The differences of RND between males and females and the correlation between age and RND based on panoramic radiographs

Suci Handayani[1], Rurie Ratna Shantiningsih[1], Rellyca Sola Gracea[1]

[1]Department of Dentomaxillofacial Radiology, Faculty of Dentistry Universitas Gadjah Mada, Indonesia

ABSTRACT

Introduction: Estimating age and sex through several radiographic methods have a significant role in the victim identification process. The mandibular ramus is thought to have a high degree of dimorphism and a close relationship with chronological age, which can be determined by ramus notch depth (RND). This study aimed to analyze the differences in RND between males and females and the correlation between age and RND based on panoramic radiographs. **Methods:** The type of study is an observational analytic cross-sectional study. The study sample comprised 70 radiographs (35 males and 35 females) aged 19-60 years with complete mandibular permanent dentition, including third molars. The samples were obtained from the database of the Dentomaxillofacial Radiology Installation of RSGM UGM Prof. Soedomo. Analysis of the radiograph was carried out by measuring the RND using EzDent-I Vatech Software with a scale of ratio 1:1. **Results:** The mean RND value was 2.31 ± 7.95 mm and 1.94 ± 4.93 mm in the male and female groups, respectively. Independent T-test results showed a significant difference ($p < 0.05$) in RND between the male and female groups. Pearson's correlation test result did not find any correlation between age and RND in the male dan female group ($p > 0.05$). **Conclusion:** RND in males is higher than in females, and there is no correlation between age and RND in both sex groups.

Keywords: panoramic radiographs; ramus notch depth; age; sex determination.

p-ISSN: 1979-0201; e-ISSN: 2549-6212; Available from: http://jurnal.unpad.ac.id/pjd/article/view/37498
DOI: 10.24198/pjd.vol34no2.37498
Submission: Jan 05, 2021; Accepted: Jul 31, 2022; Published online: Jul 31, 2022

INTRODUCTION

Forensic odontology is the branch of forensic medicine concerned with the examination, management, and presentation of dental evidence in court. The field of forensic odontology includes the examination of bite marks or orofacial wounds due to violence or sexual abuse, age estimation of living and dead individuals, human trafficking, and malpractice cases.[1,2]

Age estimation and sex identification are essential stages in the process of identifying victims of a mass disaster. The casualties due to mass disasters are oftentimes found as an incomplete entity of the body. Hence, age estimation and sex identification by dental or skeletal methods are needed to be done within Disaster Victim Identification (DVI).[3] The DVI process through such methods can be done by using part of the cranium. Age estimation can also be done to identify the

**Corresponding author: Suci Handayani, Department of Dentomaxillofacial Radiology, Faculty of Dentistry, Universitas Gadjah Mada, Indonesia, Denta I Street, Denta Sekip Utara, Yogyakarta, Indonesia, 55281. Phone: +62812-3947-3249; e-mail: suci.handayani@mail.ugm.ac.id*

basis who do not have inaccurate birth records such as refugees, immigrants, adopted children, and people who are in criminal proceedings.[1] Cranium is scientifically recognized as the most dimorphic bone aside from pelvic bone. Thus, making cranium has been proven capable to be used for sex identification.

The non-intact cranium resulting from the incidence can be substituted with the mandible.[4,5] Mandible is considered a good diagnostic fragment due to its strongest characteristic compared to the other part of the cranium. Ramus of the mandible is believed to have a high degree of dimorphism and a close relationship with chronological age, which can be determined through RND.[6] The mandibular ramus also has a relationship between morphological changes and chronological age.

Postnatal growth of the mandible in males has a more specific shape than in females. Nonetheless, the difference begins to fade due to faster growth in females at the age of 4-14 years. During puberty to adulthood, it is known that dimorphism is more common in the ramus and mental regions.[5,6,7] The mandible undergoes many anatomical and morphological changes along with growth and functional development. The remodeling process in the mandible is influenced by factors such as age, gender, and edentulous condition. Mandibular growth occurs at twice the rate of maxillary growth and involves anterior-superior rotation because posterior vertical growth exceeds anterior vertical growth.[8]

Ramus notch depth (RND) is the distance between the perpendicular line from the deepest point of the ramus notch concavity and the line drawn from the articulare (Ar) to the most posterior border of the mandibular angle.[9] According to Oksayan et al.[10] The edentulous condition affects ramus height, and age change can affect gonial angle, antegonial notch depth, and ramus notch depth (RND). RND changes can also be associated with anterior vertical facial growth and posterior vertical facial growth. Priyaet al.[11]

