Original Article

Indian Journal of Forensic Odontology
Volume 12 Number 1, January - June 2019
DOI: http://dx.doi.org/10.21088/ijfo.0974.505X.12119.1

Age Estimation by Evaluation of Pulp Tooth Area Ratio of Mandibular Canine in Western India

Drashti Bhuptani[1], Rahul Sagav[2]

[1]CRA, Forensic Odontology, Dept. of Forensic Medicine, Vardhman Mahavir Medical College, Ansari Nagar, New Delhi, Delhi 110029, India. [2]Chief Dental Surgeon, CNC Multispeciality Dental Clinic, Krishna Nagar, Delhi 110051, India.

How to cite this article:
Drashti Bhuptani, Rahul Sagav. Age Estimation by Evaluation of Pulp Tooth Area Ratio of Mandibular Canine in Western India. Indian Journal of Forensic Odontology. 2019;12(1):5-8

Abstract

Forensic odontology is concerned with the recognition, identification, individualization, and evaluation of the dental evidence. Age estimation is one of the most frequent challenges faced by forensic odontologists. The pulp/ tooth area ratio (PTR) is a nondestructive radiographic technique based on the changes due to continuous secondary dentine deposition throughout life. These changes also seem to vary with the genetic factors, habits, environmental factors and geographical areas. Thus, the aim of the study is to estimate the PTR of the right or left mandibular canine using orthopantomograms (OPG) and determine the age of individuals aged between 17 to 70 years from western part of India. Age was calculated using the Indian specific formula and the result obtained was statistically significant. It was concluded that the pulp/tooth area ratio is a useful indicator of age, although correlations may vary in different populations and hence, specific formulae should be derived for each population.

Keywords: Forensic Odontology, Age Estimation, Identification, Pulp Tooth area ratio, orthopantomograms.

Introduction

Dental identification has been considered a reliable method in cases where any other evidences are unreliable or unavailable. The structure of teeth makes it an excellent evidence for forensic investigation and victim identifications in case of mass diasaters. The chronological age estimation is an important aspect of forensic odontology. The estimation of age helps in various legal aspects. These include assessment of minor/major status in individuals without legal documents, in cases like child labor, child abuse, child marriage, child adoption, kidnapping, teenager-criminals and unaccompanied minor asylum seekers. The decision about type of trial for criminals and whether to be presented in a juvenile court or otherwise, in cases of children committing offense; is largely dependent on the individual's age [1]. It was mentioned that the developments in biochemistry have allowed very precise age estimation. Although there are many dental methods, some are very complex, destructive, and are therefore not normally used [2]. A destructive approach may not be acceptable for ethical, religious, cultural, or scientific reasons [3]. So, the dental age estimation in the living is mostly based upon non-invasive methods. The recommendations for the age estimation of living persons include a dental status, a panoramic radiograph and a general physical examination [4]. Forensic odontology has come a long way in age and gender estimation. The techniques for age estimation are divided into morphological methods, biochemical methods and radiological methods [5].

Radiographs provide a non-destructive means for age estimation of individuals. Cameriere et al. in 2006 analyzed an age estimation method based on pulp/tooth ratio (PTR) in the upper canine. The apposition of secondary dentine is taken into account, because the pulp is surrounded not only by hard tissue, such as enamel but also by dentine,

Corresponding Author: Drashti Bhuptani, CRA, Forensic Odontology, Dept. of Forensic Medicine, Vardhman Mahavir Medical College, Ansari Nagar, New Delhi, Delhi 110029, India.
E-mail: drashtibhuptani@gmail.com

Received on 17.12.2018, **Accepted on** 14.01.2019

which changes along life span. This method also eliminates certain environmental factors, which can affect the human remains [1]. The method for age estimation in adults using pulp/tooth area ratio (PTR) indirectly measures the rate of secondary dentine deposition [6]. It was found that with increasing age, the pulp chamber, in particular the root canal, becomes restricted in the mesio-distal direction but not, or only much later, in the vestibulo oral direction. Tubule density also decreases, mainly from the middle of the root canal towards the apex [7]. The mean rate of increasing dentinal thickness has been found to be 6.5 mm/ year for the crown and 10 mm/year for the root. The effect of continuous dentine deposition (physiological secondary dentinogenesis) is a progressive increase in dentinal thickness, of 0.45 mm (17.1%) and 0.60 mm (24.3%) in the crown and root areas, respectively. Thus, the size of the pulp cavity decreases gradually with age [8].

The present study comprises of identification of individual's age on the basis of evaluation of panaromic images, which may be available in the databases in the dental clinics or with the patient who have undergone specific treatments. It was designed to determine the age of an individual with the PTR using Orthopantomograms (OPG) of 75 patients aged 17-70 years. The pulp and tooth areas of the right or left mandibular canine were measured using computer software and the pulp/tooth area ratio was computed. The age was calculated using the Indian specific formula [6] and the result obtained was statistically significant. Thus, the pulp/tooth area ratio is considered a useful indicator of age, although correlations may vary in different populations and hence, specific formulae should be derived for each population.

