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Panoramic radiograph measurement of upper mandibular ramus breadth for sex determination

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ABSTRACT

Objectives: This research is aimed to see the difference of the upper mandibular ramus breadth between male and female patients in Rumah Sakit Gigi dan Mulut Pendidikan (RSGM-P) Fakultas Kedokteran Gigi Universitas Trisakti, West Jakarta according to radiomorphometry.

Materials and Methods: This research uses observational analytical design on 166 digital panoramic radiographs, 83 male radiographs and 83 female radiographs, of patients aged 18 and above from the Installation of Dental Radiology in RSGM-P FKG Universitas Trisakti. The measurement was performed on left upper mandibular ramus breadth using the computer software i-Dixel version 2.2.0.3 (Morita Japan). The data is analyzed using comparative independent t-tests to see the difference between the genders.

Results: The result of this study shows the mean value of the left upper mandibular ramus breadth in male (31.55 ± 2.66 mm) is higher than female (29.42 ± 2.58 mm) with p-value = 0.000.

Conclusion: The upper mandibular ramus breadth measurement shows significant difference between genders.

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INTRODUCTION

Indonesia is known as one of the countries that is vulnerable to disasters, especially natural disasters. In mass mortality cases, forensic identification is needed.[1,2] Families, friends, and colleagues need the identity of the deceased for social, humanity, legal and finance reasons, and to bury the deceased according to their own culture.[3]

Determination of sex is usually the first step in identifying an unknown individual, this is because age estimation and body stature of an individual depends on their sex determination. Sex can be determined with 100% accuracy when all of their adult body parts are available for analysis. However, in cases where only fragments of body parts are found, 100% accuracy of determining an individual's sex is not possible.[4]

The skull, after the pelvis, is the most sexually dimorphic bone of the skeleton and can be differentiated sexually with 92% accuracy. The morphology, crown size, and root lengths are various features of the teeth that are characteristics for male and female sexes. In cases where a fully intact skull is not found, the mandible plays an important role in sex determination.[4] The mandible is the most sexually dimorphic, the largest, and the strongest bone of the skull. Hence, the mandible becomes a beneficial media for sex determination.[5]

The mandibular ramus, especially, shows the most sexual dimorphism and the most difference between male and female is seen in the ramus compared to the mandibular corpus.[4] Sex differences can be seen through the growth rate, duration and stages of the development of the mandible through the ramus.[6] The shapes and sizes of the mandible varies between male and female, where male have a much bigger mandible than that of a female. This is caused by the difference in masticatory forces where males have a much stronger masticatory force than females. Hence, mandibular ramus is recommended for sex determination in forensic odontology analysis.[6]

Identifying an individual using radiographs has been done for so long because of its efficient technique, relatively easy, records can be obtained whether the individual is alive or deceased, and it is far more economical compared to DNA technology.[7] The main advantage of a panoramic radiograph is its wide field size, very low radiation dose, and the time to obtain the radiograph is brief.[4] Panoramic radiograph is commonly used by dentists for treatment planning and diagnosis, especially in the orthodontic field, oral surgery and oral rehabilitation. Therefore, panoramic radiograph provides an important role in identifying

individuals.[8] For that reason, this researcher aims to see the difference of the upper mandibular ramus breadth between male and female in the Indonesian population as an indicator for sex determination as seen through radiomorphometry. This research aimed to analyze the difference in the left upper mandibular ramus breadth between males and females as seen through panoramic radiographs.

MATERIALS AND METHODS

This research was an observational analytic study with a cross-sectional approach. The subject for this research were digital panoramic radiographs of patients in RSGM-P FKG Universitas Trisakti, West Jakarta. Samples were chosen by simple random sampling method. 166 samples in total were studied where 83 samples were male and 83 samples were female. This study was done in the Installation of Dental Radiology in RSGM-P FKG Universitas Trisakti, from September up until December 2021.

The inclusion criteria for the samples were digital panoramic radiographs of patients aged 18 and above, and the area to be researched is fully visible. The exclusion criteria for the samples were if there are any fractures, anomalies, or pathological lesions in the mandible, as well as distortions of the radiographs, radiographs are not clearly visible, including the presence of ghost images.

The upper ramus breadth was measured (Figure 1) adopting the measurements Abu-Taleb and Beshlawey[9] used in their research. A line parallel to the transverse plane was made from the sigmoid notch until the most posterior point of the ramus which, creating line C. From the most posterior point a line was pulled up until the most anterior point, parallel to the transverse plane, making point A the most posterior point and point B the most anterior point of the mandibular ramus. The measurements were done using i-Dixel version

2.2.0.3 (Morita, Japan) software from digital panoramic radiographs resulting from Veraviewepocs 2D (Morita, Japan). DELL Monitor S2715H with a resolution of 1920 x 1080 was used throughout the study to keep the consistency of the measurement. Measurement was done by two observers where the first observer was the main observer and the second observer was a Dentomaxillofacial Radiologist. The data were then grouped according to sex with the help of Microsoft Excel 2019. The data were then analyzed using the software IBM SPSS version 25. Intraclass Correlation Coefficient test was first done to measure the reliability of two observers measuring the left upper mandibular ramus breadth for both sexes. A normality test was done using the Kolmogorov Smirnov test and a t-test was done using the independent t-test with the level of significance (α) of 0.05 for both tests to see the relationship between the two sexes.