Also stated that there was a positive correlation between RND, ramus length, total anterior facial height, lower facial height, and posterior facial height suggest a relationship between deepening of the ramus notch with vertical anterior and posterior facial growth. Panoramic radiograph(orthopantomography) is one of the extraoral radiographic techniques which can provide a broad overview of the maxillary and mandibular dental arches and their supporting tissues in single imaging.[12] The common usage of panoramic radiograph is to evaluate jaw trauma, impacted teeth, tumors or cysts, growth of teeth, temporomandibular joint (TMJ), as well as measuring the degree of bone resorption. Panoramic radiographs also have the advantage of lower radiation doses, faster imaging taking, and more affordable prices.[12,13]

Panoramic radiographs have a lower probability of being superimposed, making them suitable for use in linear vertical measurements of the mandibular ramus and condyle.[10] Research on RND has been carried out previously to determine the correlation of RND with skeletal Class I, II, and III malocclusions.[8] Similar studies have also been carried out to find the correlation of changes in age and sex with several anatomical morphological points in the mandible, one of which is RND in dentate and edentulous subjects.[9] This study aimed to analyze the differences of RND between males and females and the correlation between age and RND based on panoramic radiographs.

METHODS

This study is an observational analytic cross-sectional study and was conducted from February to March 2021 at RSGM UGM Prof. Soedomo, Yogyakarta, Indonesia. In this study, 70 samples of digital panoramic radiographs were used which were taken in 2020 and stored in the Dentomaxillofacial Radiology Installation database, RSGM UGM Prof. Soedomo Yogyakarta with the inclusion criteria of 35 males and 35 females aged 19-60 years, the mandibular teeth were fully erupted (including the third molars) and were still complete. Exclusion criteria were no history of orthopaedic treatment, orthognathic surgery, craniofacial trauma, facial asymmetry abnormalities, and lesions due to systemic disease affecting the shape of the mandible

Digital panoramic radiograph samples were taken using a Vatech Pax-I® machine. panoramic radiographic analysis using EzDent-I Vatech 2.1 Software. RND tracing was performed by measuring the distance between the deepest point on the ramus notch concavity and the line drawn from Ar

to the posterior border of the mandibular angle as shown in Figure 1.[11] Statistical analysis using IBM SPSS version 26. Intra-observer and inter-observer reliability tests were performed with the Cronbach's Alpha test. The Kolmogorov Smirnov test was conducted to test the normality of the data and Levene's Test was performed to test the homogeneity of the data. Independent t-test was conducted to determine whether there was a difference in RND between the male and female groups. Pearson's correlation test was conducted to determine whether there was a correlation between age and RND in both sex groups. This research was approved by the ethics committee of the Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta (No. 00591/KKEP/FKG-UGM/EC/2021).

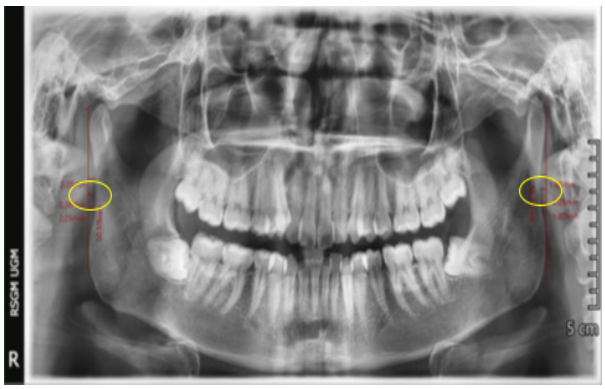

Figure 1. RND measurement on digital panoramic radiograph

RESULTS

The results of the intra-observer and inter-observer reliability tests were 0.996 and 0.997, respectively. The results of the Kolmogorov Smirnov* and Levene's Test** in Table 1 showed that the sample data is homogeneous and normally distributed ($p > 0.05$). Both test results indicate that parametric analysis can be performed in this study.

Table 1. Kolmogorov Smirnov Test and Levene's Test

Sex	RND	
	df	Sig.
Male	35	0.200*
Female	35	0.200*
	68	0.186**

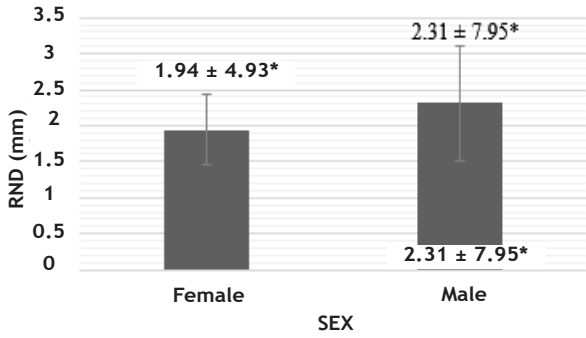

Figure 2. RND mean values in both sex groups

The Independent T-test result (Figure 1) showed a significant difference between the mean of RND values between sex groups on digital panoramic radiographs with the male group had greater RND mean compared to female group.

