Maxillary Lateral Incisor as Biomarker of Age – An in-Vivo Radiographic Study

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Abstract

Estimation of age is one of the perplexing problems faced by forensic experts and anthropologists. Changes in the size of pulp canal caused by apposition of secondary dentin as a person ages is one of the parameters employed in age estimation by X-rays. Radiographic method scores over the other methods because it is non-invasive, inexpensive and easily accomplished. This study measured the Pulp/tooth ratio mesiodistally of the maxillary lateral incisor radiographically. The model explained 74.1% of total variance.

Key Words: Maxillary Lateral Incisor, Pulp/Tooth Ratio, Radiograph, Mesiodistal Dimension

Introduction

Age refers to a period of human life, measured by years from birth. It is usually marked by a certain degree or stage of mental or physical development and involves legal responsibility and capacity. Estimation of age assumes importance from a forensic, anthropologic and medico-legal point of view. Teeth were first used as barometer of age in the 1800s.1

Fully formed teeth show aging changes that mirror those seen systemically. Hence, teeth can be used to estimate an age range for anthropologic and forensic purpose and act as biomarker of age. Many techniques have evolved over the years using teeth as medium for age estimation. In children and adolescents age estimations are based on developmental stage of permanent and deciduous dentition. Age estimation using teeth in adults is challenging and many methods have been explored. Studies reveal that for correlation with chronological age best results are provided by the analysis of tooth cementum annulations, and by determination of aspartic acid racemization.2 These methods though are invasive and cannot be used in living individuals.2 In comparision the radiographic technique is non-invasive, simple and can be used even in living and dead alike and therefore an easy co-relation is possible.

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This study is based on the concept that as a person ages the pulp chamber size decreases due to secondary dentin deposition. This size change can be measured radiographically and analysed. The purpose of this in –vivo study was to find a reliable method for chronological age estimation of adults by examining the pulp/tooth width ratio of maxillary lateral incisors at the radiographic cemento-enamel junction (CEJ).

Materials and Methods

70 Individuals within the age group of 19 – 58 years were selected for the study (Table 1). Intraoral Periapical Radiographs (IOPARS) of either of the maxillary lateral incisors of these individuals were exposed using size 2 Kodak E speed films (Eastman Kodak, Rochester, New York). Paralleling method was followed throughout the study to avoid exposure errors. All the peri-apical radiographs were at an exposure of 70 kVp and 8 mA (Evolution X -300 machine, Toshiba Co, Italy). All the radiographs were manually processed in a single batch with newly prepared processing solutions maintaining standard time and temperature.

The inclusion criteria included teeth which were in normal functional occlusion, without

any clinical or radiographic evidence of caries, trauma or restoration or any periapical pathology. IOPARS with any incidental pathologic findings in relation to area of interest were excluded from study.

Table 1: Age and Sex Cross-tabulation

measurements on the computer for the images stored in JPEG format.

Measurements of all the selected radiographs (Fig. 1 and Fig. 2) were carried out along:

1. Mesiodistal direction of the pulp along the CEJ in cms and recorded (x)

2. Mesiodistal direction of the tooth along the CEJ in cms (y)

Radiographic images of maxillary lateral incisors so obtained were digitized by indirect method (Canon SX 100 camera, 8.0 megapixel) and stored in a computer file in JPEG format (Adobe Photoshop 7.0 ®). Iconico software (ver. 4.0) screen calipers were used to carry out the

Fig 1

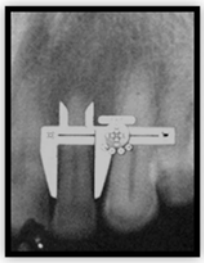


Fig 2

Fig. 1 and Fig 2 : Schematic representation of technique of measurement

The values so obtained were entered in Excel worksheet. Pulp-tooth ratio (x/y) of each tooth was calculated from the above measurements and tabulated the descriptive analysis of which is given in Table 2. This ratio method helped to reduce the effect of possible variation in angulations and magnification.

Table 2: Descriptive analysis

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	70	19.00	58.00	37.4429	12.0826
RATIO	70	0.11	0.30	0.2090	4.338E-02

Statistical analysis and results:

All measurements were carried out by same observer. To test intra-observer variability 20 peri-apical radiographs were randomly selected and re-examined after 2 weeks. The pulp-tooth ratio was used as the morphological variable. The values were entered in Excel worksheet with actual age and gender tabulated against the respective ratio.