Materials and Methods

The digital orthopantamographs (OPGs) for the study were taken from the databases of Dental Clinics in Gujarat, India. A total of 75 patients aged 17-70 years from Gujarat population visiting the outpatient department of these dental clinics were selected for this study. OPG from only the patients coming and requiring the OPG for the purpose of treatment were selected. According to the gender, 33 Males (M) and 42 females (F) constituted the study subjects. According to the age, the subjects were divided into the various groups as shown in the Table 1.

No significant differences were found between teeth from the left and the right side of the jaw;

Table 1: Age Distribution of the sample aged 17-70 years from Gujarat population which consisted of 33 male subjects and 42 female subjects according to gender

Group	Sample Size
Group 1 (17-24 years)	14
Group 2 (25-35 years)	25
Group 3 (36-50 years)	23
Group 4 (51-70 years)	13
Total	75

teeth from either the left or from the right side can be processed depending on whichever were best suited for measurement [3]. Thus, in this study the right or the left mandibular canine was selected based on the clarity and visibility in the root and pulp outline. As canines are single root teeth with largest pulp area that are often present in old age and are less likely to suffer attrition or abrasion than other anterior teeth, they are chosen for the study. Table 2 mentions the inclusion and exclusion criteria for subject selection.

Table 2: The inclusion and exclusion criteria for subjects selected for the Pulp/tooth area ratio analysis in this study

Inclusion Criteria of Sub.	Exclusion Criteria of Sub.
1. The OPG must have clear and well defined visible borders of right or left mandibular canine	1. Canine with root canal treatment, restorations, crowns or prosthesis or endodontic treatment.
2. The individual must fall under the age criteria (17-70 years age)	2. Developmental anomalies, impacted malaligned or rotated canine.
3. The selected tooth, the right or left mandibular canine is fully erupted into the oral cavity.	3. Any pathology, such as, caries or periodontitis or periapical lesions, which would alter the surface area of the tooth.
4. The root of the canine is fully formed.	4. Patient undergoing/ underwent fixed orthodontic treatment involving mandibular canines.

Orthopentamograms were saved as high resolution JPEG files on a computer and imported to AutoCAD software wherein the teeth's long axes were aligned vertically using the measure tool. AutoCAD 2016 software program (Autodesk Inc., San Rafael, CA, USA) is used for this study. AutoCAD is a commercial computer-aided design (CAD) and drafting software application. It permits to generate and manipulate 2D and 3D drawings. Using AutoCAD, a number of horizontal reference lines were marked at specific intervals along the length of the tooth using the Line tool from the Draw Toolbox after which the images were once again saved as high resolution JPEG files. The lines were marked at the following levels [6]. The cusp tip of the canine, At level corresponding to the maximum

curvature of crown on the mesial side, At level corresponding to the maximum curvature of crown on the distal side, as well as at the cemento-enamel junction (CEJ), From the CEJ, lines were marked apically at every one-eighth increments up to the root apex, the exception being the one-eighth increment immediately apical to the CEJ, On the pulp, a line is drawn at the roof of the pulp chamber. Marking of the lines, particularly the ones based on root length, allowed for designation of points at specific regions of the tooth and pulp perimeters on all radiographs. These lines showing the marked points on the Pulp and the Tooth outline of a left Mandibular Canine are shown in the Figure 1(a). Twenty points were then marked on the outline of the tooth, at the junction of the marked horizontal lines, using the point tool on AutoCAD's Draw Toolbox and a minimum of 10 points were also marked on the pulp outline, although more points were marked in some cases. Next, the points at the junction of the marked lines and tooth or pulp outline were connected. The pulp and tooth areas were measured using the area formula for these joined points with help of line tools on the Draw toolbox. This calculation of the area of Pulp and Tooth are shown in Figure. 1(b) and Figure. 1(c), respectively.

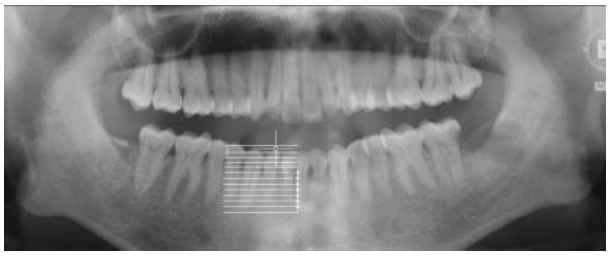

Fig. 1a: Lines showing the marked points on the Pulp and the Tooth outline of a Mandibular Canine on orthopentamogram

