triangle (PQR). Additionally, a perpendicular line (QS) was drawn. The length of all sides of the triangle and its height were then measured and recorded for comparison with previous studies, as presented in Table 2 and 3, respectively. This technique is illustrated in Figure 3.

Statistical method

The collected data was entered into a spreadsheet using Microsoft Excel. Subsequently, the data was exported to the data editor of SPSS version 20.0. The data was then analyzed using descriptive statistics such as means, standard deviations, to summarize the characteristics of the sample.

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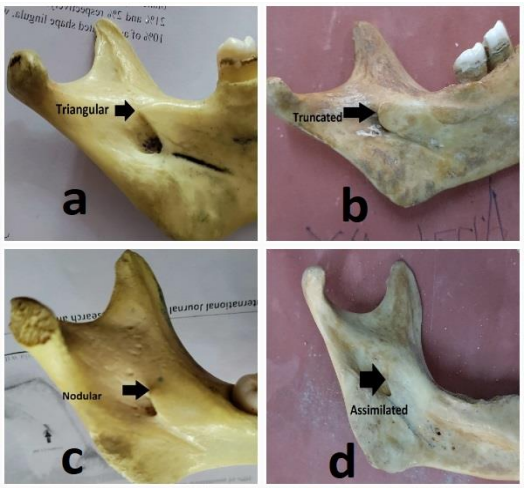

Fig.1 Image a, b, c and d Shows Triangular, Truncated, Nodular and Assimilated Shapes Of Ligula respectively.

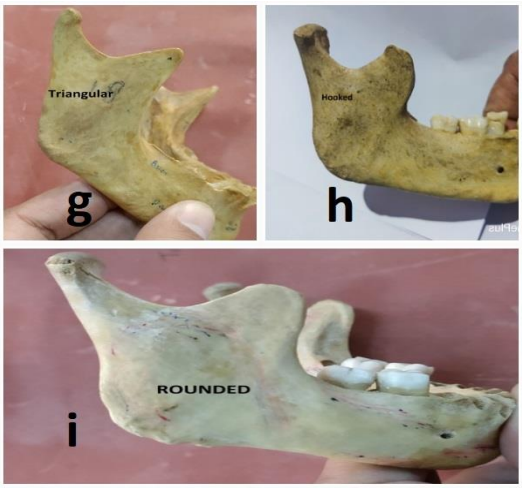

Fig. 2 Image g, h and i shows Triangular, Hooked and Rounded shapes of coronoid Process respectively.

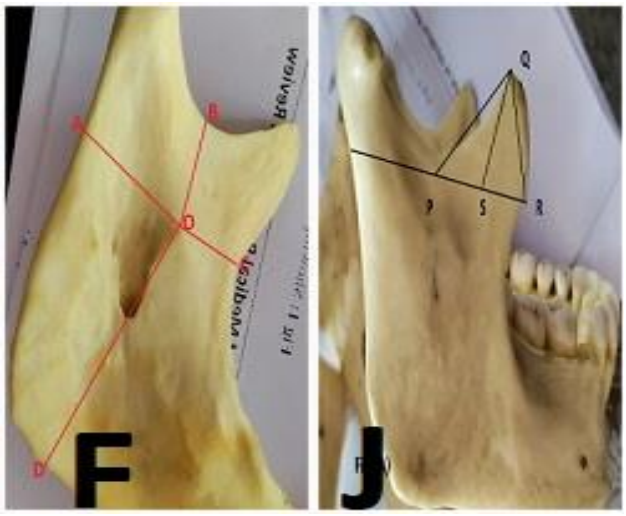

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Figure (3) image f shows position of ligula with respect to anterior border (AO), Posterior border (CO) of ramus and Notch (BO), and base of mandible. Image j shows various parameters of coronoid process

Results

The present study involved the examination of 63 adult dry mandibles, which is equivalent to 126 sides. The findings of the study revealed that triangular lingulae were the most frequently observed (50.79%), followed by nodular (21.42%), truncated (15.87%), and assimilated (11.9%) lingula. The average height of the lingula was found to be 7.48 +/- 139 mm, with an average distance of 16.33 mm from the anterior border of the ramus and 15.31 mm from the posterior border. The average distances between the base of the mandible and the mandibular notch were 19.43 mm and 30.32 mm, respectively.

