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Original Article

Determination of Sex by Morphometric Study of Dry Adult Human Mandible

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Abstract:

Introduction: An important aspect of medico legal and anthropological work is the identification of human skeletal remains. After death, bones often survive decay and provide evidence of a person's sex. As the strongest bone in the facial skeleton, the mandible often resists post-mortem damage and provides important information about sexual dimorphism.

Objective: Assessing the morphometric changes in the dry human mandible to ascertain sex is the study's goal.

Methods: From January to December 2017, a descriptive study took place at the Department of Anatomy, Sylhet MAG Osmani Medical College, Sylhet. By using a convenient sampling method 50 adults, dry, complete, undamaged human mandibles were selected.

Results: A variety of measurements were made, recorded as Mean ± SD, and examined using SPSS Statistics 21's unpaired t-test. The results showed statistically significant differences between both genders in mandibular angle, mandibular ramus's length, and mandibular foramen.

Conclusion: This research has shown that it is possible to determine the gender of the mandible by using different metrical parameters as an additional tool to establish a person's identity.

Key words: Mandible, Mandibular angle, Mandibular ramus, Mandibular foramen.

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Introduction:

The mandible is the biggest and most robust facial bone. It forms the lower jaw and is the only movable bone of the skull. It articulates with the temporal bone to form the bicondylar synovial joint called temporo-mandibular joint. This bone consists of a horizontal horseshoe-shaped body and two broad oblong rami. Each body is composed of two halves, which are united at antero-medially in the centre to form the symphysis menti by a fibrous joint which is replaced by the bone within two years of life.

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In its posterior region, the mandible's lower border forms an angle. The angle may be everted or inverted which helps in sexing of skeleton remains. The rami bear the mandibular foramen, coronoid and condylar processes. The condylar processes at the temporomandibular joint connect with the temporal bone, creating the neck and head region. The coronoid process is a pointed, flat bone extension located at the front of the condyloid process. A gap, known as the mandibular notch, separates the coronoid and condyloid processes.[1,2] This skeletal structure is considered valuable for genetic, anthropological, and forensic studies in both living and non-living populations. The identification of skeletal remains as male or female is particularly important,[3] and an integral part of medico-legal and anthropological work. The determination of sex of an individual is important and necessary both in the living and the dead for medico-legal purposes.[4]The accuracy of sex determination depends on the integrity of the remains and the extent of sexual differences present within a given population. It is usually considered that the two most sexually dimorphic elements of the skeleton are the skull (including the mandible) and the pelvis.[5] According to Krogman, the degree of accuracy in sexing adult skeletal remains is the entire skeleton 100%, Pelvis alone 95%, Skull alone 90%, Pelvis, and skull 98%, and long bones alone 80%.[6] Jaws and teeth have been used since olden times to ascertain the sex of an individual because they show sexual dimorphism in morphological features, but these are likely to be subjected to variation depending upon the experience of a worker. As a result, some morphometric standards that, when paired with additional characteristics, can be used as a guide to define sex must be established.[7]Sex determination is done by discriminate function F2, the formula is Y (sex) = a+b1×HMS+b2×HAR.[8]Numerous research has unequivocally shown that skeletal features differ among populations, necessitating the establishment of population-specific guidelines.[7]It is also important in clinical assistance in performing local anesthetic blockage and other dental procedures. After receiving radiation therapy, the mandibular foramina may potentially serve as a secondary pathway for tumor dissemination. So, the knowledge of mandibular foramen is important during planning radiation therapy. It is observed by reviewing existing literature that many works have been done on mandibles in foreign countries. But there is little existing work on mandibles in our country. We need our own standard baseline from which we can compare different morphometric parameters of mandibles in our own population. Consequently, the primary objective of this research is to explore the morphometrics of adult human mandibles. The outcomes of this study might be beneficial in providing morphometric details about our population for use in dental, medical, and judicial environments.

