

Original Article

Sexual Dimorphism in Horizontal Length and Gonial Angle of the Mandible: A Radiographic Study

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Abstract

Background: Forensic anthropology is one of the most important sub-fields of physical anthropology in which anthropometric indicators are used to examine the biological characteristics of corpses. In the meantime, the mandible bone is regarded as a significant bone following the pelvic bone due to its high resistance and dimorphism characteristics. Thus, this study aims to investigate the two parameters of the body's horizontal length and the mandible's gonial angle using radiographic images.

Materials and Methods: In this study, 120 orthopantomography images were used to examine the parameters of the horizontal length of the body and the gonial angle. The parameters were quantitatively checked using EASY-DENT software. Then, the statistical data were analyzed using Prism software version 9.0 and T-test.

Results: In this study, the mean horizontal length of the mandible body in women and men was 97.16 and 83.97 mm, respectively, and the data analysis showed a significant difference between the two sexes. Also, the gonial angle in men was measured as 173.1 and 166.9 degrees on average on the right and left sides, respectively, and on average as 144.6 and 142.1 degrees on the right and left sides in women. The data analysis indicated a significant difference between the two sexes, while the gonial angle was greater in men than women.

Conclusion: According to the findings of this study, the two parameters of the horizontal length of the body and the gonial angle of the mandible can be significant indicators in forensic anthropology and other related studies.

Keywords: Anthropometry, Mandible, Gonial angle, Horizontal length

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Introduction

One of the most important branches of anthropology is forensics. This branch is a subset of physical anthropology, which utilizes the knowledge of dissection sciences to analyze human remains to determine corpses' identity¹. There are three major principles in forensics to identify a corpse. The first involves investigating biological features such as gender, age estimation, height, and other detectable

personal characteristics. The second principle is based on the time of the corpse's death, and the third principle deals with an investigation to find reasons that would explain the cause of death². In conditions where the skeleton has been damaged or degraded, or the corpse is incinerated, forensic anthropology is used for investigating biological characteristics, including sex determination³. The study and investigation of bones and measurement of anthropometry indicators can provide information about the sex, height, ancestors,

and age of the person at the time of death⁴. In cases with only some remaining from the corpse, the pelvis and skull are the best preserved and most reliable structures⁵. Among skull bones, the mandible remains more intact against degradation compared to other parts because of its large size and being stronger structurally.

Meanwhile, this bone shows high degrees of discrepancy between the two sexes⁶. Research also suggests differences in morphological characteristics of this bone across different ages and races, which add to the importance of this bone⁷. These features make the mandible the most important element for determining biological characteristics without a complete pelvis⁸.

Among the different methods used in forensic anthropology for determining the sex, race, and age of individuals, the radiological process has advantages over physical, histological, and biochemical methods. This method is simple, rapid, economical, and noninvasive. It also enjoys high accuracy for measuring anthropometric indicators and can be used for detecting the corpse remaining^{13, 14}. Thus, considering the importance of examining and understanding the mandible bone in forensic anthropology and medicine, as well as for adapting the data to novel methods used, this study aimed to investigate the horizontal length of the body and gonial angle in mandible bone as well as sexual dimorphism based on radiographic images in Mahdasht city in 2023.

Methods

The study was reviewed and confirmed by the ethics committee at Shahid Beheshti University of Medical Sciences (IR.SBMU.MSP.REC.1401.27). In this descriptive study, 120 oral and maxillofacial radiographic images (62 males and 58 females) were chosen from patients referring to Shariati Hospital in Mahdasht City in Alborz province, with orthodontic, periodontic or root canal therapy purposes. The patients were 18 to 55 years old, and the images were captured within six months, from October 2022 to March 2023. The inclusion criteria were the mentioned age range, no history of damage or fracture in the oral and maxillofacial region, sufficient clarity in the radiographic image, and no history of

orthodontic treatment. The exclusion criteria included age younger than 18 or older than 55 years, history of fracture and damage in the oral and maxillofacial region, having genetic disorders or diseases that would influence the skeletal system, interventions and traumas affecting the oral and maxillofacial region, and insufficient resolution of the radiographic image. The radiographic images were recorded using Yoshida panoramic device (Japan) and under the same conditions and position for all patients.

