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Age Estimation from Pulpal Width of Maxillary Central Incisors: A Digital Radiographic Study

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Abstract

Background: Age is one of the prime factors employed to establish the identity of an individual and the use of teeth for this purpose has been considered reliable. The measurement of reduction in pulpal width with advancing age due to secondary dentin deposition can been used as indicators of age.

Aim: To estimate the age of patients using pulpal width of permanent maxillary central incisors and to assess reliability of estimated age based on pulpal width of permanent maxillary central incisors with that of chronological age.

Materials and methods: 240 subjects aged between 20–50 years,with equal gender distribution were included in the study. Digital intraoral periapical radiography (Charge- coupled device sensor) of maxillary central incisors with paralleling angle technique were made for all study subjects and pulpal cavity width was measured at Cemento-enamel junction (CEJ) , midpoint between CEJ and midroot level, midroot level using Planmeca Romexis software. Regression analysis was carried out to obtain the estimated age using pulpal width.

Results: The mean estimated age showed no statistical difference from the chronological age in both males and females ($p>0.05$).

Conclusion: Pulp width serves as a good indicator for age estimation in forensic odontology.

Keywords: Age estimation; chronological age; Maxillary Central Incisors; pulpal width; digital radiography; forensic odontology.

Introduction

Age, which denotes to a period of life in an individual is an important factor in establishing the identity of an individual in forensic odontology. Forensic odontology involves the examination, evaluation, management and presentation of dental evidence in criminal or civil proceedings, all in the interest of justice.[1]

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Saunders, a dentist, was the first to publish the information regarding dental implications in age assessment by presenting a pamphlet entitled "Teeth-A Test of Age" to the English parliament in 1837.[2]

Age-related changes occur in teeth between approximately 10 weeks in utero to old age.[3] Clinically, age establishment can be done by regressive changes but as age advances changes often take place inside tooth which are obscured to naked clinical examination. This further necessitates radiological examination. The dental pulp cavity reduction as result of secondary dentin deposition is an age indicator according to Kvaal et. al.[4]

Studies in the past have established a correlation between chronological age and pulp tooth ratio of maxillary central incisors based on the regression equation derived.[4,5,6] In this backdrop, the present study had been designed to determine age based on mesiodistal pulpal widths of permanent Maxillary

Central Incisors and check on its reliability in clinical settings.

Materials and Methods

The present study was conducted from June 2016 to September 2016 in the Department of Oral Medicine and Radiology, JSS Dental College and Hospital, JSS Academy of Higher Education and Research, Mysuru. Ethical approval was attained from Institutional Ethical Review Board following which 240 random patients were enrolled in this study.

Subjects falling in the age group of 20–50 years divided into three groups with gender distributed equally and with both intact permanent maxillary central incisors, having integrated dentition and good occlusion were included in the study. Optimal quality Digital intraoral periapical images of permanent Maxillary Central Incisors of these subjects only were considered.

Subjects with history/evidence of local/systemic disease/anomalies/trauma that could affect the maxillary permanent central incisors were excluded from the study. Radiographically absence of permanent maxillary central incisors teeth, presence of malformed teeth/ pulpal calcifications/ developmental variations in root canal except single canal and any distortion of images and artifacts were excluded.

The selected individuals were subjected to Digital Intraoral periapical radiography (Charge Coupled device Sensor- Size one) of Maxillary Central Incisors using paralleling technique taken at standard parameters adapting requisite radiation protection measures. All the 240 digital intraoral periapical images recorded were evaluated and 3 fixed reference lines were marked on the image using Planmeca Romexis Software measurement and enhancement tools (Fig 1). Root length (R) from Cemento-enamel junction (CEJ) till apex was measured and midpoint of root (M) was marked following which pulpal measurements were made at 3 different levels: (Fig 2).

Fig. 1: Measurement of Maxillary Central incisors pulp cavity width at 3 different levels using Planmeca Romexis Software.

- At the CEJ (A)
- At the midpoint between CEJ and mid root level (B)
- At the mid root level (C)

Fig. 2: Pulpal width measurements at three different levels.

Reliability of measurements were assessed by remeasuring the above parameters in a sample of 40 radiographs by the same observer after 15 days. It was determined by paired t test and found to display statistically no difference with that of previous measurements.

Statistical Analysis

The data tabulated was subjected to statistical analysis using the SPSS software for windows (version 20.0). Descriptive statistical procedures including mean, Standard deviation, standard error mean were used to summarize all variables. Pearson's correlation test was performed to determine the correlation between pulp cavity width and age. Regression analysis was computed for estimating age using width of pulp cavity, later students t test was performed to compare the mean estimated age with that of chronological age.

Results

Significant difference was found between the morphological variables among males and females, indicating that gender did influence the regression model used to estimate chronological age for both male and female groups (Table 1). Hence, the correlation and linear regressions for males and females were determined separately.

Table 1: Comparison of mean age, CEJ, midpoint of CEJ and midroot, midroot pulp cavity widths in males and females.