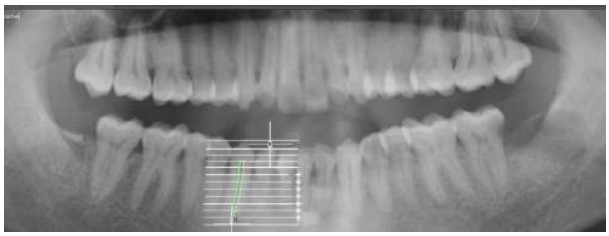

Fig. 1b: Measured Pulp area seen as the green shaded area using the Auto-CAD software

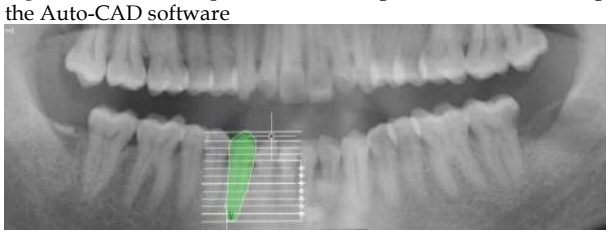

Fig. 1c: Measured Tooth area seen as the green shaded area using the Auto-CAD software

All measurements were made by the examiner without prior information about personal data of the subjects. The variables were measured in mm2 and the Pulp/Tooth Area Ratio of the Canine was calculated for all the 75 samples.

The area of pulp and tooth of all samples were saved in Microsoft Office 2010 Excel spreadsheet. The pulp/tooth area ratio (PTR) was calculated in the Excel spreadsheet by dividing the Area of the Pulp by the area of the Tooth of individual subject. The Indian specific equation was applied for the subjects for age prediction. Age was calculated using this Indian specific formula derived by Babshet *et al*., 2010 [6].

The estimated Age was compared to the known chronological Age for all the samples. The difference between Actual and Predicted age was tabulated using Microsoft Office 2010 Excel spreadsheet. The absolute value of the errors was tabulated and its average was calculated. This is the 'mean absolute error' or MAE. The MAE depicts the average magnitude of error in the age predictions and has been used as a measure of accuracy of age estimation methods [6]. Age group and gender-wise the comparison of the chronological and the estimated age was also calculated and analyzed. T-Test (IBM, SPSS Statistics 20, SPSS Inc., Chicago, IL, USA) was used to compare the estimated age and chronological age of the different groups.

Results

The chronological and the estimated age by the area ratio of the pulp tooth ratio in Indian specific formula were calculated. The Mean Chronological Age in all the study subjects calculated according to their date of births was found to be 36 years and 4 months. The Mean Estimated Age calculated according to the Pulp Tooth Area ratio was found to be 38 years and 11 months. Application of the formula on the subjects yielded a Mean Absolute Error (MAE) of 8 years and 3 months producing acceptable age estimates (i.e. error <10 years of actual age). It was indicated that the chronological age and the estimated age in all the three age groups showed a difference in the Mean Absolute Error. MAE of 7 years and 8 months was obtained in the age group 25-35 years and 4 years and 5 months was obtained in the age group 36-50 years producing the acceptable age estimates of <10 years of actual age in both these groups. But the age groups <25 and >50 years produced unacceptable age estimates, MAE 13 years and 1 month and 11

years and 1 month years, respectively (MAE >10 years of actual age). In overall results of all the study subjects, a pattern of systematic over estimation of age in younger subjects and underestimation in older individuals was found.

Similarly, the effect of gender on age estimation was also determined in this study, and found the age estimation difference according to the gender. It was indicated that the chronological age and the estimated age in males and females showed a difference in the Mean Absolute Error. MAE of 7 years and 7 months was obtained in the males and MAE of 8 years and 10 months was obtained in females producing the acceptable age estimates of <10 years of actual age. 't' Test was used to compare the estimated age and chronological age of all the subjects and found the p value to be 0.096. Since $p > 0.05$, it was concluded that there is no significant difference between estimated age and chronological age. The p value for males and females is 0.559 and 0.088, respectively ($p > 0.05$). There was no significant difference between actual and estimated age in males and females.

Discussion

This study determines more accurate age estimation in Age groups between 25-50 years and in males as well as females. An error of <10 years of actual age is considered significant in Forensic Age Estimation. There is no significant difference between the overall estimated and chronological age in this study. This is in accordance to the various previous studies conducted by R. Cameriere et al. [7], Joseph *et al.* [9], Keraarslan *et al*. [10], Babshet et al. [11], Sharada P. [12], Ayad *et al*. [13], Dumpala et al. [14] and S. Saxena [15]. It confirms that estimating the age using Pulp Tooth area ratio is relatively accurate. There is no significant difference between actual and estimated age in males and females. This is in accordance with studies conducted by Joseph *et al*. [9] and Ayad *et al*. [13]. But there may be requirement of Age, Gender and geographical area specific formula to obtain more accurate results. It is also recommended that the population-specific equation be used since this produces more 'stable' age estimates as it takes into account the low correlation between secondary dentine deposition and age in Indians. This is due to the several differences (genetic, cultural and environmental factors, socio economic status, habits) existing in the development and deterioration of the skeletal system, among individuals as well as across populations and between sexes [8]. However, this method of age estimation has certain limitations. This method of age estimation cannot be employed in multirooted teeth, as accurate measurements of multirooted teeth were difficult to perform. Similarly, as the curved arch of the jaw is projected on to an OPG, there will always be certain amount of distortion when measuring the image presented there. The dentine deposition changes are also highly variable in each individual.