Methodology:

Between January 2017 and December 2017, a cross-sectional observational study was performed in the Anatomy department of the Sylhet M. A. G. Osmani Medical College Hospital in Sylhet. By using convenient sampling method 50 adult, dry, and unknown-sex human mandibles were selected. The inclusion criteria encompassed adults with fully developed and undamaged mandibles, while the exclusion criteria involved mandibles that were damaged, deformed, or exhibited pathological conditions, as well as those with fewer than 14 tooth sockets. The research instrument was a pretested semi-structured questionnaire. Data processing and analysis were performed with the help of SPSS version 21.0. Data were expressed as mean± SD and comparison was done between the Groups by unpaired 't' test. Statistically significant gender variations were present. A probability value of less than 0.05 was considered statistically significant. Before the study began, the research protocol received approval from the Ethical Committee at Sylhet M.A.G Osmani Medical College in Sylhet.

Results:

The sex of the collected mandibles was determined by the discriminate function F_2, according to the criteria set by Ionescu et al.[8]By these criteria, we found 29 (58%) male and 21 (42%) female mandibles.

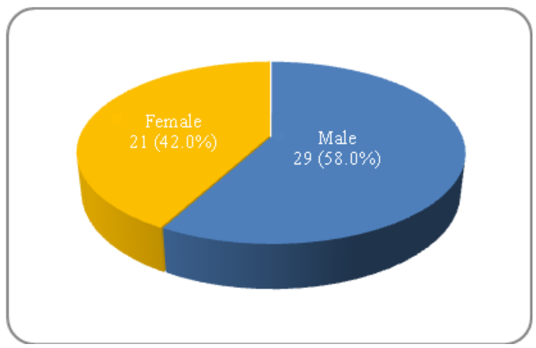

Figure 1: Sex determination of dry mandible (n=50)

Males had a substantially smaller mean mandibular angle on both the left and right sides as compared to females. There was a statistically significant difference.

Table I: Mandibular angle (n=50)

Side	Mandibular angle (degree)		p-value
	Male (n=29)	Female (n=21)	
Right	120.90 ± 8.47	127.29 ± 7.46	p=0.008
Left	120.10 ± 8.31	127.52 ± 7.62	p=0.002

Data were presented as mean ± standard deviation and comparison was made using unpaired t-test.

Males had a considerably greater mean length of the ramus of the mandible on both the left and right sides than females had. Males also had a longer mandibular notch to mandibular base distance in both the right and left mandibles than matched females. Differences were statistically significant.

Table II: Measurement in relation to mandibular ramus (n=50)

Side	The mandibular ramus's length (mm)		p-value
	Male (n=29)	Female (n=21)	
Right	65.61 ± 4.17	50.77 ± 5.16	p<0.001
Left	64.26 ± 4.07	48.68 ± 6.56	p<0.001
	Distance between mandibular notch and base of the mandible (mm)		
Right	47.45 ± 4.14	31.73 ± 9.24	p<0.001
Left	47.32 ± 4.26	31.15 ± 9.00	p<0.001

The unpaired t-test was used to compare the data, which were shown as mean ± standard deviation.

Males had a longer horizontal diameter in the mandibular foramen (statistically significant) than females did on both sides. However, males and females had nearly identical vertical diameters of the mandibular foramen on the left and right sides (statistically not significant).

Table III: Diameter of mandibular foramen (n=50)

Side	Horizontal diameter of mandibular foramen (mm)		p-value
	Male (n=29)	Female (n=21)	
Right	2.96 ± 0.63	2.39 ± 0.52	p=0.001
Left	2.88 ± 0.57	2.34 ± 0.61	p=0.002
	Vertical diameter of mandibular foramen (mm)		
Right	3.08 ± 0.79	2.60 ± 0.55	p=0.022
Left	2.95 ± 0.76	2.68 ± 0.71	p=0.218

Data were shown as mean ± standard deviation, and the unpaired t-test was used to compare the results.