RESULTS

166 samples of the left upper mandibular ramus breadth were measured, 83 samples of male patients and 83 samples of female patients. 8 samples from each sex, total 16, was measured by two observers to measure reliability in measuring the left upper mandibular ramus breadth. The inter-observer reliability test was done using the Intraclass Correlation Coefficient test. All tests in this research is done with the help of the software program IBM SPSS version 25.

The result of the coefficient from the test for both male and female was >0.90 which shows excellent reliability. Male showed the value of 0.995 which is 99.5% and female showed 0.957 which is 0.957%. This shows that there is a rather high agreement between observer 1 and observer 2 in measuring the left upper mandibular ramus breadth on 16 samples which included 8 males and 8 females.

A normality test was then conducted to see if
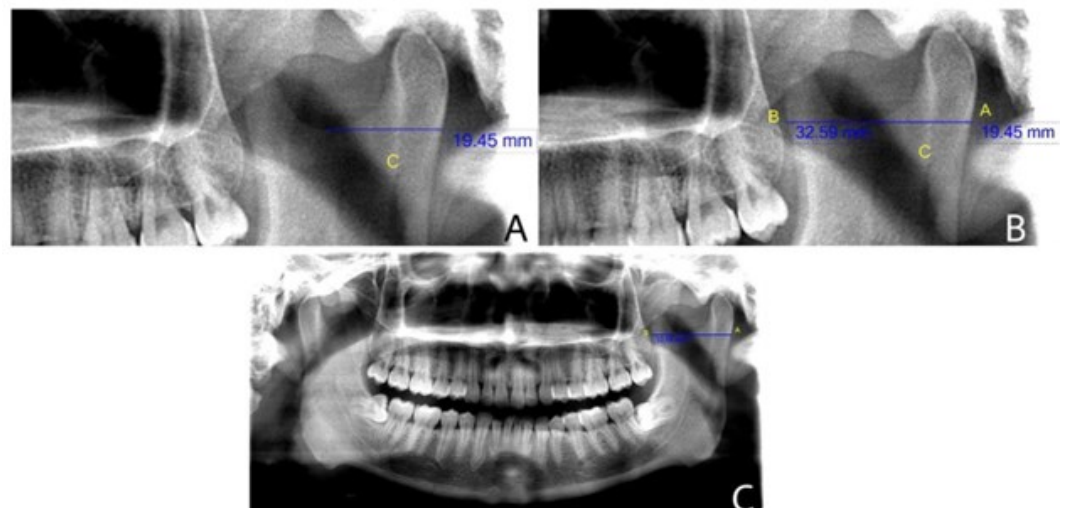
Figure 1. Upper mandibular ramus breadth measurement, (A) A line parallel to the transverse plane was made from the sigmoid notch until the most posterior point of the ramus. (B) From the most posterior point a line was pulled up until the most anterior point, parallel to the transverse plane. (C) Left upper mandibular ramus breadth was measured.

Table 1. Comparison test of the left upper mandibular ramus breadth between male and female using the Independent t-Test

Groups	n	Mean ± Standard Deviation (mm)	t	df	p-value
Male	83	29.42 ± 2.58	5.247	164	0.000
Female	83	31.55 ± 2.66			

the data measured were distributed normally or not. The normality test used was Kolmogorov Smirnov because each group had more than 50 samples, which is 83 samples for each sex group. Data is said to be normally distributed if the p-value is larger than 0.05, and if the p-value is lower than 0.05 then data is not normally distributed.

The p-value for both sex groups are larger than 0.05, which is 0.200, on 83 samples in each sex group. This means that the measurement data on both male and female left upper mandibular ramus breadth is normally distributed and an independent t-test can be done to compare the relationship between the two sex groups. A comparison test is done to compare the mean between the two sex groups. Levene's test was used for homogeneity of variance with the p-value being greater than 0.05, which is 0.987, meaning that the variances are not significantly different from each other. Results can be concluded by looking at the p-value.

The mean of the left upper mandibular ramus breadth in male is 29.42 ± 2.58 mm and left upper mandibular ramus breadth in female is 31.55 ± 2.66 mm, as shown in Table 1. P-value shows the result of 0.000 which can be concluded that there is a statistically significant difference of the result between the groups.