The study also found that the triangular shape was the most prevalent for coronoid processes (58.73%), followed by hook-shaped (33.33%) and rounded (7.93%). The mean heights of the coronoid processes on the right and left sides were measured to be 18.76 +/- 1.44 mm and 18.74 +/- 1.99 mm, respectively. On the right and left, comparable average side widths were observed, with mean widths of 17.57 +/- 1.90 mm and 16.73 +/- 1.78 mm, respectively. Furthermore, various parameters of the coronoid process were measured and are shown in table 2 and figure 3.

parameters	**Shape**	**Bilateral**	Unilateral		total	%age
			right	**Left**		
lingula	Triangular	54	4	6	64	50.79
	Nodular	24	2	1	27	21.42
	Truncated	16	2	2	20	15.87
	Assimilated	12	1	2	15	11.9
total		**106**	**9**	**11**	**126**	--------
Coronoid process	Triangular	--------	44 (59.45%)	30 (40.54%)	74	58.73
	Hook Shaped	--------	24 (57.14%)	18 (42.85%)	42	33.33
	Rounded	--------	6 (60%)	4 (40%)	10	7.93
total		--------	**74**	**52**	**126**	-------

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Table1 shows distribution of different shapes of lingula and coronoid process

Measurements	Right side			Left side			AVERAGE
	Mean (mm)	S.D (mm)	Range (mm)	Mean (mm)	S.D (mm)	Range (mm)	
Height of lingula	7.95	1.28	5-10	7.01	1.50	4-9	7.48
Lingula to anterior border of ramus	16.57	2.85	11-21	16.09	2.04	9-22	16.33
Lingula to posterior border of ramus	15.52	2.74	11-21	15.11	2.58	10-21	15.31
Lingula to mandibular notch	19.31	3.22	14-27	19.55	3.35	13-26	19.43
Lingula to base of ramus	30.01	5.00	24-43	30.63	5.03	23-40	30.32
Base of coronoid process (PR)	18.76	1.44	17-22	18.74	1.99	16-23	18.75
From base to tip (RQ)	18.23	1.39	16-21	18.52	1.67	15-21	18.37
From tip to mandibular notch (QP)	19.34	1.55	15-22	19.50	1.44	16-22	19.42
Perpendicular line from base to tip (QS)	17.57	1.90	14-21	16.73	1.78	14-20	17.15

Table 2 shows the measurements of various parameters of lingula and coronoid process

Discussion:

Lingula: The lingula serves as an important landmark in identifying the mandibular foramen, through which the vessels of the inferior alveolar nerve pass via the mandibular canal.[19] In various orthognathic techniques, the lingula is also crucial for determining the lines of osteotomy in sagittal split ramus procedures to preserve the inferior alveolar nerve.[20,21] Although many morphometric and morphologic studies have been conducted on the lingula, these studies are still significant due to the diversity of morphologic and morphometric features observed among different individuals. Tuli et al. were the first to describe the different shapes of the lingula, including triangular with a broad base and narrow or pointed apex, truncated with a rounded or quadrangular apex, nodular as a nodule-like bony projection of varying size, and assimilated as wholly embedded in the mandibular ramus.[16]

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To date, several studies have been conducted on the lingula's various shapes in different populations. Tuli et al. conducted a study on 165 dry mandibles of Indian origin and found the triangular shape to be the most prevalent (68.5%), followed by truncated (15.8%), which was more common than nodular (10.9%), and assimilated (4.8%), which was the least common.[16]Sophia MM et al. carried out a study on 50 dry human mandibles and observed the most prevailing shape to be triangular (49%), followed by nodular (23%), truncated (18%), and assimilated (10%).[22] Similarly, Smita Tapas studied 50 dry human mandibles and noticed the truncated shape in 36%, assimilated in 12%, and nodular shape in 10% of the samples.[23]

In a study conducted by Gupta and Pandey on the Indian population, they found that 50% of individuals had a triangular-shaped lingula, 33.82% had a truncated shape, 11.76% had a nodular shape, and 2.9% had an assimilated shape.[24] Similarly, Nirmale et al. carried out a study on the Indian population and found that 47.67% had a triangular-shaped lingula, 27.97% had a nodular shape, 13.69% had an assimilated shape, and 10.71% had a truncated shape.[25] Kositbowornchai et al. conducted research on 72 dry adult human mandibles in the Thai population and found that the most prevalent shape was truncated at 47.2%, followed by nodular at 22.9%, triangular at 16.7%, and the least common was the assimilated shape at 16.7% [26] A CBCT-based study conducted on the Turkish population by Senel et al. included 63 patients, and the most common shape they observed was the nodular type at 32.5%, followed by the assimilated shape at 26.2%, then triangular at 22.2%, and truncated at 19%.[27]

In our present study, we noted that the triangular shape of the lingula was the most common at 50.79%, followed by nodular at 21.42%, truncated at 15.87%, and assimilated shape at 11.9%. These findings are similar to the observations noted by Gupta and Pandey,[24] Sophia et al.[22] and Nirmale et al.[25] where they also observed the triangular shape as the most prevalent. However, our results contradict the observations recorded by Smita Tapas,[23] who found the nodular shape to be the least prevalent, and Senel et al. [27] who noticed the nodular shape as the most existing in their CBCT-based study. The disparity in the shape of the lingula is yet to be understood. As reported by Tuli et al.[16] the variation in the shape of the lingula is due to the origin of the sphenomandibular ligament from its tip, which is also an accessory ligament of the temporomandibular joint.

