Indonesian Journal of Legal and Forensic Sciences (IJLFS)
Volume 13, Nomor 1, Tahun 2023: 13-19
e-ISSN 2657-0815, p-ISSN 1979-1763
Association of Indonesian Forensic Science
DOI: https://doi.org/10.24843/IJLFS.2023.v13.i01.p02

Estimated Age Calculation with *Tooth Coronal Index* (TCI) Method Using Orthopanthomography in Malang City Population

Eha Renwi Astuti[1], Alhidayati Asymal[1], Dina Karimah Putri[1*], Sri Wigati MM[1], Otty Ratna Wahyuni[1], Yunita Savitri[1], Deny Saputra[1], Ramadhan Hardani Putra[1], Aga Satria Nurrachman[1], Nastiti Faradila Ramadani[1]

[1] Staff, Department of Dentomaxillofacial Radiology, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia, 60132
**Corresponding author e-mail: dina.karimah.p@fkg.unair.ac.id*

Article History:
Received: 02-12-2022
Accepted: 03-02-2023
Published:30-06-2023

Abstrak

Estimasi usia merupakan aspek penting dalam forensik karena berperan dalam menentukan identitas individu. Dalam kasus identifikasi forensik mayat yang sulit diidentifikasi secara visual atau dalam kondisi buruk, radiografi menjadi pilihan metode non-invasif yang dapat digunakan untuk estimasi usia, salah satunya adalah *orthopanthomography*. Metode *Tooth Coronal Index* (TCI) merupakan salah satu metode yang dapat digunakan untuk mengidentifikasi usia biologis seseorang melalui *orthopanthomography*. Perbandingkan usia kronologis dengan usia biologis yang diperoleh dari pengukuran metode TCI pada gigi premolar rahang bawah menggunakan *orthopanthomography* pada penduduk Kota Malang adalah hal yang ingin diteliti. Pengukuran TCI dilakukan dengan mengukur tinggi mahkota gigi (*Coronal Height*) dan tinggi kamar pulpa (*Coronal Pulp Cavity Height*) secara vertikal dari *Cemento Enamel Junction* (CEJ) pada gigi premolar rahang bawah. Kemudian nilai tersebut dimasukkan ke dalam persamaan regresi yang telah ditentukan untuk mendapatkan perkiraan usia biologis. Lalu, hasil perkiraan usia biologis tersebut dibandingkan dengan usia kronologisnya. Terakhir, perbedaan antara usia biologis dan kronologis dihitung untuk menentukan perkiraan usia. Hasil yang didapat yaitu rerata perbedaan usia kronologis dan usia biologis adalah ± 1,32 tahun dan tidak ada perbedaan yang signifikan antara usia biologis dan usia kronologis (p value 0,11). Sehingga disimpulkan metode TCI pada gigi premolar rahang bawah menggunakan *orthopanthomography* dapat digunakan untuk memperkirakan usia penduduk Kota Malang.

Kata kunci:
Estimasi Usia; Identifikasi Forensik; O*rthopanthomography*; Pelayanan Kesehatan; *Tooth Coronal Index*

Abstract

Age estimation is an important aspect in forensics because it plays a role in determining individual identity. In cases of forensic identification of bodies that are difficult to identify visually or in poor condition, radiography is the choice of non-invasive method that can be used for age estimation, one of which is orthopanthomography. The *Tooth Coronal Index* (TCI) method is one method that can be used to identify a person's biological age through orthopanthomography. Comparison of chronological age with biological age obtained from the measurement of the TCI method on mandibular premolars using orthopanthomography in residents of Malang City is what we want to study. TCI measurement was performed by measuring the crown height (*Coronal Height*)

and the pulp chamber height (*Coronal Pulp Cavity Height*) vertically from the *Cemento Enamel Junction* (CEJ) on the mandibular premolars. Then the value is entered in the regression equation that has been determined to obtain an estimate of biological age. Then, the results of the estimated biological age are compared with their chronological age. At last, estimated age is obtained by comparing the difference between biological and chronological age. The mean difference between chronological age and biological age is ± 1.32 years, so it can be concluded that there is no significant difference between biological age and chronological age (p value 0.11). TCI method on the mandibular premolars using orthopanthomography can be used to estimate age in Malang City Population.

