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Morphometric Analysis of Dry Adult Human Mandibular Ramus

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Abstract

Background and Objective: The knowledge of morphometric analysis of the ramus of mandible helps in forensic analysis as well as in several maxilla-facial surgeries. Many studies on linear and angular morphometry of the mandibular body have been conducted, but those on the mandibular ramus have not yet been reported. Our study aimed at doing Morphometric analysis of mandibular ramus. *Materials and Methods:* Fifty dry adult human mandibles were collected from the collection of the department of Anatomy of Navodaya Medical College, Raichur. The Morphometric analysis of the mandibles was done with vernier calipers. *Results:* The mandibular ramus was at the same distance from each landmark on both sides demonstrating symmetry. There was no significant difference in the values on the right and left sides of the mandibles. *Conclusion:* Anatomic knowledge of the morphometry of the ramus of mandible helps us in solving forensic problems as well as in maxilla-facial surgeries.

Keywords: Mandible; Mandibular Condyle; Human; Anatomy; Population.

Introduction

Mandible is the largest, strongest and lowest bone in the face and best preserved part of the body after death along with maxilla and teeth [1]. If we consider skull for sex determination; mandible may play a vital role, as it is the most dimorphic bone of skull [2]. Mandible is an important tool in the determination of gender with high accuracy [3]. Human mandibular morphology is often thought to reflect mainly function, and to be of lesser value in studies of population history. Previous descriptions of human mandibles showed variation in ramal height and breadth to be the strongest difference among recent human groups. Mandible is the largest, strongest and movable part of the skull [4]. They are extremely durable in fire and bacterial decomposition makes them invaluable for identification [5]. The mandibular ramus is quadrilateral, and has two surfaces, four borders and two processes. The lateral surface is relatively featureless [6]. The anterior part of ramus is thin above but the posterior is thick and rounded and can be used as the donor site for reconstruction of small bone defects in the oral and maxillofacial region [7,8]. The mandibular ramus suffers morphological alteration associated with tooth losses [9,10]. Many studies on linear and angular morphometry of the mandibular body have been conducted, but despite the significance of mandibular ramus, studies on the mandibular ramus have not yet been reported. Our study aimed at doing Morphometric analysis of mandibular ramus.

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Materials and Methods

Our study group included 50 dry adult human mandibles with complete dentition with intact alveolar margin and intact ramus and of unknown sex which were collected from the department of Anatomy of Navodaya Medical College, Raichur of Karnataka state. Pathological, fractured, deformed and developmental disturbances of the mandible were excluded from the study. Vernier calipers was used to measure the linear measurements of following parameters: 1. from the base of mandible to the highest point of the head of mandible (Figure 1). 2. from the base of mandible to the mandibular notch (Figure 2) and 3. the maximum breadth of ramus from anterior edge of ramus to posterior edge of ramus at the occlusal plane (Figure 3). The two authors recorded the above measurements independently and a mean of the two recordings was taken for final statistics. Measurements were recorded to the nearest millimetre. After each parameter was measured, calculated, and assessed, the mean value and standard deviation were computed using Microsoft Excel of Microsoft Office 2000. The paired "t" test was used to compare the mean values of right and left sides of the mandible. p-value <0.05 was considered statistically significant.

Results and Observations

In our study we noted that the mean measurement from the base of mandible to the highest point of the head of mandible was 64.2±6.6 mm on the right side and 64.3±7.1 mm on the left side. The minimum and maximum values on the right side were 52 mm and 77 mm respectively. The minimum and maximum values on the left side were 51 mm and 79 mm respectively. The mean measurement from base of the mandible to the mandibular notch was 39.5±9.2 mm on the right side and 40.2±9.0 mm on the left side. The minimum and maximum values on the right side were 27 mm and 59 mm respectively. The minimum and maximum values on the left side were 26 mm and 62 mm respectively. The mean measurement from the anterior edge to the posterior edge of ramus corresponding to its width was 29.4±4.6 mm on the right side and 29.5±4.8 mm on the left side. The minimum and maximum values on the right side were 21 mm and 37 mm respectively. The minimum and maximum values on the left side were 18 mm and 38 mm respectively (Table 1). On statistical analysis, it was found that there was no significant difference in the values on the right and left sides of the mandible.

Table 1: Morphometry of mandibular ramus (ns= Not Significant)

Sl. No	Variables	Right Side (mm) MEAN± SD (n=50)	Left Side (mm) MEAN± SD (n=50)	p VALUE
1	Distance from the base of mandible to the head of mandible	64.2±6.6	64.3±7.1	0.47 (ns)
2	Distance from base of the mandible to the Mandibular notch	39.5±9.2	40.2±9.0	0.47 (ns)
3	Distance from the anterior edge to the posterior edge of RAMUS	29.4±4.6	29.5±4.8	0.17 (ns)

Fig. 1: Measurement of the distance from the base of mandible to the head of mandible using vernier calipers

Fig. 2: Measurement of the distance from base of the mandible to the mandibular notch using vernier calipers

Fig. 3: Measurement of the distance from the anterior edge to the posterior edge of ramus at the occlusal plane using vernier calipers

Discussion

The morphology of the human mandible is often thought to be of only functional significance. However, it is also important in studying the population history, sexual dimorphism as well as its role in maxilla-facial surgeries. Previous descriptions of human mandibles showed variation in ramal height and breadth to be the strongest difference among recent human groups. Several mandibular traits that differentiate Neanderthals from modern humans include greater robusticity, a receding symphysis, a large retro-molar space, a rounder gonial area, an asymmetric mandibular notch, and a posteriorly positioned mental foramen in Neanderthals [11].