Several morphometric studies have been conducted to determine the position of the lingula, which varies among ethnic and racial groups. Suwadee et al.[28] studied 72 dry human mandibles from the Thai population and found that the lingula's distance from the anterior border of the mandibular ramus was 20.70 ± 2.27 mm, from the posterior border it was 18.88 ± 3.03 mm, from the mandibular notch, it was 16.41 ± 3.60 mm, and from the base of the mandible, it was 35.79 ± 3.38 mm.

Padmavathi et al.[29] studied 65 human adult mandibles and found that the lingula's position from the anterior border was 21.32 ± 4.12 mm, from the mandibular notch it was 18.62 ± 3.71 mm, from the posterior border of the ramus of the mandible it was 19.61 ± 3.30 mm, and from the

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base of the mandible, it was 36.05 ± 4.12 mm. They also measured the lingula's height as 7.41±2.23 mm. Samanta et al.[30] studied 60 dry mandibles and noted that the lingula's location from the anterior border of the mandibular ramus was 20.0 ± 2.4 mm, from the posterior border of the ramus of the mandible it was 15.0 ± 2.7 mm, and from the mandibular notch it was 15.4 ± 2.7 mm. In our study, we observed the lingula's location from the anterior border, posterior border of the ramus of the mandible, mandibular notch, and base of the mandible as 16.33 ± 2.4 mm, 15.31 ± 2.66 mm, 19.43 ± 3.28 mm, and 30.32 ± 5.01 mm, respectively. The lingula's height was found to be 7.48 ± 1.39 mm. Our findings are consistent with previous studies, with

minor variations.

Different shapes of the coronoid process have been reported by previous researchers, including triangular, rounded, and hooked shapes.[12,13] In our study, we observed that the most common shape was triangular (58.73%), followed by hooked (33.33%) and rounded (7.93%). This is consistent with the findings of Khan and Sharieff,[18] Sudha et al.[31] Isaac et al.[17], and Desai et al.[32] However, our results contradict the studies conducted by Pradhan et al.[33] and Prajapati et al.[13] where the hook-shaped coronoid process was found to be the least common. In this study the observation bias has been reduced to large extent by grouping and repeated measurements of coronoid process by two different observers to reconfirm results. On right side the mean length was noted 17.57 ± 1.90mm while on left side it was observed 16.73 ± 1.78mm and shows that right sided coronoid process being markedly longer than left side. Hence results observed are concordant with the observations of Nand Kishor Karmali et al,[34] Gindha GS et al.[11]And Kasat PA et al,[35]where they observed that the right side coronoid process is larger in length than that of left side. But in another study conducted by Subbaramaiah M [36] and Kahlon S et al.[37] Where they noted markedly lower values with an average length ranging from 12.53 to 15.1 than observed in our present study. In our study the observed width was 18.76 ± 1.44 and that of left was recorded as 18.74 ± 1.99mm which coincides with the findings of Lang et al,[38] PA kasat and PS bhuiyan.[35] Lang et al[38] calculated mean width as 20.4mm and 20.3mm in their study, whereas mean width calculated by kasat and bhuiyan was 19.3 and 19.1mm.

S.no.	Authors Name	Year Of Research	Triangular	Hook Shaped	Round
1.	Isaac et al.[17]	2001.	49.0	27.4	23.6
2.	Khan and sharief.[18]	2011.	67.0	30.0	3.0
3.	Prajapati et al.[13]	2011.	54.2	21.3	24.6
4.	Sudha et al.[31]	2013.	60.8	25.6	14.0
5.	Desai et al.[32]	2014.	68.0	24.0	8.0
6.	Pradhan et al.[33]	2014.	46.7	17.9	35.3
7.	Gaur NL et al.[39]	2019.	62.15	9.37	28.12
8.	Nand Kishor Karmali et al.[34]	2022.	60.00	34.00	12.00
9.	Present study.	2022.	58.73	33.33	7.93

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Table 3 The comparative studies of various shapes of coronoid process by various authors.

Conclusion: In conclusion, the present study provided detailed morphological and morphometric data of the mandibular coronoid process and lingula in the North Indian population. The most common shape of the coronoid process was triangular, followed by hook-shaped and then rounded. The position of the lingula was found to be consistent with previous studies in other populations. The knowledge of the position and shape of the coronoid process and lingula is essential for the surgical management of mandibular fractures, maxillofacial implant placement, and local anesthesia administration. The data obtained from this study may serve as a reference for clinicians and researchers in the field of oral and maxillofacial surgery. Further studies involving larger sample sizes and diverse populations are recommended for a more comprehensive understanding of the variations of the mandibular coronoid process and lingula.

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