Table 2. Pearson's Correlation Test

Sex Groups	Statistic	Value
Males	*Pearson Correlation*	-0.036
	Sig. (2-tailed)	0.835
	N	35
Females	*Pearson Correlation*	-0.161
	Sig. (2-tailed)	0.357
	N	35

Pearson's correlation test result (Table 2) showed insignificant negative correlation between age and RND of two groups involved in this study ($p > 0.05$).

DISCUSSION

The reliability test was aimed to determine the possibility of the instrument used by the first researcher to be able to be used or adapted by subsequent researchers and to ensure the data's reliability. The reliability tests were carried out on 20% of the total samples which consisted of 7 male and female radiograph samples respectively. The intra-observer test was conducted twice within a week while the inter-observer test was conducted with other researchers after the perception equation was carried out.

The results of the Cronbach's Alpha test showed that the intra-observer reliability in this study was 0.996 and the inter-observer reliability was 0.997 which was categorized as highly reliable. The results of the Independent T-test showed that there was a significant difference ($p<0.05$)

between the mean of RND values between males and females. The mean ± standard deviation of RND in the male group is 2.31 ± 7.95 and the mean RND value in the female group is 1.94 ± 4.93 as shown in Figure 2. The result of this study is similar to the previous studies conducted by Basheer et al.[9] Which carried out linear measurements on five mandibular morphological parameters including RND in 300 patients at the dental clinic of King Saud Bin Abdulai University for Health Sciences using Planmeca Romexis Software 4.5.2.R. The data of the aforementioned study showed that the mean value of RND in the male group was 2.88 ± 1.18 mm and in the female group 2.21 ± 0.75 mm. The other studies concerning RND also showed a similar result.[9]

Another study by Sairam et al.[14] on 150 people as subjects by using RadiAnt DICOM VIEWER software and the resulting data that the mean RND value in the male group was significantly greater than the female on the right side. The mean value of RND in the young age group is 2.16 ± 0.7 mm in males 39 and 1.73 ± 0.64 mm in females, while in the older age group the mean RND values for males were 2.41 ± 0.82 mm and 2.23 ± 0.73 mm for females.[14]

The morphological features of the mandible in male are more irregular and larger with a prominent chin compared to females which are a more rounded chin and regular form of the mandible.[15] This results in a higher value on linear measurements in male and greater angular measurements in female. The difference in the size of mandible among those sex groups can be influenced by various internal factors. Bone and muscle remodeling activity in male is affected by the testosterone hormone and Insulin Growth Factor-1 (IGF-1). The testosterone hormone causes a parallel growth pattern and supports the domination of intramembranous ossification. Otherwise, the growth of bone and muscle growth in female is influenced by the estrogen hormone which is able to increase bone mass quickly without creating any change in bone width.[6]

The correlation between age and RND in the male group based on the Pearson's correlation test in Table 1 showed no significant results ($p > 0.05$) and the probability scores show a negative and weak correlation ($r = -0.036$). Similar results were found in the female group, the results were not significant ($p > 0.05$) and the probability number showed a negative and weak correlation ($r = -0.161$). Thus, the mean value of RND could not be used as an age estimation method in this study. There are no previous studies that provide the result of the correlation test between age and RND. Previous research conducted by Oksayan et al.,10 the young dentate group (16-21 years old) showed the lowest value of RND that may suggest that RND increases with age. Another similar research by Basheer et al.[9] On 300 subjects divided into partially edentulous (older age group) and fully dentate group (younger age group) showed a higher value of RND in partially edentulous group.

The absence of the correlation between age and RND in this study might be happening due to the small amounts of samples and uneven age distribution. The absence of the correlation between age and RND in this study might be happening due to the small amounts of samples and uneven age distribution. Therefore, the authors recommend increasing the number of samples in further research to produce a more representative correlation test.

