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Original article

Determination of sex in Bosnia and Herzegovina population based on morphometric measures on mandible: bigonial width and bicondylar width

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Abstract

Introduction: Determination of sex from an unknown human bone is an important role in forensic and anthropology field. The mandible is the largest and hardest facial bone, that commonly resist post mortem damage and forms an important source of information about sexual dimorphism.
Aim: To determine the sex of unknown human adult mandible using metrical parameters.
Material and Methods: A random collection of 80 dry, complete, undamaged human adult mandibles of Bosnia and Herzegovina population were subjected to metrical parameters like Bigonial width, Bicondylar width using specially designed Ellips software. The data's were expressed as Mean ± SD and then analysed by t-test by use of SPSS software. Discriminating point and limiting points were also calculated.
Results: In the present study, the Bigonial width was observed to be 9.57 ±5.19 cm in males and 8.87 ± 6.78 cm in females. The independent t test was done on to compare the two sets of means and P value was less than 0.0001 ($p<0.05$) which proves to be statistically significant. The Bicondylar width was observed to be 11.27 ± 5.57 cm in males and 10.75 ± 7.68 cm in females. The independent t test was done to compare the two sets of means and P value was less than 0.008 ($p<0.05$) which proves to be statistically significant.
Conclusion: The present study revealed that the sex of human mandible can be assessed by using metrical parameters as an additional tool to establish the identity of a person.
Keywords: Mandible, Sex determination, Bigonial width, Bicondylar width

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Introduction

Identification of human skeletal remains is very important and 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 purpose. According to Krogman, the degree of accuracy in sexing adult skeletal remains is entire skeleton 100%, pelvis alone 95%, skull alone 90%, pelvis and skull 98% and long bones alone 80% (1). In case of mass disasters like explosions, earthquake, warfare, aircraft crashes, floods, only when the fragmented bones are found, sex determination with 100% accuracy is not possible and it depends largely on the available parts of skeleton. Skull is the most dimorphic and easily sexed portion of skeleton after pelvis. However, in cases where intact skull is not found, mandible may play a vital role in sex determination, as it is the most dimorphic bone of skull.
The mandible is the largest and hardest facial bone and retains its shape better than other bones in the forensic and physical anthropologic field. The mandible can be used to distinguish among ethnic groups and between sexes. Mandibular ramus can differentiate between sexes, as the stages of mandibular development, growth rates, and duration are distinctly different in both sexes (2). In addition, masticatory forces exerted are different for males and females, which influences the shape of the mandibular ramus (3).
Identification of sex is made on differences in shape and size of the morphological marks (4). The morphological marks are more subjective and sex determination depends on experience of the investigator, so visual methods of sexing skull are likely to be inaccurate when performed by an inexperienced worker (5). In sexing a skull the initial impression is often the deciding factor; a large and robust skull is generally male, a small and gracile skull is female (6). This subjective approach of sexing skull may sometimes produce misleading results. Methods based on measurements and

morphometry are accurate and can be used in determination of sex from the skull. Discriminant function analysis of skeletal measurements is a reliable method that overcomes some of the problems inherent in subjective methods of sexing skulls. It is increasingly utilized for sex diagnosis from skeletal measurements.

Material and methods

The material used for the study contained 80 human mandibles of known sex obtained from Department of Anatomy, Medical Faculty, University of Sarajevo. The bones collected were free from any pathological lesions or fractures. Totally edentulous mandibles with absorbed alveolar margins were excluded from this study. All mandibles were photographed using a Nikon D5200 (AF-S 18-105MM VR KIT LENS) digital SLR camera. All photos were transferred in the specially designed Ellips software (ViDiTo, Zoltan Tomoris, Kosice, Slovac republic, tomori@saske.sk.)
Mandibular measurements were performed using Linea system program. All measurements were done in centimeters and all the values were read out to two decimal places. Bicondylar width - it is the straight distance between the most lateral points on the two condyles. Bigonial width - it is the distance measured horizontally from the right gonion to the left gonion. All the variables were measured by two two professors of anatomy who were trained to use the same reference points required for obtaining the measurements of the linear distances on each picture.