Meanwhile, the device would record the radiation conditions based on the patient's age group. A radiology expert captured the images, and after confirmation from the radiologist, it underwent anthropometric investigations. For examining the anthropometric parameters of the mandible, Indra et al.¹⁵ methods and EASY-DENT software were used for precise measurement of two parameters, horizontal length of the mandible and gonial angle. For the linear analysis, two points and the line connecting these two points were used (Fig. 1)¹⁶. This study defines the horizontal length as the distance between two horizontal lines intersecting Gonion and Gnathion⁷. Also, Gnathion is defined as the bottommost and foremost point on the anterior edge of the mandible body symphysis. In contrast, Gonion is a point at the intersection of the mandible body and branch¹⁸. The Gonial angle is created between the ramus and mandibular lines; in this definition, the ramus line is a line tangential to the posterolateral of the mandibular ramus, while the mandibular line is considered as infra-lateral of the mandible body (Figure 1)¹⁹.

Statistical analysis: The statistical investigation was done using Prism software, Version 9.0. Normal data distribution was confirmed using the Shapiro-Wilk test, and considering the number of groups in this study



Figure 1. Method of measuring the parameters using EASY-DENT software. The blue measurement pattern is related to the Gonial angle while the red one is associated with the horizontal length of the body.

t-test was used. The mean value of the data was measured on both the right and left sides, then compared between males and females to examine any possible relationship. The significance level was considered lower than 0.05 ($P < 0.05$).

Results

In this study, the mean age of the participants was estimated at 38.4 years. The results showed that the horizontal length of the mandible body with a mean value of 97.16 was significantly larger in women compared to men ($P < 0.05$) (Table 1 and Diagram 1). Meanwhile, regarding the Gonial angle parameter, the values on both right and left sides, 173.1 and 166.9, were significantly larger in men compared to women ($P < 0.05$) (Table 2 and Diagram 2).

Discussion

Our study showed that the two parameters of the horizontal length of the mandible body and Gonial angle were significantly different between the two

Table 1: Anthropometric indicators of the mandible in males and females.

Parameter	Mean \pm SD ¹		P value ¹
	Female	Male	
Body horizontal length (mm) ¹	97.16 \pm 12.5	83.97 \pm 20.44	0.0185 or*
Gonial angle (right)	144.6 \pm 8.7	173.1 \pm 6.01	0.001 or**
Gonial angle (left)	142.1 \pm 8.03	166.9 \pm 5.2	0.0331 or*

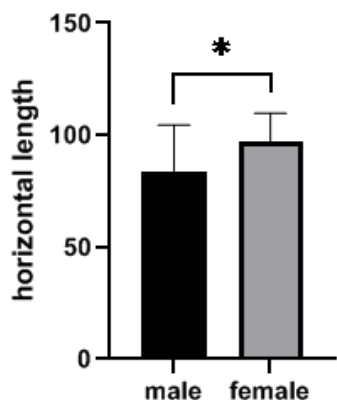


Diagram 1. Horizontal length parameter showing significant difference between the two sexes ($P = 0.0185$).

Table 2: The mean Gonial angle in other studies.