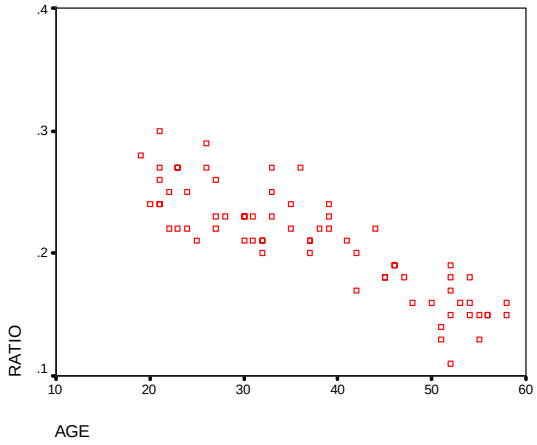
Statistical analysis was performed using SPSS for windows (SPSS statistical software, Ver. 16). In order to assess the difference between actual chronological age and predicted age, a linear regression model with first order interaction was developed. The regression analysis was carried out with age as the dependant variable and ratio and gender as independent variables. As gender did not contribute significantly a step down analysis was done. Following the regression analysis the following regression formula was obtained.

Age = 87.5703 - 239.84 X 2, (X 2 = ratio)

This model could explain 74.1 % of variation (Graph 1). The residual statistics obtained are given in Table 3.

Table 3: Residuals Statistics

	Minimum	Maximum	Mean	Std. Deviation
Predicted Value	15.6170	61.1875	37.4429	10.4038
Residual	-12.8046	13.1877	-3.4614E-14	6.1441
Std. Predicted Value	-2.098	2.282	.000	1.000
Std. Residual	-2.069	2.131	.000	.993



Correlation co-efficient were obtained between actual age and predicted variables. The standard error of the estimate was 6.1891 .

Graph 1. Scatter graph showing relation between age and ratio

Discussion

Adulthood heralds many time–related biological changes, many of which can be used to determine age. Current macroscopic methods of age estimation involve teeth, cranial suture, pubis, auricular surface of ilium and sternal rib.3 Teeth are commonly employed for age estimation when skeletal remains are in poor condition as humidity, fire or trauma renders many parts not usable.4 Dental wear is the method commonly used by anthropologists but since attrition is related to diet and culture, this method has little significance except for the population where the data was collected.4 Secondary dentin deposition was introduced by Gustafson for age estimation along with attrition, periodontal recession, cementum apposition, apical translucency and external root resorption as other factors. 2 The apposition of secondary dentine is often preferred because pulp is surrounded by dentin, which changes during an individual's life and leads to reduction in size of pulp cavity. Secondary dentin has been studied using several methods, both by section and radiographic. 4,5 Radiographic study is a non-invasive, simple and reproducible method that can be employed both on living individuals and unknown dead, either in identification cases or archaeological investigations.3,5,6 Many studies using radiographic applicability of pulp-tooth ratio for age estimation have found a positive co-relation. 3,5,6,7 However Meinl et al found that the application of regression formula given by various researchers to their sample either lead to over or under estimation. 2 However, it must be noted that radiographic differentiation between secondary and reparative dentin is not possible.6

This study is unique in the concept that the pulp – tooth width ratio of maxillary lateral incisors at radiographic cemento enamel junction (CEJ) of digitized IOPARs were considered for predicting age. Maxillary lateral incisor was the tooth chosen because the study by Paewinsky, Pfeiffer and Brinkmann showed that this tooth had the strongest correlation coefficient for age amongst the anterior teeth at CEJ level.7 Moreover maxillary anteriors show considerably less crowding and attrition as compared to their mandibular counterpart. The study by Kvaal et al did not find any statistical disparity in teeth between right and left side of jaw for age estimation, hence lateral incisor from either side was randomly selected.6

Various studies on pulpal morphology have shown that width of pulp is a better indicator of age than length.5,6 This study is in tandem with other studies which have highlighted the correlation between pulp-tooth ratio as a good predictor of age.1,5,7,8 In this study minimum predicted age value was 15.6170 and the maximum 61.1875, as in comparison to the actuals which were 19 and 58 years respectively. Other studies using the same concept as ours gave a correlation coefficient value in the range of 71 – 91% as compared to 74 % obtained in this study. 5,1 The result indicates the appropriateness of using maxillary lateral incisor as a viable variable in chronological age prediction. The advantage of this method of study is that it can be safely applied in living individuals also. It should however be noted that maxillary lateral incisors are one of the commonly missing and malformed teeth, although fortunately bilateral incidence of these anomalies is quite rare.

The accuracy of the study depends mainly on the exactitude of measurements and technique of the radiograph exposure. This study gives an analysis of contemporary local population and results could vary in different racial populations. Therefore it would be worthy to note the variations in a larger and more heterogeneous population, with increased variables.

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