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CASE REPORT

SEXING OF THE MANDIBLE FROM VARIOUS MORPHOMETRIC PARAMETERS (A DRY BONE STUDY)

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ABSTRACT

Identification of human skeletal remains is a critical problem and is very important in 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 and anthropological study purpose. Bones often survive the process of decay and therefore provide the major evidence of human age and sex after death. The mandible is the strongest bone of facial skeleton and the best preserved after death. The mandible is the best suitable bone for the study to determine the sex and age of the human remains. This study based on the known sex of 100dry human mandibles. Various measurements will be taken. The difference between measurements of male mandibles and female mandibles will be calculated by taking the mean value of measurements taken, which will help in determination of sex of the mandible. The mandibular index will be calculated from the measurements between right and left mandibular foramina and mean of measurements betweenmandibular foramen and genial tubercles. All these measurements will help in determining the sex of the mandible, even from fragments we can calculate and determine the sex of human mandible. This is the aim of our study.

INTRODUCTION

The mandible 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. It is the largest and strongest bone of the face and it consists of a horizontal horse shoe shaped body and two broad and oblong rami which are projecting upward and slightly backward. 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 thebone within two years of life. The rami are having two processes, condyloid process and coronoid process. The condyloid process is having head and below the head there is constricted part called neck. On the anterior and upper part of neck there is fovea called pterygoid fovea in which there is insertion of the lateral pterygoid muscle. The coronoid process is a conical flat bony projection on the anterior of the condyloid process. The coronoid process is having, anterior and posterior borders, and medial and lateral surfaces. On its apical part, anterior and posterior borders, and most of the medial surface there is insertion of temporalis muscle. In between the coronoid process and condyloid process there is superior border the medial surface of ramus,which is known as mandibular notch, through which masseteric nerve and vessel pass. On the lateral surface of ramus there is insertion of masseter muscle near the angle of the mandible. On the medial surface of the ramus, there is insertion of medial pterygoid muscle near the angle. On the medial surface of the ramus there is a foramen called mandibular foramen through which inferior alveolar nerve and vessels pass to supply to the lower jaw and lower teeth also. On the anterior margin of mandibular foramen there is conical projection called lingula on which sphenomandibular ligament attaches. On the posterior border of ramus of mandible above its angle there is attachment of stylomandibular ligament. On the inner surface of symphysis menti there are projections called genial tubercles, on which genioglosis on the superior tubercles and geniohoid on the inferior tubercles attach. On the outer surface of mandible, on both sides of symphysis menti there are foramina known as mental foramina through which mental nerve and vessels pass (Standring, 2008; Snell, 2012).

The mandible is the largest and strongest bone of the face. There are less chances of its damage during disaster and accidents. The mandible bone is very helpful in investigations like age, sex,because it is having many points for determination

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of age andsex. In these days when there is increase in atrocity on women, the mandible bone is very much helpful in determining the sex of the deceased. So the mandible bone is very much helpful for forensic medicine, anthropological workers and maxilla-facial surgeons who can use the coronoid process for grafting purpose (Harrison, 1995).

According to Hu *et al.* 2006, "the mandible is the largest and hardest facial bone and remains its shape better than other bones in the forensic and physical anthropologic field." Thisis of particular important in relation to human identification as its durability can be the only reason a skeletal remains true identity is known. This quality can be exploited to distinguish ancestry and to identify gender.

The mandible and its variations in age, sex and race will help physicians, surgeons, medico-legal authorities and anthropologists to give correct interpretations for the result of diagnostic procedures in living (Saini *et al*., 2011; Dutta, 2002; Singh 2009).

In the present study, morphometric study will be done from various points on the adult 100 dry human mandibles to determine the sex of mandible which will be useful for the forensic medicine, anthropologist and maxillofacial surgeons and this study will be compared with the studies done by the other authors.

MATERIALS AND METHODS

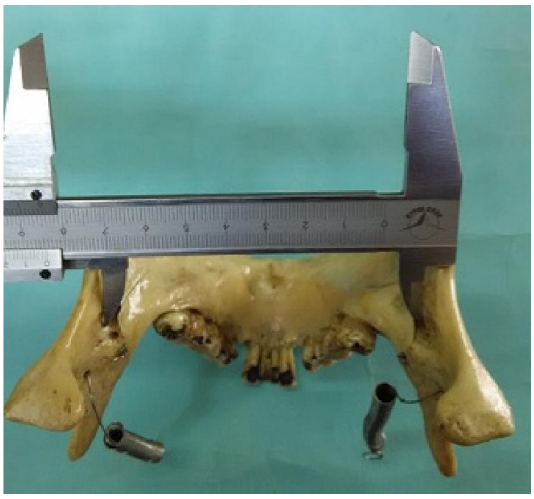
The present study is conducted on 100 adult dry human mandibles of known sex (63 mandibles of male and 37 mandibles of female) which were collected from the Department of Anatomy of M.M. Medical College and Hospital, Kumarhatti, District: Solan (Himachal Pradesh) India. All the mandibles were of adult age.100 dry human mandibles are the material for this study.Any deformed or broken mandibles were discarded. The measurements were taken from different points of all the mandibles as shown in (Tables – I) and (Table – II). These measurements were taken from the mandibles of both the sexes differently and compared the measurements with each other of both the sexes to see the differences which will help in determining sex of human the mandibles. The present study will be compared with the standard literature and studies done by other authors.

