A retrospective institutional study for age determination by the root length of the mandibular third molar on a panoramic radiograph in Deutero-Malay subject

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Abstract

Objective: This study aimed to produce formula age determination by the root length of the mandibular third molar on a panoramic radiograph in the Deutero-Malay subject.

Material and Methods: The analytical study was done with 130 mandibular third molars on 90 panoramic radiographs of the Deutero-Malay subject from patients who visited the Oral and Maxillofacial Radiology Unit at Dental Hospital Universitas Padjadjaran, Bandung, Indonesia. The inclusion criteria were patients aged 15 to 21, good-quality panoramic radiographs, and the root of the mandibular third molar still developing. The panoramic radiograph with the teeth showed root anomaly, dental pathology, and malposition as bucco-linguangular were excluded. The root length of the third molar was measured from CEJ - root apex in millimeters, followed by thevissen’s modified scoring method using Fiji ImageJ-Win64. The simple linear regression of statistical I Biometric software was used to analyze the result. The author evaluated the reliability of the observers to see the observer’s variability.

Results: There was a very strong correlation between the root length of the mandibular third molar and chronological age for male (R=0.949) with formula CHRONOLOGICAL AGE = 11.847 + 0.459 (Root Length), (R²=0.901), (SEE=0.692), and for female (R=0.946) with formula CHRONOLOGICAL AGE = 13.701+0.410 (Root Length), (R²=0.895), (SEE=0.622).

Conclusion: The root length of the mandibular third molar on a panoramic radiograph can be used for age determination in Deutero-Malay subjects.

Keywords: Age determination by teeth, Ethnic groups, Molar, Panoramic, Radiography

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Introduction

Age determination of an individual narrows the search for antemortem data during identification procedures for the unknown, helps establish the difference between juvenile and adult status in legal cases, and allows people without a birth certificate to know their presumed age. The previous study by Yunus et al. mentioned that age determination by teeth could be seen or measured from the tooth’s maturity, which the stage of tooth eruption and tooth calcification can determine. While the stage of tooth calcification is a more reliable criterion for determining tooth maturation, tooth calcification is possible to evaluate each tooth at examination using radiographs.

Multiple teeth at various stages of growth and development provide a good source of data for accurate age determination, but only up to 14 years of age or until the teeth are in apical closure. Third molars are the only teeth still developing in late adolescence and early adulthood. The previous studies the root development of the third molars occurs at the age of 15 to 21 years. Hence, the root development of the third molar can be used as an indicator for age determination in late adolescence and early adulthood.

According to Thevissen et al. in the Thai population, there was a correlation between chronological age and root length of third molars compared to second molars. This method is less appropriate because humans have different variability in the size of second and third molars. In consequence, Thevissen’s modified scoring method, in which the third molar’s root length was measured by morphological changes while the root was still developing, not compared to the dimensions of the neighboring teeth, is more appropriate, easy to do, and objective.

Radiology plays an essential role as a non-invasive method of dental age determination. In the previous studies, the age determination based on the root development of the third molar on the panoramic radiograph has been mentioned earlier in Thai, Belgian, Sub-Saharan African, Malaysian, Japanese, European UK, and Bangladeshi UK populations. A previous study by Jung et al. measured the root length using Adobe Photoshop® software application. Hisham et al. and Karkhanis et al. used Fiji Imagej open-source software to measure the root length. Based on the previous study, Fiji Imagej open-source software has been widely used to measure dental morphology. Consequently, Fiji Imagej open-source software becomes the authors’ best choice to measure the root length of the mandibular third molar.

Other previous studies on age determination based on the root development of the third molars have been carried out on belgian caucasian origin.
Thai, Indian, Sub-Saharan African, Malaysian, Japanese, European UK, and Bangladeshi UK populations. However, the pattern of tooth maturation has variations and differences in every ethnic group worldwide. Therefore, requiring further analysis depends on the characteristics of each ethnic group to improve human identification. To date, there is scanty of the same study in the Deutero-Malay population. This study aimed to produce formula age determination by the root length of the mandibular third molar on a panoramic radiograph in the Deutero-Malay subject.

**Material and Methods**

The analytical study was done with a database of patients who visited the Oral and Maxillofacial Radiology unit at Dental Hospital Universitas Padjadjaran, Bandung, Indonesia, 2018. Samples that belong to the Deutero-Malay subject were clarified honestly with informed consent and attached proof of Identity Card (IC) with two faithful generations of the Deutero-Malay subject. The Ethics Committee of the Faculty of Medicine Universitas Padjadjaran, Bandung, Indonesia, approved this study with the registration number (76/UN6.KEP/EC/2021) on January 28th, 2021.