Keywords:
age estimation; forensic identification; health services; orthopanthomography; Tooth Coronal Index

1. INTRODUCTION

Age estimation is an important aspect in forensics because it plays a role in determining the identity of an individual. Age identification on forensic examination is required in cases where the chronological age of the individual is not known because the original identity is not present or there are indications of identity falsification. Examples of cases that are often encountered and require age estimation, for example in cases of murder, cases of falsification of employment age, marriage, athletes, child guardianship, immigration, or mass disasters.[1][2]Therefore, we need an age estimation method that is accurate, transparent and non-invasive and follows the rules of medical ethics and existing legal principles, such as the use of minimal radiation exposure and the agreement of two parties.[3][4]

Radiography is a non-invasive method that has an important role in forensic dentistry to reveal hidden facts, which cannot be seen by physical examination. Radiographic techniques that can be used for age estimation are periapical intraoral radiography and panoramic extraoral radiography.[12] Orthopanthomography can be used for age identification because it is the most common dental radiographic examination and produces images of the maxilla and mandible and supporting tissues in one large film. There are two methods used to estimate age using dental radiography, namely using the atlas method and the measurement/scoring method. The measurement/scoring method is carried out by measuring the dimensions of the teeth or also through scoring each tooth based on the stages of tooth development. An example of a scoring method is the Demirjian method, while an example of a measurement method is Kvaal and Tooth Coronal Index (TCI).

The TCI method is one method that can be used to identify a person's biological age. The teeth used in the TCI examination were the mandibular premolars and molars. This is because on the radiographic image of the lower jaw teeth are seen more clearly than the teeth in the upper jaw.[2] Estimated age in the TCI method is calculated by

comparing the height of the crown and the height of the horn of the dental pulp with a panoramic photo examination using a formula so that it can be related to age. According to Drusini (2008), the measurement of the pulp chamber is based on the formation of secondary dentin which is directly proportional to increasing age.[13]

In measurements using radiographic examination, the mandibular premolars and molars are preferred because the images are more visible than the teeth in the maxilla.[2] In addition, posterior teeth are preferred because the boundaries of the crown and root (Cemento Enamel Junction/CEJ) are more clearly visible than the anterior teeth. Based on this, in this study, the teeth used for calculating age estimation using the TCI method on orthopanthomographs were mandibular premolars. This is because in previous studies it was stated that the average TCI of premolars was higher than that of molars.[14] In addition, according to a study by Afify in Egypt, the correlation between age and dental pulp ratio was highest in the mandibular second premolars compared to the mandibular canines and first premolars.[15]

2. RESEARCH METHODS

This research was done by using secondary data which is orthopanthomograph from dentist in Malang City Population. The research samples were 75 orthopanthomographs with age around 20-60 years, and had good quality evaluation.

Measurements were carried out by 3 observers using *Image J* software on the mandibular premolars using orthopanthomography. Each panoramic measured using the TCI method in 2 parts, namely *Crown Height* (CH/CH) measured from CEJ to the tip of the highest crown cusp; and *Coronal Pulp Cavity Height* (CPCH) as measured from the CEJ to the vertical tip of the highest pulp horn. Then the measurement results are entered into the TCI formula (**Figure *1***), so that the TCI value will be obtained.

$$TCI = \frac{CPCH\ X\ 100}{CH}$$

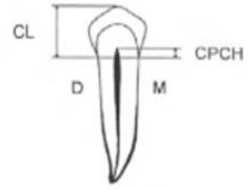

Figure 1. TCI Formula

Statistical analysis of the entire sample was performed using SPSS Version 17.0 for Microsoft (IBM Corp, Chicago, USA). The Kolmogrov – Smirnov test was chosen to measure the normality of the data, while Levene Statistics was used to test the homogeneity of variance. Then at a significance level of 0.05, a test for differences between groups was performed using a paired t-test.