Observations

The present study the measurements were taken from the different points of 100 adult dry human mandibles and given in the (Table – I) and (Table – II). Out of 100 dry mandibles, 63 dry adult human mandibles were of male and 37 dry mandibles were of female. These 100 dry adult human mandibles were material for this study. The measurements were taken of all the dry mandibles with the help of set scare, vernier caliper, and metallic scales, and both the rami were measured differently in both the sexes, the mean and average were taken of the measurements. These measurements were used for the calculations to determination of the sex of the mandibles. The different measurements are as following:-

1. Distance between right mandibular foramen (rmf) and left mandibular foramen (lmf)
2. Distance between right mental foramen (rmnf) and left mental foramen (lmnf)
3. Distance between right mandibular foramen (rmf) and center of genial tubercles (rmf-gt)
4. Distance between left mandibular foramen (lmf) and center of genial tubercles (lmf-gt)
5. Height of right coronoid process (rcp) from the base of the mandible
6. Height of left coronoid process (lcp) from the base of the mandible
7. Height of right condyloid process (rcdp) from the base of the mandible
8. Height of left condyloid process (lcdp) from the base of the mandible.
9. Mandibular index calculated by the following formula: -

$$\text{Mandibular Index} = \frac{\text{Distance between Avg. (right and left) mf and gt}}{\text{Distance between Avg. rmf and lmf}} \times 100$$



Photograph I. Mandibular foramen to Mandibular foramen

Photograph II. Mental foramen to Mental foramen

Photograph III. Mandibular foramen to Genial tubercles

Photograph IV. Height of Coronoid process

Photograph V. Height of Condyloid process

Table 1.

Serial Number	Measurements (in mm)	Average Distance in male (in mm)	Average Distance in female (in mm)	Differences in Distances in male and female (in mm)
1.	mf – mf	77.86	74.84	3.02
2.	mnf - mnf	49.89	49.08	0.81
3.	rmf – gt	70.20	68.76	1.69
4.	lmf – gt	70.20	68.51	1.44
5.	rcp height	60.30	56.81	3.49
6.	lcp height	59.89	56.76	3.13
7.	rcdp height	52.09	48.32	3.77
8.	lcdp height	51.86	48.32	3.54

Table 2.

Mandibular Index	In Male	In Female
	70.22/77.86×100=90.18%	68.77/74.83×100=91.90 %

The mean distance between the mandibular foramen to mandibular foramen (mf-mf) (Photograph – I) in 63 male was measured as 4905 mm the average value for one mandiblecomes as 77.86 mm whereas in 37 female dry mandibles total measurement was 2769 mm and average distance for one mandible was 74.83 mm (Table 1).There is difference of 3.o2 mm between male and female measurements which shows that female ramus is less wide than the male.

The distance between right and left mandibular foramina to genial tubercles measured separately (Photograph – III) and took the average of these two distances of male and female mandibles.In male the average distance was 70.22 mm where as in female it was 68.77 mm (Table 1). Again there was difference between male and female distance of 1.45 mm which shows that body of male mandible is longer as compared to body of female mandible. By this measurement we can estimate the sex of the mandible even from its fragment.

The distance between mental foramen to mental foramen in male and female was very less (photograph – II),even less than one millimeter so this distance is insignificant, accept the external features of the mandible, butfrom this distance we cannot say or identify the sex of the mandible. The arches of the male and femalemandibles are almost same but the shapes are different. The shape of the male mandible is rectangular and less prominent whereas female mandible is rounded, prominent and pointing forward. From the shape and size of the mandibles, we can identify the sex of the mandible

We measured the height of the right and left coronoid processes separately (Photograph – IV). The height of right coronoid process in male was 60.30 mm and left coronoid process was 59.89 mm.There is difference between right and left coronoid process. This can be due to eating and chewing habits. Some persons are having the habit of chewing and eating only the right side. In that case his/her coronoid process will be developed more and will be longer (Table 1). In female the right coronoid process measured as 56.81 mm and left coronoid process as 56.76 mm. again in female also right coronoid process is longer as compared to left (Table 1). This

is also due to eating and chewing habit. If we compare the heights of male and female coronoid process there is again difference of 3.31 mm; it means the coronoid processes of males are longer as compared to the coronoid processes of female. From this measurement we can determine the sex of the mandible.