The inclusion criteria were patients aged between 15 to 21 years confirmed from the medical records, good-quality panoramic radiographs, and the root of the mandibular third molar is still developing. The panoramic radiograph with the teeth showed root anomaly, dental pathology, and malposition as bucco-linguangular were excluded. This study used 90 panoramic radiographs with 130 mandibular third molars on both genders table 1. All panoramic radiographs were taken with Vatech Picasso Trio (Vatech DCT Pro®; 2006; Vatech, Suwon, Korea; scan parameters: 90 kVp, 10 mAs, and 12 x 8.5- cm Focal Through) in JPG equipped with the patient’s gender information and chronological age at the time of radiography exposure. Fiji ImageJ-win64 (ImageJ, 1.34 n; National Institute of Health, Bethesda, MD, USA) was used to analyze the root length from CEJ - root apex followed by Thevissen’s modified scoring method on a mandibular third molar figure 1.

The measurement was performed by intra- and inter-observer (oral and maxillofacial radiologists). The first observer measured 25 samples of intra-observer measurement with one repetition in intervals of three weeks. Meanwhile, the first and second observers measured the same 25 samples of inter-observer measurement simultaneously. Cronbach’s alpha was used to analyze the reliability of intra- and inter-observer. An independent t-test was calculated to know the differences in score in the root developmental of the mandibular third molar according to the right-left sides of the jaw and the gender groups. The correlation coefficient (R), determination coefficient (R²), and standard error of estimate (SEE) were evaluated with simple linear regression based on gender using IBM SPSS Statistic 23.0 (IBM, Chicago, IL, USA).

**Results**

The reliability test showed excellent reliability for intra-(R=0.993) and inter-observer (R=0.987) measurements, and it can be concluded that all the observers had the same measurement validity. The results of an independent t-test showed no statistically significant differences between the average score in the root development of the mandibular third molar according to the right-left sides of the jaw (p=0.865) and the gender groups (p=0.59).

The root length of the mandibular third molar had a statistically significant correlation with chronological age (p<0.01) in the male and female groups. The result of the linear regression equation revealed the correlation coefficient for male (R=0.949) female (R=0.946), the determination coefficient for male (R²=0.901) female (R²=0.895) with standard error of estimate for males (SEE=0.692) females (SEE=0.622). The value implied that the root length affected the chronological age of 90.1% of males and 89.5% of females. Meanwhile, other variables outside this study influenced 9.9% of males and 10.5% of females. The regression equation of the root length measurement that fitted the data produced the following equation in table 2. The equation represented the age as a dependent variable and the root length of the mandibular third molar as an independent variable. The scatter graph showed that the root length increased with chronological age figure 2 and figure 3.

**Discussion**

When encountering a dead body, establishing its identity becomes very important. Age estimation dramatically helps in this process of identification. Dental maturity plays a significant role in estimating the chronological age of individuals because of the low variability of dental indicators and in living persons who make false age statements.

In the present study, the intra- and inter-observer reliability tests showed that the observers had a small measurement variability by giving consistent results. This study agrees with the previous study by Thevissen et al.7 and Gunst et al.13 which used...
The present study contrasts with the previous studies on Malaysian and Korean mentioned that the third molar root development is more advanced in males. As far as the authors are concerned, these two different study results are related to the characteristic of the growth and development of a specific population. In addition, this study showed no statistically significant differences between the root development of the right and left mandibular third molars. This study agrees with the previous studies in Portuguese, Turkish, Southwestern Chinese, and Iranian population. As the authors know, most study results showed no difference between the left and right sides. Understanding that root growth and the development of right and left sides should simultaneously occur if no pathological factors can inhibit growth and development. It can be concluded the left and right mandibular third molar can use the same regression formulation. However, this study did not consider variables that may affect the third molar development, such as level of chewing habit, type of food, genetics, nutrition, socioeconomic, craniofacial morphology, hormonal, and systemic disease, because of the limited secondary data observed retrospectively. The authors noted these as limitations, and further study is necessary to analyze this aspect. The authors found that the root length of the mandibular third molar had a very strong correlation with chronological age based on Thevissen’s modified scoring method for males ($R=0.949$) and females ($R=0.946$) in the Deutero Malay subject. The Scatter graph of the correlation in the present study conveys that the age increase aligns with the growth and development of the root length mandibular third molar. Similarly, with the previous study in the South Indian population, Bhat et al. mentioned that the root development of the mandibular third molar had a very strong correlation with chronological age based on skeletal maturity for both genders ($R=0.92$). This study partially agrees with the previous study, which mentioned that the third molar’s root length had a strong correlation with chronological age based on the Kullman method for both genders ($R=0.76$) in the Indian and ($R=0.28$) in the Swedish population. However, in the present study, the correlation coefficient that used the root length of the third molar was higher than in the previous study. Moreover, the present study used age estimation based on the scoring method, which had more objectives than ages estimation based on the atlas method.