Analyses of human mandibular form addressed the temporal trend toward gracilization observed in modern humans [12,13,14]; evaluated the usefulness of the mandible in classifying human groups [15,16]; assessed patterns of sexual dimorphism [16-21] and functional aspects of mandibular morphology [22]; and described differences between modern and fossil forms [23-25]. Traits found to differ among recent human populations include ramal height and breadth, ramal obliqueness, corpus robusticity, mandibular (sigmoid) notch shape, bi-condylar breadth, and mental foramen position [22,26]. However, in some cases, these differences are thought to be related to masticatory behaviour and adaptation [22,27]. In the earlier studies, it has been found out that males and females differ most markedly in the height of the symphysis and of the ramus, and differences are more pronounced in the ramus than in the body of the mandible [18,19,27]. The study on the mandibles of Arctic populations has described them as large and robust, with a short, broad, and oblique vertical ramus; a low and robust coronoid, resulting in a shallow mandibular notch. The same study also revealed the Arctic mean configuration with a low coronoid process, an antero-posteriorly broad ascending ramus [11]. This type of wide ramus is thought to increase the moment arm of the temporalis and masseter muscles, while the low position of the coronoid process results in a more vertical orientation of the temporalis. Previous studies have found a reduction in the ramus width and in the anterior length of the mandible and the face from H. Heidelbergensis to Neanderthals [24,28].

Studies by Loth & Henneberg describe a flexure in the posterior margin of the ramus that was present in male, but absent in female mandibles, and that the ramus flexure is useful in sex determination. They claimed sexing accuracy ranging from 90.6% to 99% that the ramus is flexed in males at the occlusal plane whereas in females it is either straight or flexed near the neck of condyle process or in association with gonial prominence [29, 30, 31]. On the other hand, the studies by Donnelly et al. and Haun report about poor association between ramus flexure and sex determination [32,33]. Some studies have reported that the method of using ramus flexure as a tool to study sexual dimorphism is of more diagnostic sensitivity to females [34,35]. The controversy among researchers regarding the predictive accuracy of ramus flexure method has, obviously, resulted from differences in the nature of the samples employed by different investigators. In our study, we have not analysed the sexual dimorphism of the mandibular ramus.

The changes in the shape of the mandible is affected by the forces of muscles, particularly the elevator muscles, which is determinant in the modelling of the mandibular ramus. These forces are at their peak in young adults [36]. This is the time around which the growth at the temporo-mandibular joint ceases. Prior to that age and throughout the period of active growth, the expression of the shape of mandible including ramus flexure is in response to hormonal influences and is governed, in both sexes, by the forces exerted by the masticatory muscles. Thus, the observed variations in mandibular ramus morphology have a biomechanical rather than hormonal origin [36].

In males, where rugosity of the medial pterygoid muscles attachment is noticeably more pronounced than that of the masseter, the ramus appears much more vertical. The temporalis and the lateral pterygoid muscles attach well above the flexure [29]. The influence of muscles in moulding the mandibular ramus is expected to come to a complete halt at the cessation of growth at the temporo mandibular joint around the age of young adulthood. Further musculoskeletal maturation at older ages is not expected to incur any significant change in the shape of females, but the mandible in both sexes retain its pubertal shape in older ages [37]. Researchers have attributed the differences in their findings to population specific factors influenced by environmental functional variables such as chewing habits and food type [37].

In our study, the mean measurement from the base of mandible to the highest point of the head of mandible was 64.2 ± 6.6 mm on the right side and 64.3 ± 7.1 mm on the left side. The present finding is consistent with Rai et al [38] and Mesbahul Hoque et al [39] but differed from Saini et al. [40] and Rosa et al. [41].

In our study, the mean measurement from base of the mandible to the mandibular notch was 39.5 ± 9.2 mm on the right side and 40.2 ± 9.0 mm on the left side. This finding of the present study is consistent with Keros et al. [42] but differed from Jerolimov et al. [43] and Mesbahul Hoque et al [39].

In our study, the mean measurement from the anterior edge to the posterior edge of ramus corresponding to its width was 29.4±4.6 mm on the right side and 29.5±4.8 mm on the left side. This finding of the present study is consistent with Keros et al. [43], Jerolimov et al. [43], Oguz and Bozkir [44], Kilarkaje et al. [45] Ennes and Medeiros [46] and Mesbahul Hoque et al [39].

Conclusion

Our study concludes that the mean measurement from the base of mandible to the highest point of the head of mandible was 64.2±6.6 mm on the right side and 64.3±7.1 mm on the left side. The mean measurement from base of the mandible to the mandibular notch was 39.5±9.2 mm on the right side and 40.2±9.0 mm on the left side. The mean measurement from the anterior edge to the posterior edge of ramus corresponding to its width was 29.4±4.6 mm on the right side and 29.5±4.8 mm on the left side. There was no significant difference in the values on the right and left sides of the mandible which depicts that mandible maintains bilateral symmetry. Anatomic knowledge of the morphometry of the ramus of mandible helps us in solving forensic problems, in anthropological assessments as well as in maxilla-facial surgeries.

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