In sex determination, there were statistically significant differences in the distances between the mandibular notch and mandibular foramen, mandibular angle and mandibular foramen, symphysis menti and mandibular foramen, as well as the mandibular head's highest point and mandibular foramen. These differences were more pronounced in males, as the measurements were generally longer than in females. However, there was no statistically significant disparity in the mean difference between the right and left sides for both genders

Table IV: Measurement of the distance in relation to mandibular foramen(n=50)

Side	Distance between mandibular notch and mandibular foramen (mm)			p-value
	Male (n=29)	Female (n=21)	Total (n=50)	
Right	23.24 ± 3.97	19.98 ± 3.88	21.87 ± 4.21	p<0.001
Left	22.93 ± 3.42	20.42 ± 3.21	21.87 ± 3.53	p<0.001
p-value	p=0.744	p=0.690	p=1.000	
	Distance between mandibular angle and mandibular foramen (mm)			
Right	26.59 ± 3.32	17.52 ± 5.45	22.78 ± 6.24	p<0.001
Left	26.29 ± 3.92	17.70 ± 4.70	22.68 ± 6.01	p<0.001
p-value	p=0.756	p=0.910	p=0.937	
	Distance between symphysis menti and mandibular foramen (mm)			
Right	79.08 ± 4.35	74.67 ± 5.45	77.23 ± 5.14	p<0.001
Left	78.98 ± 5.13	73.71 ± 5.33	76.77 ± 5.79	p<0.001
p-value	p=0.939	p=0.557	p=0.677	
	Distance between themandibular head's highest point and mandibular foramen (mm)			
Right	41.46 ± 4.05	34.74 ± 4.14	38.64 ± 5.25	p<0.001
Left	41.56 ± 4.04	34.00 ± 3.52	38.39 ± 5.35	p<0.001
p-value	p=0.921	p=0.536	p=0.815	

Unpaired t-test was applied for comparison, and the data was displayed as mean ± standard deviation.

Discussion:

Sex determination is typically the initial stage in the identification process of adult skeletons, as subsequent methods for estimating age and stature depend on it. The accuracy of sex determination is contingent upon the completeness of the remains and the extent of sexual dimorphism present in a given population. Among the skeletal elements, the skull (including the mandible) and the pelvis are commonly regarded as the two most sexually dimorphic. This research is necessitated by the rising occurrences of violence and the growing number of unidentified and mutilated bodies being submitted to forensic experts. If different parameters are tested within specific population groups, both qualitative and quantitative criteria can be identified and used in combination to distinguish sex, age, and ethnicity.[5]The mandible, the hardest facial bone, has a forward-curving horizontal body and two broad upward-pointing rami that extend from the back. These rami have processes that are coronoid and condyloid. Among the bones of the human facial skeleton, the mandible is particularly strong and holds its shape better than other bones. Gender differences in the features of the mandible may result from differences in how the musculoskeletal system, especially the muscles of mastication connected to the jaw, developed.[5]

From January to December 2017, a descriptive study was carried out at the Anatomy Department, Sylhet MAG Osmani Medical College, Sylhet with a view to evaluate the morphometric variations of the 50 adult human mandibles in males and females. Then the sex of the collected mandibles was determined by the discriminate function F_2, according to the criteria set by Ionescu et al. and other sex differentiating features in mandibleslike size, shape, weight, and surface of the bone, etc.[8]For acquiring the discriminate function at first two measurements were done. Height of the mandible symphysis ([HMS) and Height of the ascending ramus (HAR). The discriminate formula for gender identification is Y (sex)= a+b1XHMS+b2X HAR.Y= result (score) the discriminate function, a= a constant= -15.1464752, b1=nonstandard coefficient for HMS variable = 0.16569111, b2=nonstandard coefficient for HAR variable = 0.18474021. If the score (Y) of the discriminate function of a mandible is positive that is a value bigger than section point '0' (zero) indicates the masculine gender and if the value is negative that is smaller than section point '0' (zero) indicates feminine gender. By these criteria, we found 29 (58.0%) male and 21 (42.0%) female mandible.[8]

The mean mandibular angle in this research, both right side (120.90 ± 8.47 degree versus 127.29 ± 7.46 degree; p=0.008) and left side (120.10 ± 8.31 degree versus 127.52 ± 7.62 degree; p=0.002) was significantly smaller in male compared to female. This result was also concordant with other studies.[9,10,11,12]