3. RESULTS AND DISCUSSION

3.1. Results

Table 1. Descriptive Statistics

	Number of Samples (N)	Minimum	Maximum	Mean	Std. Deviation
Biological Age	75	21.09	69.11	40.80	8.90
Chronological Age	75	26.00	57.00	39.48	7.55
Age Difference	75	-15.91	21.11	1.32	7.09

The difference between the biological age and the chronological age of each sample is calculated and then the average age difference will be obtained (**Table 1**). As shown in **Table 1** above, the mean age difference between biological age and chronological age is 1.32 years with a standard deviation of ±7.09. These results were obtained from linear regression analysis with the least squares test between age and the average TCI results on the mandibular premolars of the three observers, in order to obtain the age estimation formula as follows:

$$Y = 77.602 - 1.713\ (average\ TCI\ value)$$

Figure 2. Regression Equation

Furthermore, the average TCI value is entered into the regression equation above (**Figure 2**), to obtain an estimate of biological age. The final step is to compare the results of the estimated biological age with the chronological age.

As shown in **Table 2** below, the correlation value between biological age and chronological age is 0.64, which means that the biological age obtained from the estimation calculation has a fairly good relationship compared to the known chronological age. In addition, the results of the paired t-test calculation show that the p value is 0.11 (with a significance degree of $p<0.05$), it can be interpreted that there is no significant difference between biological age and chronological age using the TCI method on mandibular premolars.

Table 2. Paired t-test results between chronological age and biological age

	Number of Samples (N)	Correlation	P value
Biological Age - Chronological Age	75	0.64	0.11

3.2. Discussion

Age is a unit of time that is calculated from the time a person is born until someone is at this time. According to Krogman (1968), age is divided into several types, namely chronological age, biological age, behavioral age, mental age and self-concept age. [5] Chronological age is the age that is known based on the date, month, and year of birth. In general, somatic development is related to chronological age as in the measurement of somatic maturity, such as bone age, menstruation, and height. Somatic maturity can be used to estimate chronological age in the absence of other

accurate age data. This information is important in medical and dental practice for evaluating patient progress.[6]

Meanwhile, biological age is a calculation of the maturation status which is supported by the functional status of various body systems. [7] Biological age is determined from skeletal development (skeletal age), teeth (dental age), puberty (circumpubertal age), and morphological age (morphological age). [5][8] One of them is tooth maturity, which can be determined by the eruption stage or the stage of tooth formation. The stage of tooth formation is considered a reliable criterion for determining tooth maturity. [9] Teeth go through a stage of growth and development, as well as degenerative changes that occur with increasing age. Because teeth are the hardest part of the body and can last for a long time, teeth are an indicator of an individual's age forecast from intrauterine age to adulthood.

Teeth are often used to assess maturity and estimate age because they are the hardest tissue in the body and are protected in the oral cavity. In addition, the outermost layer of the tooth consists of enamel and cementum which can last for a long time. [10] This is why teeth are the strongest body parts and are still left in good condition even in bodies that have been burned, or decomposed. Teeth also play an important role in estimating age because teeth grow and develop throughout human life with well-measured stages of growth that occur in short periods of time, both in living and deceased individuals, and teeth are stable, resistant to decay and also very individualistic. [11]

In this study, we use the sample age range, which is between the ages of 20-60 years, where at that age belongs to the adult to elderly age group, according to the Ministry of Health of the Republic of Indonesia. After the research, we found that the mean age difference between biological age and chronological age obtained from the age estimation using TCI method in mandibular premolar is 1.32 years with a standard deviation of ±7.09. This difference is relatively small, this could be because in that age group, there has been stability in the size of the pulp chamber so that it has a relatively small difference in biological and chronological age. These results are in line with those obtained in the study of Talabani et.al (2015) who also used the mandibular posterior teeth for age estimation using orthopanthomographs. [16] Another study also stated that the TCI method is considered a good age estimation method to be used for those under 50 years old, therefore the age difference between biological age and chronological age tends to be small.[17]

In addition to the above factors, other factors that can influence the difference between chronological age and biological age include variations in the shape of the teeth used in age estimation,

secondary dentin deposition which varies from individual to individual, and distortion in the results of the radiographic image used which is influenced by the patient's position and/or the position of the X-rays. Besides that, it is also influenced by external factors such as the process of bone growth in the elderly, which can be affected by differences in nutritional intake, lifestyle, presence of disease, and socio-economic status of a person. All of these factors can be interrelated and affect the age estimation results. [18][19]

There is no significant difference between chronological and biological ages at each age, this indicates that this method can be used in all age groups. Therefore, from the results obtained from this study, it is hoped that it can contribute to the field of forensic radiology and odontology that the reduction of the pulp chamber seen through orthopanthomographs on the mandibular premolars can indicate an estimate of a person's age which can be used for identification.