Researchers	Studied population	Mean Gonial angle (°)
R.B. Upadhyay et al. ²⁶	India	129.36
Qiu-Fei Xie DDS et al. ²⁷	Finland	123.5
S. Ghosh et al. ²⁸	India	122.29
V. Dhara et al. ²⁹	India	118.5
Bhuvaneshwari et al. ³⁰	India	128.1

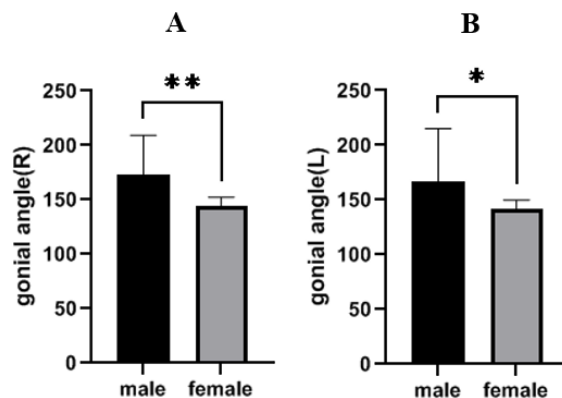


Diagram 2. A) Gonial angle parameter on the right side showing a significant difference between males and females ($P = 0.001$); B) Gonial angle parameter on the left side, again revealing a significant difference between men and women ($P = 0.0331$).

sexes. In this study, the horizontal length of the mandible body with a mean value of 97.16 mm was significantly larger in women compared to men. In contrast, the Gonial angle with the mean values of 173.1 and 169.9 on the right and left sides was significantly higher in men than women.

In the study by Sharma et al., in line with the present research, a significant difference was observed in the parameters of horizontal length, oblique length, and ramus minimum width between the two sexes, while in that study horizontal length of the body was significantly larger in males compared to females¹⁷. Although in both studies, the horizontal length parameter is regarded as a favorable parameter for sexual dimorphism, the difference in the details of results can overshadow the application of this parameter. The difference observed in the results of the two studies can arise from differences in genetic, environmental, and racial factors, as well as dietary

habits in the two populations²⁰. Further, the activity of the mandible at the early stages of development can affect the anthropometric factors of this bone²¹.

In line with the results of this research, Bali et al. showed that the Gonial angle with a significant difference between the two sexes can be considered a parameter for sex determination. In the mentioned study, incongruent with the present study results, the Gonial angle was measured as larger in females compared to males on average²². Meanwhile, the results of Sharma et al., discordant with the present study findings, showed no difference in the Gonial angle of the two sexes¹⁷.

Measurement of parameters indicated that the horizontal length of the body in the present study was 83-97 mm; these values differ from the investigation of an Indian population with sizes up to 71 mm¹⁷. Meanwhile, the measurement of the Gonial angle in this study, with a mean value of 170 in males and 143.35 in females, has been larger compared to studies presented in other populations (Table 2). Furthermore, the mean Gonial angle in the studied population was larger on the right than the left side, which can be related to the unilateral masticatory habit in people¹⁸. Dimorphism of the mandible bone can arise from differences in the sedimentation rate of minerals, bone resorption, absorption, growth of the masticatory muscles, and differences in the strength of these muscles²³. Meanwhile, differences in the size of these parameters across different populations can emanate from discrepancies in diet, living environment, and race of individuals²⁴.

Extensive studies have been done on the dimorphism capacity in the mandible bone. Franklin et al. reported differences in the shape and size of the mandible and considered the most significant shape difference in the two sexes related to condyle and ramus¹². The results of a study by Soltani et al. showed that the length of the mandible ramus was higher in men than women. In contrast, no significant difference was reported in this study between the mandible ramus's width and the mandible body's length²⁵. Following previous studies and based on the present research findings, it can be stated that two parameters of the horizontal length of the body and the Gonial angle of the mandible, given the differences observed between the two sexes, can indicate sex determination in forensic anthropology.

Conclusion

With its large thickness, the mandible body is one of the strongest parts of this bone against damage, making its associated parameters useful in forensic anthropology. Meanwhile, after investigating and confirming the difference in the parameters of the horizontal length of the body and the gonial angle of the mandible between the two sexes using radiographic images, the present study considers these two parameters valuable and reliable indicators in sex determination.

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Conflict of interest

The authors further declare that they have no conflict of interest.

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