In the present study, there was a significant correlation between the root length of a mandibular

| Table 1 Distribution of subjects according to gender and age |
|------------------|------------------|------------------|------------------|
| Age (years) | Female | Male | Frequency |
| 15 | 2 | 7 | 9 |
| 16 | 5 | 7 | 12 |
| 17 | 9 | 5 | 14 |
| 18 | 11 | 10 | 21 |
| 19 | 13 | 9 | 22 |
| 20 | 13 | 10 | 23 |
| 21 | 8 | 6 | 14 |
| 22 | 9 | 6 | 15 |

Figure 1 Measurement procedure of third molar’s root length in (mm). Determined one point in the mesial and distal Cemento Enamel Junction (CEJ) of the third molar to connect a line between them with a straight-line tool. Tracing the outer contour from Cemento Enamel Junction (CEJ) to the mesial root apex with a segmented line tool.

| Table 2 The regression equation for age determination |
|------------------|------------------|
| Gender group | Regression equation |
| Male | CHRONOLOGICAL AGE = 11.847 + 0.459 (Root Length) |
| Female | CHRONOLOGICAL AGE = 13.701 + 0.410 (Root Length) |

the same method based on the root length of the third molar. This study, in line with the previous study by Kullman et al. noted that to avoid individual bias, several observers repeat the measurements independently, provided that the observers have calibrated beforehand. This study revealed no statistically significant differences between the root development of third molar male and female groups. This study is similar to the previous studies on South Indian and African populations.
results might be explained by the age range of the samples according to the root development of the third molars.

Thevissen’s modified scoring method showed high accuracy with standard error of estimate for males (SEE=0.692) and females (SEE=0.622). The previous study by Thevissen et al.\textsuperscript{7} showed that the accuracy of the regression formula for males (SEE=1.74) and females (SEE=1.80) was lower than the present study. This difference in results could be due to modifications in sample size, sample criteria, root length measurement techniques, and image processing.

In the present study, root length measurement traced the outer contour mesial root from the CEJ to the apex by forming a segmental line. The measurement considered the morphology variability and the root morphological characteristics of the mandibular third molar that angulated distally to reduce deviation during the measurement procedure. This present study contrasts with the previous study by Thevissen et al.\textsuperscript{7} noted that the root length measurement technique draws a perpendicular line from the Cemento Enamel Junction (CEJ) to the apex of the mesial root. According to Thevissen et al.\textsuperscript{7} the measurement method allowed deviation that occurred during the measurement procedure.

Maled et al.\textsuperscript{24} mentioned that a digital panoramic radiograph is better for dental analysis than a panoramic film radiograph in resolution and contrast levels to interpret the tooth developmental stages. In the present study, a digital panoramic radiograph showed the third molars’ position and root morphology in the oral cavity well, providing the necessary information to assess root development. Besides that, the anatomical structures on the panoramic image are primarily influenced by the patient’s position at the focal through exposure.\textsuperscript{25} The disadvantage of using panoramic radiographs is that the areas of diagnostic interest may lie outside the focal trough, which causes the image to be blurred, enlarged, reduced, distorted, a ghost image, a double, or a triple image picture.\textsuperscript{25-27} The using limitation of the panoramic radiograph allows the root length’s radiographic appearance to shorten or elongate, which the authors noted. Therefore, to reduce errors in the measurement process, the authors determined that the angulation of the mandibular third molar as bucco-linguangular was excluded.

Image processing applications with efficient and easy-to-use algorithms are needed to interpret biological images.\textsuperscript{28} The Fiji ImageJ open-source software is used frequently for measurements in image manipulation. It is preferable to other meth-

Figure 2 The scatter graph showed the relationship between the male group’s root length (mm) and chronological age (year)

Figure 3 The scatter graph showed the relationship between the male group’s root length (mm) and chronological age (year)

17. Vodanovi M, Maru A, Gali A. The authors report no conflict of interest.