The current investigation uncovered that the mean length of the mandibular ramus of both right side (65.61 ± 4.17 mm versus 50.77 ± 5.16 mm; p<0.001) and left side (64.26 ± 4.07 mm versus 48.68 ± 6.56 mm; p<0.001) were significantly longer in male compared to female. This study was correlated with the report by Hoque.[12] But, not correlated to Rosa et al. which might be due to racial and geographical variations.[11]The space from the mandibular notch to the base of the mandible of both right side (47.45 ± 4.14 mm versus 31.73 ± 9.24; p<0.001) and the left side (47.32 ± 4.26 mm versus and 31.15 ± 9.00 mm; p<0.001) were longer in male compared to female. There was a statistically significant mean difference between the mandibular notch and the base of the mandible in males and females (p<0.001).

In this study, the horizontal measurement of the mandibular foramen's diameter of both right (2.96 ± 0.63 mm versus 2.39 ± 0.52 mm; p=0.001) and left side (2.88 ± 0.57 mm versus 2.34 ± 0.61 mm; p=0.002) was longer in male compared to female. The mean difference was statistically significant. But the vertical measurement of the mandibular foramen's diameter of both right (3.08 ± 0.79 mm versus 2.60 ± 0.55 mm; p=0.022) and left side (2.95 ± 0.76 mm versus 2.68 ± 0.71; p=0.218) was almost similar in male compared to female (statistically not significant).

This study examined, the gap between the mandibular notch and mandibular foramen of both right side (23.24 ± 3.97 mm versus 19.98 ± 3.88; p<0.001) and left side (22.93 ± 3.42 mm versus 20.42 ± 3.21 mm; p<0.001) were longer in male compared to female. But, the gap

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between the mandibular notch and mandibular foramen of the right side (21.87 ± 4.21 mm) and left side (21.87 ± 3.53 mm) did not differ statistically significant (p=1.000). The mean discrepancy between the right side and left side in males (p=0.744) and females (p=0.690) was not statistically significant. We found almost similar findings in other studies[13,14,19,20]but dissimilar to Ennes et al.[15]On the right side, The demarcation between the mandibular foramen and mandibular angle was 26.59 ± 3.32 mm in males and 17.52 ± 5.45 mm in females; the difference was statistically significant (p<0.001). On the left side, the space between mandibular angle and mandibular foramen was 26.29 ± 3.92 mm in males and 17.70 ± 4.70 mm in females; the difference was statistically significant (p<0.001). However, there was no statistically significant difference in the mean between the right and left sides in males (p=0.756) and females (p=0.910). The results of this study were also in agreement with those of other studies.[16-20] The distance between symphysis menti and mandibular foramen of both right side (79.08 ± 4.35 mm versus 74.67 ± 5.45 mm; p<0.001) and left side (78.98 ± 5.13 mm versus 73.71 ± 5.33 mm; p<0.001) were longer in male compared to female. But, the distance between symphysis menti and mandibular foramen of the right(77.23 ± 5.14 mm) and left side (76.77 ± 5.79 mm) did not differ statistically significant (p=0.677). The mean difference of the right and left sides in males (p=0.939) and females (p=0.557) was also not statistically significant. This result was consistent with the study of Kilarkaje et al. and Hoque et al.[20,22] The distance between the highest point of the mandibular head and mandibular foramen of both right sides (41.46 ± 4.05 mm versus 34.74 ± 4.14 mm; p<0.001) and left side (41.56 ± 4.04 mm versus 34.00 ± 3.52 mm; p<0.001) were longer in male compared to female. But,It had no statistically significant distinction (p=0.815) in the distance measured between the mandibular foramen on the right side (38.64 ± 5. 25 mm) and left side (38.39 ± 5.35 mm) from th e highest point of mandibular head. The mean difference between the right and left sides in males (p=0.921) and females (p=0.536) was not statistically significant. This finding of the present study was quite similar to Jerolimov et al. and Kilarkaje et al.[21,22]

Conclusion: In summary, the majority of the morphometric characteristics of the male human dry mandible were longer, but the female human mandible's angle was broader than that of the comparison group. The morphometric data did not significantly differ between both sides of the mandible.

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