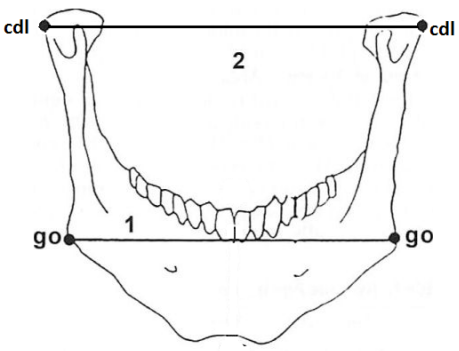

Figure 1. Bigonal and bicondilary widths (1,2)

After all the measurements were done, observations were statistically analysed by SPSS Statistics 21. Independent t-test for samples was used to test the difference between genders in the total sample size. The level of statistical significance was set at $p < 0.05$.

Results

Bigonial width of male mandible varied from 85.6 – 10.51 cm with an average of 9.57 ± 5.19 and that of female mandible varied from 7.82 – 10.3 cm with an average of 8.87 ± 6.78. The demarking point of Bigonial width for male was more than 10.91 and for female was less than 8.01. Limiting point for Bigonial width was 9.22, by which 72% of male and 80% of female were correctly sexed. The gender differences in mean values of Bigonial width of male and female mandible was statistically highly significant (p=0.0001) (Table 1).

Table 1. Bigonial width

Details of measurement	Male	Female
No of bones	40	40
Ranges (cm)	8.56 –10.51	7.82 –10.30
Mean ± SD	9.57 ±5.19	8.87 ±6.78
p value	0.0001	

Bicondylar width of male mandible varied from 10.27 – 12.20 cm with an average of 11.27± 5.57 and that of female mandible varied from 8.65 – 11.65 cm with an average of 10.75 ± 7.68. The demarking point of Bicondylar width for male was more than 13.05 and for female was less than 9.61. Limiting point for Bicondylar width was 11.01, by which 72% of male and 68% of female were correctly sexed. The gender differences in mean values of Bicondylar width of male and female mandible was statistically highly significant (p=0.008) (Table 2).

Table 2. Bicondylar width

Details of measurement	Male	Female
No of bones	40	40
Ranges (cm)	10.27 –12.20	8.65 – 11.65
Mean ± SD	11.27 ± 5.57	10.75 ± 7.68
p value	0.008	

Discussion

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 (7) and in attempts at reconstructing the lives of ancient populations (8). The sexual difference in the human skeleton has been well studied in many populations (6) The skeletal components most often investigated for gender determination are the pelvis (6) and the skull (9). Identification of humans using the unique features of teeth and jaws has been used since Roman times, because humans show dimorphism in jaw and teeth dimensions and morphology of both adults and

children. One of the important aspects of forensics is to determine sex from fragmented jaws and dentition (10). Numerous studies have clearly demonstrated that skeletal characteristics vary by population and that there is a need for population specific standards for sex determination (11).

In the present study the mean value of the bigonial width of mandible was found to be 9.57 cm in males and 8.87 cm in females. The values in the female mandible was lesser compared to that obtained in males.

Jayakaran et al., in their series of 207 mandibles found that the mean of bigonial width for male mandible was 9.38 cm and of females was 8.71 cm (12). Franklin et al., based on measurements of 225 mandibles suggested that the mean of bigonial width in males was 9.35 cm and of females was 8.70 cm. (13).

Ranganath et al., in their study on 111 mandibles (65 males, 46 females) showed that the mean for bigonial width for male was 8.68 cm and for females was 8.62 cm. (14). Ongkana studied data on 102 mandibles which showed that the mean value of bigonial width for male mandible was 9.68 cm and for female was 8.97 cm (15).

In a study by Vinay et al., that included 250 mandibles, showed that the mean value of bigonial width of male mandibles was found to be 9.45 cm and in female mandibles was 8.74 cm. (16).

The present study showed statistically significant difference between male and female mandible values. The mean value of male mandibles in the present study was similar to previous studies. The mean values of females were found to be lesser than in males.

Conclusion

Determination of sex from skeletal remains has high forensic importance. The determination of sex by analysing the morphological aspects depends on the expert's ability. The present study has helped us to determine sex using metric parameters like bigonial width and bicondylar width, which are easy to determine and more reliable compared to traditional non-metric method.

Declaration of interest

The authors declare no conflicts of interest.

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