Comparison of mandibular ramus and mental foramen among men and women: a study of panoramic radiographs in dental hospital of universitas gadjah mada

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ABSTRACT

Background: *The identification of victims is becoming an integral part of forensic investigations. The initial step in forensic identification is sex determination. Using panoramic radiographs, it is possible to determine the height of the mandibular ramus and the distance to the mental foramen for the purpose of sex determination. This study aimed to compare the mandible ramus height and mental foramen distance on panoramic radiographs between men and women.*

Method: *This study utilized 70 panoramic radiographs of complete mandibular dentition from 35 men and 35 women aged 20 to 40 years. The samples were obtained from Dental Hospital of Universitas Gadjah Mada.*

Result: *The average height of mandible ramus in male and female groups were 58.39±2.25 mm and 53.14±2.66 mm, respectively. The distance of the mental foramen was 12.68±1.63 mm in the male group and 10.83±1.23 mm in the female group. The Independent Sample t-test revealed that the p value for the difference between men and women in ramus height and mental foramen distance was 0.000 (p<0.05).*

Conclusion: *Based on the result of this study, both the height of the mandible ramus and the distance of mental foramen on a panoramic radiograph differ significantly between males and females*.

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INTRODUCTION

Individual identification is a method of identifying people based on their physical characteristics that commonly used to identify victims in an accident or disaster. In addition to providing legal certainty for living individuals, the identification procedure plays a crucial role in determining the cause of death and providing the victim's family with psychological closure by establishing the victim's identity (1). Sex, age, and racial identity are variables that can be used to identify an individual. Sex determination is an important first step in the forensic identification because it can determine a 50% possible match in individual identification and can influence other examination methods such as age and height estimation (2).

Human skeleton identification is regarded as a starting point for forensic identification and is critical for further investigation. The most commonly studied skeletal components for sex determination are the pelvic and cranial bones. Mandibles can also be used to investigate sexual dimorphism in a fragmented skeletal condition. Sexual dimorphism refers to sex differences in certain body part. Among other skeletal component in the head and face, the mandible is most resistant to changes in external conditions. This occurs because the mandible has a dense bone layer (3).

Measurements of mandible can be made with a panoramic radiograph (4). Currently, digital radiographic technology enables more effective morphometric and anthropometric measurements. A panoramic radiography produces a single tomography image of the facial structure, including the upper and lower dental arches as well as the supporting tissues (5).

Previous study has revealed that the male and female mandibles differ in shape and size (3). The measurements for ramus height of mandible can be performed on digital panoramic radiographs to identify sex differences, with males having a larger and higher ramus than females (6,7). In addition to measuring the height of the mandible ramus, linear mandibular measurements related to the position of the mental foramen can be used to determine sex differences. A previous study also found that the distance between the mental foramen and the mandibular base in panoramic radiography differed between men and women (4).

This study compares the measurements of ramus height and mental foramen distance on panoramic radiograph among patients of RSGM UGM Prof. Soedomo in male and female groups. The results of this study are anticipated to provide a description of the height of the mandibular ramus and mental foramen, which can be used as a foundation for future studies aimed at sex determination in the Indonesian population.

METHOD

This study used a cross-sectional design to conduct an observational analysis. This study was approved by the Research Ethics Commission of the Faculty of Dentistry at Universitas Gadjah Mada (Ref No. 00613/KKEP/FKG-UGM/EC.2021). Total of 35 panoramic radiographs of male patients and 35 panoramic radiographs of female patients taken in 2019–2020 are used as samples in this study. Panoramic radiographs were collected from patients aged 20 to 40.

Panoramic radiographs were retrospectively collected from Dentomaxillofacial Radiology department at Prof. Soedomo Dental Hospital, Universitas Gadjah Mada, Yogyakarta, Indonesia. As the study sample, radiographs that meets the following criteria were used: the radiograph includes the entire maxillary and mandibular teeth; and their supporting tissues; the right and left molar teeth provide a symmetrical mesio-distal width; the

apical of maxillary teeth is clearly visible; the visible ghost shadow at the contra-lateral of the mandible must be as thin as possible; the cervical spine should be visible; the patient's identity and the date of radiograph taking should be clearly visible and not superimpose with the normal anatomical structure; the radiograph must have a clear symbol R (right) or symbol L (left). Furthermore, the panoramic radiograph should present the patient head in the proper position.

Figure 1. Measurement of mandibular ramus height using EzDent-I Vatech 2.1 Software

Measurements of mandibular ramus height and mental foramen distance on panoramic radiographs were performed using EZDent-I Vatech 2.1 Software. Figure 1 illustrates the height of the mandibular ramus as measured in this study. Two tangents of the gonion are initially created, one along the back edge of the mandibular ramus and the other along the lower edge of the mandible. The height of the mandibular ramus is measured on a digital panoramic radiograph by drawing a line from the most superior point of the condyle to the point where the two tangents meet. The mandibular ramus was measured on both sides, and the average height of the left and right mandibular ramus was calculated.

