

Age estimation from maxillary central incisor pulp chamber using dental radiographs

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Abstract

Age estimation using the radiographic method is a simple and non-invasive method that is suitable for age estimation because it can provide information about tooth maturity and morphological changes related to increasing age and is feasible to do in both living and dead persons. The maxillary central incisor teeth are selected for age estimation because it has a single root, large pulp and tends to present in old age. This study aimed to estimate age based on the Kvaal method on the maxillary central incisors using dental radiographs. This is an analytic observational study using 46 samples of dental radiographs of maxillary central incisors. The measurements were based on the Kvaal method, analyzing the pulp/tooth ratio and then substituted to linear regression to obtain the biological age. The difference between chronological age and biological age about 1.76 years. Kvaal method on the maxillary central incisors using dental is reliable for age estimation with the difference between chronological age and biological age about 1.76 years.

Keywords: Kvaal's method; Maxillary Central Incisors; Age estimation; Periapical Radiograph;

1. Introduction

Age is one of the most fundamental factors in identifying a person. Age estimation is important for determining the individual's identity not only for the legality and ethical needs but also when it's dealing with either crimes or mass disasters.¹ Teeth are parts of the human body that are useful for age estimation since their resistance to post-mortem changes caused by high temperature, microbial activity, and mechanical forces.² There are several methods for age estimation based on tooth morphologies and structures such as histologic, radiographic, and biochemical methods. The radiographic method is a simple and non-invasive method that is suitable for age estimation in both living and dead persons.³

Radiograph examination provides information about the tooth maturity and morphological changes related to increasing age that can not be seen in clinical examinations such as pulp chamber condition, deposition of secondary dentine, cementum apposition, and root resorption. Deposition of secondary dentin occurs in the pulp chamber continuously and leads to a narrowing of the pulp chamber. As advancing age, the pulp chamber is reduced in size due to this secondary dentin deposition, making the measurement of the pulp chamber's size on radiographs become one of the indicators for age estimation.⁴

Kvaal methods were first introduced in 1995, this is a method for estimating the chronological age based on the size of the pulp/tooth ratio using dental radiographs of six types of teeth including maxillary central incisors.⁵ The maxillary central incisor can be used for the measurement of age estimation since this tooth has a relatively wider pulp space than the other maxillary teeth, tends to be present in old age, and also shows less crowding and attrition than the mandibular

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teeth.⁶ This present study was conducted to estimate age based on the Kvaal method on the maxillary central incisors using dental radiographs at the Dental Radiology Department, Dental Hospital of Universitas Airlangga Surabaya.

2. Materials and methods

The present study sample was 46 high-quality dental radiographs collected from Male/Female patients with an age ranging from 20 to 50 years old. The patient's chronological age was noted from medical records after the measurement.

The dental radiographs of maxillary central incisors were measured by 3 observers based on Kvaal's method using a digital caliper. The first step was to determine the measurement points i.e the tooth length from incisal to the apex (t), the pulp length from the highest pulp to the apex (p), the root length from the cemento-enamel junction (CEJ) to the root apex (r), and the pulp and root width in three levels (Figure 1).⁵

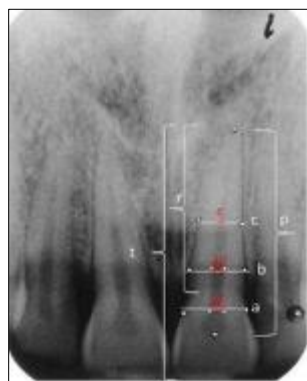


Figure 1 The points measured according the Kvaal method; tooth length (t) , pulp length (p), root length (r), root width at CEJ (a), pulp width at CEJ (a'), root width between a and c point (b), pulp width between a and c point (b'), root width at midroot point (c), pulp width at midroot point (c')