Differences in the mean RND values for male and female related to age in these studies can occur due to various factors. Puberty in girls occurs faster but has a short period compared to boys who have slow puberty but have a longer period. This is proven by the earlier termination of bone growth in female at the age of 18 compared to male at the age of 21.[14,16] RND is naturally formed due to bone apposition in the posterior part of the condyle due to an increase in load on the condyle area, which also affects the shape of the mandible including the antegonial notch and RND.[10] The edentulous condition affects the height of the ramus with age can also affect the gonial angle, antegonial notch depth (AND), and RND.[9] Differences in RND in males and females in this study can be used for the comparison process of antemortem and postmortem data in forensic cases. The linear measurements of RND can complete the condyle height (CH), ramus height (RH), antegonial notch depth (AND), and GA in exhibiting variation in dental status, sex, and age. The potential use of RND is supported by its high degree of dimorphism and its morphological changes in correlation with age, especially during the growth period.[4,9]

CONCLUSION

RND in males is higher compare to females and there is no correlation between age and RND in both sex groups.

ACKNOWLEDGEMENT

This study was supported by a research grant from Faculty of Dentistry, Universitas Gadjah Mada 2020.

REFERENCES

1. Houck MM, Crispino F, McAdam T. The Forensic Team: Officers, Scientists, and Specialists. In: The Science of Crime Scenes. 2nd Ed. China: Elsevier; 2017. p. 71–83.
2. Smitha T, Sheethal HS, Hema KN, R F. Forensic odontology as a humanitarian tool. J oral Maxillofac Pathol. 2019; 23(1): 1–10. DOI: 10.4103/jomfp.JOMFP_249_18
3. David TJ, Lewis JM. Forensic odontology: Principles and practice. In: Forensic Odontology: Principles and Practice. Pondicherry: Wiley Blackwell; 2018. p. 1–320.
4. Markande A, David MP, Indira AP. Mandibular ramus: An indicator for sex determination - A digital radiographic study. J Forensic Dent Sci. 2012; 4(2): 58. DOI: 10.4103/0975-1475.109885.
5. El-Shafey M, El-Sherbiny M, Sherif RN, El-Atta HM. Sexual Dimorphism of Mandibular Ramus in an Egyptian Sample: A Radiographic Study. Med J Cairo Univ. 2019; 87(March): 645–51. DOI: 10.21608/MJCU.2019.52522
6. Motawei SM, Helaly AM, Aboelmaaty WM, Elmahdy K, Shabka OA, Liu H. Length of the ramus of the mandible as an indicator of chronological age and sex: A study in a group of Egyptians. Forensic Sci Int Reports. 2020; 2(1): 6. DOI: 10.1016/j.fsir.2020.100066
7. Kelly MP, Vorperian HK, Wang Y, Tillman KK. Characterizing mandibular growth using three-dimensional imaging techniques and anatomic landmarks. Arch Oral Biol. 2017; 77: 27–38. DOI: 10.1016/j.archoralbio.2017.01.018
8. Godge P, Sharma S, Pavitra V, Kulkarni S, Shroff J, et al. Age changes of jaws and soft tissue profile. Sci World J. 2014; 2014; 26-30. DOI: 10.1155/2014/301501
9. Basheer B, Muharib S Bin, Moqbel G Bin, Alzahrani A, Alsukaybi M, Althunyan M. Mandibular morphological variations in partially edentulous adult patients : an orthopantomographic study. Int J Med Res Heal Sci. 2019; 8(11): 67–74.
10. Okşayan R, Asarkaya B, Palta N, Şimşek I, Sökücü O, Işman E. Effects of edentulism on mandibular morphology: Evaluation of panoramic radiographs. Sci World J. 2014; 2014. DOI: 10.1155/2014/254932
11. Priya B, Pandian S. Assessment of ramus notch depth in different skeletal malocclusion. Drug Invent Today. 2019;12(3):480–5.
12. Mallya SM, Lam EWN. White and Pharoah's Oral Radiology : Principles and Interpretation. 8th Ed. China: ELSEVIER; 2019. 1958 p.
13. Ogawa T, Osato S, Shishido Y, Okada M, Misaki K. Relationships between the gonial angle and mandibular ramus morphology in dentate subjects: A panoramic radiophotometric study. J Oral Implantol.
14. Sairam V, Potturi GR, Praveen B, Vikas G. Assessment of Effect of Age, Gender, and Dentoalveolar Changes on Mandibular Morphology: A Digital Panoramic Study. Contemp Clin Dent. 2018;9(1):49–54. DOI: 10.4103/ccd.ccd_704_17
15. Sikka A, Jain A. Sex Determination of Mandible: A Morphological and Morphometric Analysis. Int J Contemp Med Res. 2016;3(7):1869–72.
16. Setiawati R, Rahardjo P. Bone Development and Growth. In: Osteogenesis and Bone Regeneration. 2019. p. 1–20. DOI: 10.5772/intechopen.8245