4. CONCLUSION

The TCI method used on mandibular premolars using orthopanthomographs can be used to estimate age with a difference between chronological age and biological age of about ± 1.32 years, and there is no significant difference between biological age and chronological age (p value 0.11).

5. ACKNOWLEDGMENTS

All authors have no potential conflict of interest to declare for this article. And this article does not contain any studies with human or animal subjects performed by the any of the authors.

6. REFERENCES

[1] Cameriere R, Ferrante L, Cingolani M. Precision and Reliability of Pulp/Tooth Area Ratio (RA) of Second Molar as Indicator of Adult Age. J Forensic Sci. 2007; 49: 1319-1323.

[2] Panchbai, AS. Dental Radiographic Indicators, a Key to Age Estimation. Dentomaxillofacial Radiology. 2011; 40: 199–212.

[3] Black SM, Aggrawal A, Payne-James J. Age Estimation in the Living: The Practitioners Guide. Wiley-Blackwell, West Sussex. 2010.

[4] Ritz-Timme S, Cattaneo C, Collins MJ, Waite ER , Schutz HW, Kaatsch HJ, Borrman HI. Age Estimation: The State of The Art in Relation to The Specific Demands of Forensic Practice. Int. J. Legal Med. 2000; 113: 129–136.

[5] Krogman, WM. Biological Timing and Dentofacial Complex. J Dent Child. 1968; 35: 176.

[6] McKenna CJ, James H, Taylor JA, Townsend GC. Tooth development standards for South Australia. Aus Dental J. 2002; 3: 223-7.

[7] Gerson J. The Relation between Biological Age, Intraindividual Variability, and Central Nervous System Functioning in Older Adults. Thesis. San Diego: Master of Arts University of California. 2006.

[8] Muthu MS, Sivakumar N. Pediatric Dentistry: Principles & Practices. Elsevier: New Delhi. 2009; 92-93.

[9] Uysal T, Sari Z, Ramoglu SI, Bastiftci FA. Relationship between Dental and Skeletal Maturity in Turkish Subjects. Angle Orthodontist. 2004; 74 (5).

[10] Shrestha J. Comparative Evaluation of Two Established Age Estimation Techniques (Two Histological and Radiological) by Image Analysis Software Using Single Tooth. Forensic Res; 2014. 5: 1-6.

[11] Al, Qahtani, Sakher. Webinar: Dental Age Estimation. Faculty of Dental Medicine. Universitas Airlangga; 2020.

[12] Carvalho SPM, Alves da Silva RH, Lopes-Ju´ nior C, Peres AS. Use of Images for Human Identification in Forensic Dentistry. Radiol Bras. 2009; 42: 1–12.

[13] Drusini, AG. The Coronal Pulp Cavity Index: A Forensic Tool for Age Determination in Human Adults. Cuad Med Forense. 2008; 14(53-54): 235-249.

[14] El Morsi, DA , Rezk HM , Aziza. Tooth Coronal Index as a Tool for Age Estimation in Egyptian Population. J forensic Sci Criminol. 2015; 3(2): 201.

[15] Afify MM, Zayet MK, Mahmoud NF, Ragab AR. Age Estimation From Pulp/Tooth Area Ratio in Three Mandibular Teeth by Panoramic Radiographs: Study of an Egyptian Sample. Forensic Res. 2014; 5: 3.

[16] Talabani RM, Baban MT, Mahmood MA. 2015. Age estimation using lower permanent first molars on a Panoramic Radiograph: A digital image analysis. Journal of Forensic Dental Sciences 7: 158-62.

[17] Veera SD. 2008. Morphometric Analysis of Pulp Chamber as a Method of Age Estimation Using Panoramic Radiographs. Bangalore Karnataka: Rajiv Gandhi University of Health Sciences;. p. 57.

[18] Azevedo Ade C, Alves NZ, Michel-Crosato E, Rocha M, Cameriere R, Biazevic MG. Dental age estimation in a Brazilian adult population using Cameriere's method. Braz Oral Res. 2015;29:S1806-83242015000100215

[19] Jackes M. Building the bases for paleodemographic analysis: adult age determination. In: Katzenberg, M.A., Saunders, S.R. (Eds.), Biological Anthropology of the Human Skeleton. New York: Wiley-Liss, Inc.; 2000. p.417e466.