DISCUSSION

The mandible becomes an important media for identifying and determining sex when only fragments of the skull is found in cases where mass mortality happens.[4] The upper ramus breadth is one of the measurements that Abu-Taleb and Beshlawey[9] has done on the ramus mandibula out of five measurements, therefore it can be used to help identify a victim in cases where only fragments of the mandibula is found. In Abu-Taleb and Beshlawey's research, the upper ramus breadth is defined as the distance between the most anterior point to the most posterior point of the ramus passing through the sigmoid notch along a line parallel to the transverse plane.

The sample used in this research has an inclusion of panoramic radiograph of patients from the age of 18 and above. This is because the bone stops developing at the earliest age of 18 years old.[10] The reason for there being no age limit is because according to Rehman, Yasmeen and Qamar's[11] research, there is no significant difference between the ramus breadth of patients suffering from osteoporosis and those that are not suffering from osteoporosis. This research only uses the left side of the mandibula and this is to

reduce confusion. According to Abdulmawjood's[12] research, there is no significant difference in linear measurements seen through the lateral cephalometry and orthopantomography.

The panoramic radiograph is used to measure the left upper mandibular ramus breadth in this research because of its wide field size and its ability to capture the maxilla and the mandible.[13] A panoramic radiograph is able to show the anatomical structures needed in this research which are the posterior and anterior part of the ramus and the sigmoid notch along with it. Other than that, the panoramic radiograph is now commonly used by dentists to help with diagnosis.[14]

The result of the measurements in this study showed the mean of males left upper mandibular breadth is 31.55 ± 2.66 mm and females left upper mandibular breadth is 29.42 ± 2.58 mm. This data shows that males left upper mandibular ramus breadth is bigger than females. The statistic shows p-value lower than 0.05 which shows that there is a significant difference between the measurements of the two sex groups. This can be concluded that the left upper mandibular ramus breadth is one of the anatomies in the mandibula that is sexually dimorphic.

In cases where the deceased is found with their soft tissues still intact, such as the fingerprints, this is the ideal method to identify someone. However, in cases where the victim is mutilated, burnt, or the body has decomposed, it is not possible to identify the victim anymore. Therefore, the best forensic examination to identify a victim in cases like this is by using the victims' teeth and bone. The teeth and bone are very resistant to environmental factors, especially to fire and heat.[8]

The result of this study is in agreement with Abu-Taleb and Beshalwey's research, where male had a bigger ramus width than female. According to Abu-Taleb and Beshlawey's study, mean value of male is 4.22 cm whereas female is 4.02 cm with a p-value of <0.001. The measurement in this study differs from Abu-Taleb and Beshlawey's measurement where in the previous research, upper ramus breadth and lower ramus breadth is used to calculate the total ramus breadth, whereas this study uses only the upper ramus breadth mentioned in Abu-Taleb and Beshlawey's research.

This present study was also in agreement with a study conducted by Bhagwatkar et al.[15]. Five measurements were done to measure the mandibular ramus which are the maximum ramus breadth, minimum ramus breadth, maximum ramus height, projective ramus height, and coronoideus height. These measurements were done on both sides of the ramus on the two sex

groups. In their research, mean value of maximum ramus breadth in male is 42.01 mm and the minimum ramus breadth is 33.02 mm. Whereas mean value of maximum ramus breadth in female is 37.53 mm and the minimum ramus breadth is 31.57 mm. All variables showed the p-value <0.001 which can be concluded that there is a significant difference statistically between male and female ramus. This shows that the present study is in agreement with Bhagwatkar et al. study which demonstrates that male have a larger ramus breadth compared to female.

Indira et. al[4] conducted a study with the same measurements as Bhagwatkar et. al[15] and showed similar results. The mean of male maximum ramus breadth is 74.20 mm and the minimum ramus breadth is 51.35 mm, whereas female maximum ramus breadth is 68.98 mm and the minimum ramus breadth is 46.98 mm. The statistics showed p-value <0.001 in all variables measured on the mandibular ramus. A p-value lower than 0.05 shows that there is a significant difference between the two sex groups. This result is in agreement with their study as well.

One of the reasons for this significant difference in upper mandibular ramus breadth between male and female is because of hormones. Male that are going through puberty have testosterone that dominates the body along with IGF-1. Testosterone cause increased muscle mass and strength, whereas IGF-1 plays a role in bone anabolism. The combination of testosterone and IGF-1 together cause significant changes that cause the pattern of bone growth to change and is then dominated by periosteal apposition. Female produce higher estrogen levels and lower testosterone which results in the escalation of bone mass but not with bone widening. The increase in bone mass is caused by more endosteal apposition than periosteal apposition.[16] Other than hormones, the length of the puberty period influences the upper ramus mandibular breadth, where males have longer puberty periods than females.[17] Masticatory forces also play a role in influencing the size of the upper ramus mandibular breadth.[18]

CONCLUSION

The upper mandibular ramus breadth measurement shows a significant difference between genders, whereas the mean value of male is higher than female. This research strengthen previous studies where male tend to have a larger ramus that may be used to assist in sex determination.

ACKNOWLEDGMENTS

FOOTNOTES

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