Moreover, the distance measurements of the mental foramen are depicted in Figure 2. A vertical line is drawn from the most inferior point of the mental foramen to the mandibular inferior border to measure the distance. After measuring the distance between the left and right mental foramen, the average distance between the two sides is calculated. The Independent Sample t-Test was performed to determine whether the height of the mandibular ramus and the distance of the mental foramen differed between males and females groups.

Figure 2. Measurement of mental foramen distance using EzDent-I Vatech 2.1 Software

RESULTS

Table 1. Mean and standard deviation of mandibular ramus height and mental foramen distance

Group	n	Age (Mean ± SD)	Mandibular Ramus Height (mm) (Mean ± SD)	Mental Foramen Distance (mm) (Mean ± SD)
Male	35	29 ± 6.6	58.4 ± 2.3	12.7 ± 1.6
Female	35	28 ± 5.5	53.1 ± 2.7	10.8 ± 1.2

Table 1 displays the average and standard deviation of mandibular ramus height and mental foramen distance. Male subjects had an average age of 29 ± 6.6, while female subjects had an average age of 28 ± 5.5. According to Table 1, men had a greater average mandibular ramus height and mental foramen distance than women.

All of the measurements are then tested for reliability on 20% of the total 70 panoramic radiograph samples, including 7 samples from male and 7 samples from female subjects. The reliability test aims to find out whether or not the same object remains consistent when the measurement is taken (9). In an interval of one week, two measurements for the intra-observer test were made. The validity

of the measurement was also assessed using the inter- observer test. The results of Cronbach's Alpha indicated that intra-observer reliability was 0.999 and that inter-observer reliability was 1.000. The reliability test results in this study are in the range of values 0.80 - 1.00, indicating that these measurements are very reliable (8).

Table 2. Results of Independent Sample t-Test of mandibular ramus height and mental foramen distance between the right and left sides

Independent Sample t-test				
Group	**Mandibular Ramus Height Right and Left Side**		**Mental Foramen Distance Right and Left Side**	
	df.	Sig. (2-tailed)	df.	Sig. (2-tailed)
Male	68	0.327	68	0.379
Female	68	0.709	68	0.753

In this study, measurements were taken on both the right and left sides of the mandible to determine the mental foramen distance and the height of the mandibular ramus. The results of the Independent Sample t-test for the right and left measurement data are listed in Table 2. The Independent Sample t-test results in Figure 3 indicate that the height of the mandibular ramus and the distance of the mental foramen between male and female groups differ significantly ($p < 0.05$).

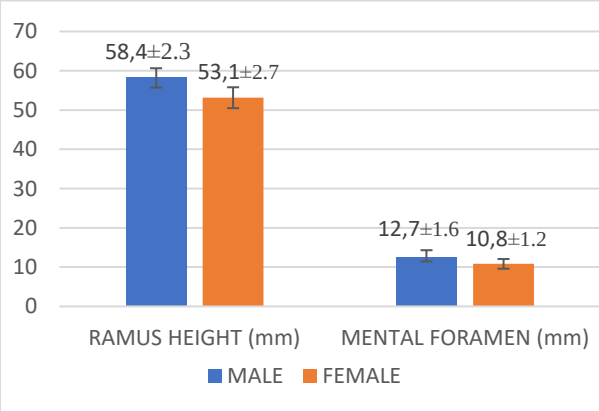

Figure 3. Results of Independent Sample t-Test of mandibular ramus height and mental foramen distance on men and women. The data is presented in a graph of the mean and standard deviation *p<0,05

DISCUSSION

The facial structure, including the upper and lower dental arches and their supporting tissues, can be seen in a single tomographic image generated by panoramic radiography. Panoramic radiographs are commonly used to support the diagnosis of oral and maxillofacial diseases. The primary advantages of using panoramic radiographs are their broad image coverage, low radiation doses, short exposure time, and ability to be used for retrospective studies. Previous studies have found that panoramic radiographs provide accurate linear and angular measurements of mandibles (10,11).

As measured by panoramic radiographs using EzDent-I Vatech Software, the male group had a greater mandibular ramus height and mental foramen distance than the female group, as shown in Table 1. Furthermore, the Independent Sample t-test significant level was $p < 0.05$, indicating that there is a statistically significant difference between men and women groups in terms of the height of the mandibular ramus and the distance of the mental foramen (Figure 3).