Conclusion

In this study, it was found that the pulp/tooth area ratio measured from OPG on right or left mandibular canine can be used to for forensic age estimation with fairly accurate results. It is concluded that age estimation using pulp/tooth area ratio that there is no significant difference between estimated age and chronological age. Age estimation through the evaluation of the PTR using single rooted tooth on OPGs revealed the most reliable results for the middle age (25-50 years) of life. It showed less reliable results for the younger age (<25 years) individuals. The reliability of age estimation is also reduced in older age groups (>50 years). Thus, this method of age estimation provides fairly accurate and reliable noninvasive method and is a useful indicator of age, although correlations may vary in different populations and hence, specific formulae should be derived for each population for more accurate results.

Source of Funding

The Scientific Study was done in Gujarat Forensic Sciences University as a part Research in Final semester.

Disclaimers

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the University.

Conflict of Interest

The authors declare that they have no conflict of interest

References

1. Manisha M.K., A.D. Dinkar, Junaid A. Forensic Anthropology Population Data Accuracy of age estimation methods from orthopantomograph in forensic odontology: A comparative study. Forensic Sci. Int. 2014;234:184.e1–184.e8
2. Roberto C., Giuseppe B., Luigi F., Dora M., Claudia V., Mariano C., *et al*. Reliability in Age Determination

by Pulp/Tooth Ratio in Upper Canines in Skeletal Remains. J Forensic Sci. 2006;51(4):861-64

3. Sigrid I. Kvaal, Kristin M.K., I.B. Thomsenb, Tore S. Age estimation of adults from dental radiographs. Forensic Sci. Int. 1995;74:175-85
4. Dr. Rer. Nat. Application of age estimation methods: Comparative validity and problems in practical implementation. Doctoral Thesis, University of Vienna. 2007
5. C Priyadarshini, Manjunath P Puranik, SR Uma. Dental Age Estimation Methods: A review. Int. J Adv Health Sci. 2015;1(12):19-25
6. Medha B., Ashith B.A., Venkatesh G.N. Forensic Anthropology Population Data Age estimation in Indians from pulp/tooth area ratio of mandibular canines. Forensic Sci. Int. 2010;197:125.e1–125.e4
7. R. Cameriere, E. Cunha, S.N. Wasterlain, S. De Luca, E. Sassaroli, F. Pagliara, *et al*. Age estimation by pulp/tooth ratio in lateral and central incisors by peri-apical X-ray. J Forensic and Legal Med. 2013;1-7.
8. Roberto C., Stefano D Luca B, Inmaculada A., Luigi F., Mariano C. Age estimation by pulp/tooth ratio in lower premolars by orthopantomography. Forensic Sci. Int. 2011;214:105-12
9. Charis CJ, BH Satheesha, Nithin MC, SK Kannan, Giju G., Sam J. Intraoral digital Radiography for adult Age Estimation-A Reliable Technique. J Indian Acad of Oral Med and Radiol. 2013;25(4):287-90
10. Bekir K., Emine S.K., Abdul Semih O., Ertan E. Age Estimation for Dental Patients Using Orthopantomographs. Eur J Dent. 2010;4:389-94
11. Medha B., Ashith B.A., Venkatesh G.N. Age estimation from pulp/tooth area ratio (PTR) in an Indian sample: A preliminary comparison of three mandibular teeth used alone and in combination. J Forensic Legal Med. 2011;18:350-54
12. Sasidhar S., Sharada P. Age estimation using pulp/tooth area ratio: A digital image analysis. J Forensic Dent. Sci. 2009;1(1):37-41.
13. Caroline E.A., Hiba M.H., Elsafi A.A. la, Samih A.K. Estimation of Age for Sudanese Adults using Orthopantomographs. Glob J Med Res.: J Dentistry and Otolaryngology. 2014;14(1):6-14
14. Rakesh K.D., Venkateswara R.G., Geetha K.M, Naveen R. Age estimation using pulp/tooth area ratio and hand wrist radiographs: A comparative study. Health Sci. 2013;4(2):JS006
15. Sudhanshu S. Age estimation of Indian adults from orthopantomographs. Braz Oral Res. 2011;25(3):225-29