The second step was to calculate the ratio based on the measurement from the referral points. The ratios were : P (pulp length/root length), R (pulp length/tooth length), A (ratio of the pulp/root width at the CEJ), B (pulp/root width between CEJ and midroot point, and C (pulp/root width at the midroot point. The obtained values of these measurements were applied to the formula for age estimation.⁵

$$\text{Age} = 110.2 - 201.4(M) - 31.3(W-L)$$

Figure 2 Formula to age estimation on maxillary central incisors; $M = P + R + A + B + C / 5$, W = mean value ratio from B and C point, L = mean value of P and R, $W - L$ = difference between W and L.⁵

All the data obtained were analyzed with SPSS version 17.0 for Microsoft (IBM Corp, Chicago, USA). Kolmogorov-Smirnov test was performed for the normality test of the data, Pearson test for the correlation between the chronological test and the ratio.

3. Results

The results of measurements using the Kvaal method carried out by 3 observers obtained variables T, P, R, A, B, C, M, W, L, and W-L. The M and W-L values were then calculated with the linear regression test and the regression equation was obtained. From the results of these equations, the value of the biological age of the maxillary central incisors was obtained.

Pearson correlation test was performed to determine the correlation between the ratios and chronological age. The negative r-value on M and W-L indicates a negative correlation between age and the measured variables. P-value < 0.001 indicates that each variable is significant (Table 1). Based on the Kvaal method, a linear regression test was carried out to obtain an equation to determine the biological age as shown in table 2.

Table 1 Correlation between chronological age and measurements based on the Kvaal method of maxillary central incisors

Measurements	Relationship with Age	
	r-value	P-Value
M	-0.938	< 0.001
W-L	-0.916	< 0.001

Table 2 The regression formula for biological age estimation

Gigi	Re	r ²	S.E.E (Standard Error Estimation)
Maxillary Central Incisor	Usia= 90,19 - 41,44 (M) - 45,0 (W-L)	0.89	±9.47 years

4. Discussion

The Kvaal method is one of the methods that can be used to determine age estimation on dental radiographs. This method was first performed on the Norwegian population and was later carried out in several countries. This present study was conducted with 46 samples of the research subject with an age range of 20-50 years using the maxillary central incisors and then measured using the Kvaal method. Dental radiographs with the parallel technique were used in purpose to produce a high-quality image by placing the film parallel to the tooth axis while the direction of the beam is perpendicular to that axis. This parallel technique can also minimize distortion so that measurements can be made on the radiographic image.⁷

The negative correlation between age and the measured variables (table 1) shows that the average ratio of pulp width and length ratio and the difference between the average ratio of pulp width to the ratio of pulp length decreases with age. That means the increasing age will affect the height and width of the pulp chamber. This result is similar to the previous studies conducted by Du *et al.*, and Ayad *et al.*, that the pulp space narrowing is associated with increasing age due to the activity of secondary dentin formation.^{8,9}

The estimation of biological age in this study was derived from a linear regression equation (table 2) with an estimated standard error of ± 9.47 years. The result of this estimation standard error is smaller than the estimated standard error generated in previous studies using the Kvaal regression formula in the Indian population, which is ± 12.3.¹⁰ This difference shows that the ethnic differences might have a different variation or pattern in secondary dentine deposition and affected the results between estimated biological and chronological ages.

The average result of the difference between chronological age and biological age in this study was 1.76 years. The slight difference between chronological and biological age in this study is because of the width of the pulp chamber of the central incisors that were seen clearly in dental radiographs. The results of this study are consistent with previous studies that the maxillary central incisors have a significant correlation between biological age and chronological age due to the width morphological form of the pulp chamber.⁶ Based on this result it can be concluded that the maxillary central incisors are one of the good indicators of age estimation.

5. Conclusion

Based on the results of this study, it can be concluded that age estimation based on the Kvaal method on the maxillary central incisors using dental can be the indicator of age estimation with the difference between chronological age and biological age about 1.76 years.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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