The measurements of heights of right and left condyloid processes in male as well as female mandibles (Photograph – V). There was difference between the heights of condyloid processes of male and female mandibles of 3.66 mm. This shows that the condyloid processes are longer in male than in female. From this measurement we can estimate the sex of the mandible even if we do not know the differences between male and female dry adult mandibles by their external features.

From the measurements of right mandibular foramen to left mandibular foramen and mandibular foramina to genial tubercles we calculated the mandibular index (Table 2). In male the mandibular index was calculated as 90.18 % where as in female it was calculated as 91.90 %. From mandibular index we can estimate or determine the sex of mandible even if we have the broken or fragmented mandibles which are having the mandibular foramina and genial tubercles.

With the help of all these measurements we can estimate and determine the sex of the mandible from its fragments even if there no external features are clear bywhich we can say the sex of the dry mandible. This study will help the forensic dentistry and anthropologist in their diagnosis and in determination of sex of the mandible in their studies.

DISCUSSION

According to Rai *et al*. (2007), one of the main differences of the genetic male and female is the individual characteristic of their skeleton. The skeleton is referred to as an excellent material in living and nonliving population for genetic, anthropological, odontology and forensic investigations. The identification of skeletal remains as male or female is particularly important as it can help to confirm or exclude an individual's identity. As Kemkes-Grotternthaler (2002) identified, thin determination of gender can be conducted by using two method, metrically(using previous statistics) or descriptively (morphologically). As the cranial features vary between the two genders, and the differentiation usually based on the features that are typically more prominent and well defined in the males as compared to those found in the females (Rai *et al*., 2007). It is possible to exploit this differentiation for the purposes of identification.

Vodanovic *et al*. (2006) suggested that along with others that the mandible of the male is more robust and defined, in other terms chiseled, than that of the female.The study conducted by Suazo *et al*. (2008), they noted that the mandible of a female appears filed, smooth to touch and look and had an overall general small dimensions when measured. Franklin *et al*. (2007), Johnson *et al*. (1990) and Naccarato and Johson (2008) all noted that the dimensions of the male mandible is considerably larger and longer especially in the length and height of the mandible body. In addition, male mandibles typically have squarer chin and thicker, roughened muscle attachments than female mandible. An adult mandible can be used to identify both sex and population affinity with increased sensitivity and objectivity as compared to other standard analytical techniques (Franklin *et al*., 1996). Sex may even be determined from lower jaw fragments (Potsch-Schneider *et al*., 1985).

There is statistically significant sex difference in the mandibular angle and length in context to gender and race for example the average angle of the black Zimbabweans is greater than the value reports for some black African population (Mbjiorgn *et al*., 1997). Anthropologists worked in different regions to evaluate the mandibular angle and to analyze the relationship of the ramus of mandible to the gender, so as to study its role in the anthropological diagnosis (Rai *et al*., 2007).

The identification of sex from human remains is of fundamental importance in forensic medicine and anthropology, especially in criminal investigations as well as in the identification of missing persons and in attempts at reconstructing the lives of ancient population.One of the important aspectsof forensics is to determine the sex from the fragmented jaws and dentitions (Vodanovic *et al*., 2006).The determination of sex based on morphological marks is subjective and likely to be inaccurate, but the methods based on measurements and morphometery are accurate and canbe used in determination of sex from the skull (Humphrey *et al*., 1999; Franklin *et al*., 2007; Franklin *et al*., 2008). The mandibles were used for analysis for two sample reasons; firstly, there appears to be a panicity of standards utilizing this element and secondly, this bone is often recovered largely intact (Franklin *et al*., 2008).The mandible contributes immensely to the determination of sex. Winson (2004) suggests that direct observation of certain features help in the preliminary identification, however to confirm sex a number of other measurements must be taken of the mandible, skull and pelvic.

The present study correlates with the studies done by Vodanovic *et al*. (2006), Suazo *et al*. (2008), Franklin *et al*. (2007), Johnson *et al*. (1990), Naccarato and Johnson (2008).They reported that the dimensions of male mandibles are considerably larger and longer in lengths and heights of the mandible body as compared to mandible of female.The present study is helpful in determining sex of the mandible which is helpful for the forensic medicine, forensic dentistry, anthropologists and maxilla-facial surgeons in their diagnosis and treatment.

Conclusion

The mandible bone is the largest and strongest bone of the face. It can easily beavailable after the disasters. It destroys very less and decays very late. It is the bone by which we can easily determine the sex by its external features and by its various measurements and parameters. The variations in external features and various measurements of the human mandibles of both the sexeswill help in determination of sex of an individual. By keeping in mind all the variations and differences of the studies, we can identify the sex of the person from the unknown mandible. This study will be helpful to the forensic

dentistry, forensic medicine and anthropologists to give there correct identification of sex of the individual in medico legal cases.

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