In Table 2, the significance level for the Independent Sample t-test for the height of the mandibular ramus and the distance between the right and left sides is $p > 0.05$. According to the test results in Table 2, there are no significant differences between the left and right measurement results.

The average mandibular ramus height for men were 58.4 ± 2.3 mm and for women were 53.1 ± 2.7 mm (Table 1 and Figure 3). The results obtained in this study are in accordance with previous studies that showed the average height of the mandibular ramus in men was 68.7 ± 7.8 mm and in women was 62.9 ± 8.0 mm (6). Based on other studies, the average height of the mandibular ramus in men was 53.2 ± 5.8 mm and in women

was 49.1 ± 4.5 mm. The results of this study are consistent with these findings (12). The height of the mandibular ramus was greater in men than in women according to this study and previous studies.

Due to different remodelling process and deformations in the mandibular ramus, men and women tend to have different mandibular ramus heights. The difference in growth rate between men and women also results in a difference of the mandibular ramus height. Moreover, men have craniofacial dimensions that are 5 – 9% larger than women. The hormonal differences between men and women also play significant role in bone development. Increased levels of testosterone and IGF-1 regulate bone and muscle growth during male puberty. Increased testosterone causes an increase in muscle mass and strength, whereas the hormone IGF-1 affects bone structure and strength. Sex hormones in women, such as estrogen and progesterone, can affect bone growth rates and cause craniofacial morphological differences between men and women (13,14). The shape of the mandibular ramus can also be affected by the differences in masticatory forces between men and women. In general, men have stronger masticatory muscle than women, so the male mandible is shaped differently than the female mandible (15).

Figure 3 shows the results of measuring the distance of the mental foramen in men and women. In men, the distance is 12.7 ± 1.6 mm and in women, it is 10.8 ± 1.2 mm. In line with the previous research, the distance of the mental foramen in men and women was determined to be 10.4 ± 1.8 mm and 8.6 ± 1.5 mm, respectively (4). Other studies have shown that the average results of mental foramen distance in men and women aged 20 – 29 are 14.5 ± 1.8 mm and 13.6 ± 1.3 mm, aged 30 – 39 are 14.9 ± 1.2 mm and 12.6 ± 1.3 mm, and aged 40 – 49 are 14.5 ± 1.9 mm and 12.4 ± 2.2 mm (16). Based on the results of this study and previous studies measuring the distance of the mental foramen, it was defined that the distance of the mental foramen was greater in men than in women.

Gender, race, and mandibular development from infancy to adulthood influence mental foramen anatomical variations. The enlargement of mandibular arch and craniofacial type result in a wide face shape, so the mental foramen will be more posteriorly located. As the mandibles grow, the mental foramen will shift further posteriorly. These changes are the result of the expansion of the mandibular corpus. The mandibular corpus tends to be elongated in order to accommodate the eruption of permanent molar teeth. In addition, the location of the mental foramen is affected by the development of mandibular symphysis, mandibular condyle, changes in alveolar processes, the eruption period of teeth, the development of inferior alveolaris nervus, and the movement of teeth into the mesial. The general rate of growth and the stages of growth at different ages are different for men and women (17).

In forensic analysis, differences in mandibular ramus height and mental foramen distance between men and women can be used to compare antemortem data (collected during life) and postmortem data (collected after death). In accordance with previous study, forensic analysis requires an individual's biological identities, including gender, age, height, and ethnic background (10). Mandibles and their changes in relation to age, gender, and race can aid physicians, surgeons, medico-legal experts, and anthropologists in making the correct decisions and obtaining accurate sex determination.

In cases where the cranium is missing, the mandible plays a significant role in sex determination because it is the most dimorphic, largest, and strongest part of the skeleton in the

head and neck region. In addition, the mandibles can last longer and well preserved compared to other bones. Dimorphism in the mandible is visible from their shape and size. Men mandibles are generally larger and stronger than in women (3). The size and composition differences between men and women also have an impact on the mandible (18). In general, men have a larger, irregular mandible shape with a more prominent chin, whereas women have more regular mandible shape and a more rounded chin. Several factors, including the acceleration of mandibular growth during adolescence, the stages of mandibular development, growth rate, and duration, are responsible for the differences in the mandible between men and women. In addition, masticatory force can affect the shape of the ramus in men and women (19).

CONCLUSION

On panoramic radiographs, the height of the mandibular ramus and the distance of the mental foramen between males and females revealed statistically significant differences. Men have greater ramus height and mental foramen distance than women. In this study, measurements of mandibular ramus height and mental foramen distance were taken bilaterally, i.e., on both sides of the mandible for the male and female groups. However, there was no difference in mandibular ramus height and mental foramen distance between the right and left sides, both in male and female groups. Based on the scientific findings of this study, further studies can be developed to propose a method of sex determination for the Indonesian population.

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