Variables	Male		Female		P Value
	Mean	Sd	Mean	Sd	
AGE (Years)	35.55	8.19	35.16	8.78	0.85 NS
CEJ pulp cavity width (mm)	4.4	0.75	3.9	0.95	0.000 S
Midpoint of CEJ and midroot level pulp cavity width (mm)	2.9	0.59	2.7	0.63	0.045 S
Midroot pulp cavity width (mm)	1.9	0.36	1.8	0.42	0.017 S

Table 2: Student's t-test between mean chronological age and mean estimated age in males.

	Mean	N	Std. Deviation	Std. Error Mean	p-value
Chronological age	35.56	120	8.192	.748	0.999
Estimated age	35.55	120	1.55788	.14221	

Table 3: Student's t-test between mean chronological age and mean estimated age in females.

	Mean	N	Std. Deviation	Std. Error Mean	P-value
Chronological age	35.17	120	8.782	.802	0.999
Estimated age	35.16	120	1.77934	.16243	

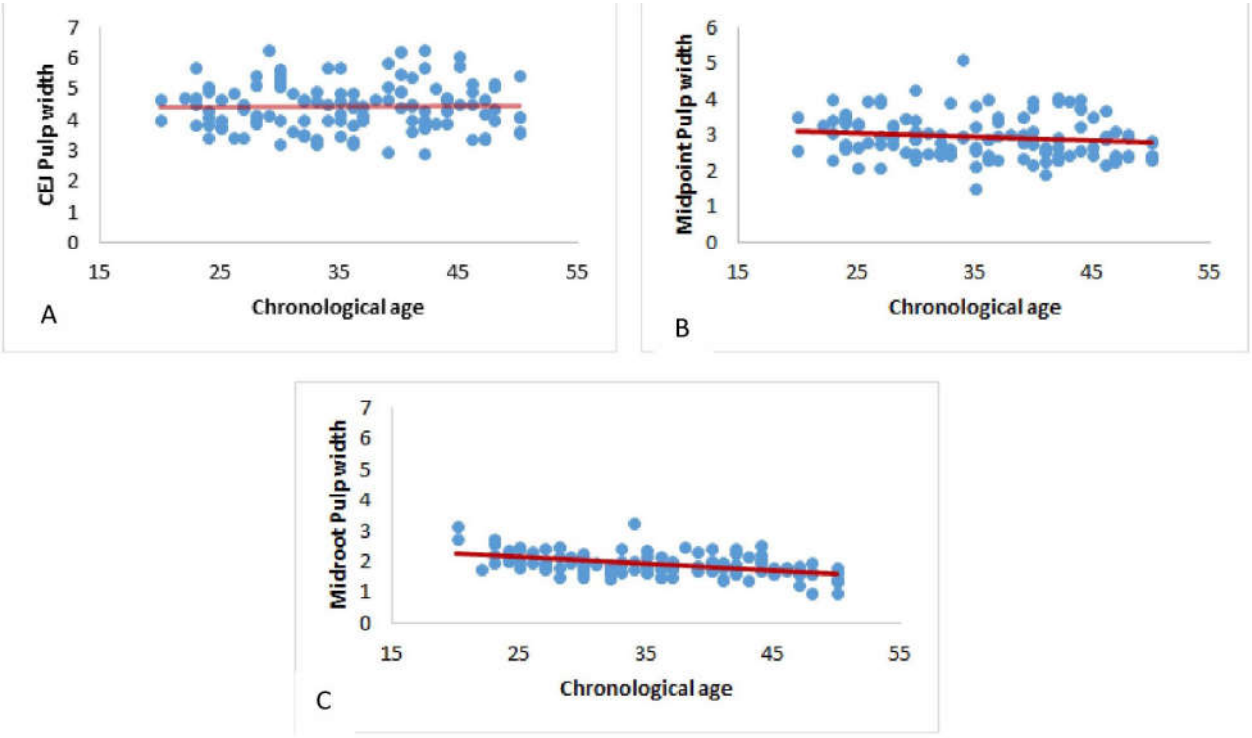
Pearsons correlation test performed between pulpal widths and chronological age revealed values in males as, CEJ: r = 0.028, midpoint= -0.161 and midroot, r = –0.481 and in females as, CEJ: r = –0.193, midpoint= –0.257 and midroot, r = –0.225 respectively. A negative linear relationship was attained,indicative of the fact that as age increases, the pulp cavity width decreases (Graphs 1–2). Strong correlation was observed with midroot level in males whereas strong correlation was observed with midpoint of CEJ and midroot of pulp cavity in females.

Multiple linear regression analysis was performed with age as a dependent factor and pulp cavity width as an independent factor. To obtain an estimated age of 3 means (ABC), the linear functions were calculated using the formula: $y = a + b_1x_1 + b_2x_2 + b_3x_3$; where, y is estimated age, a= constant, b= rate of change and x is corresponding pulp widths at 3 different levels.

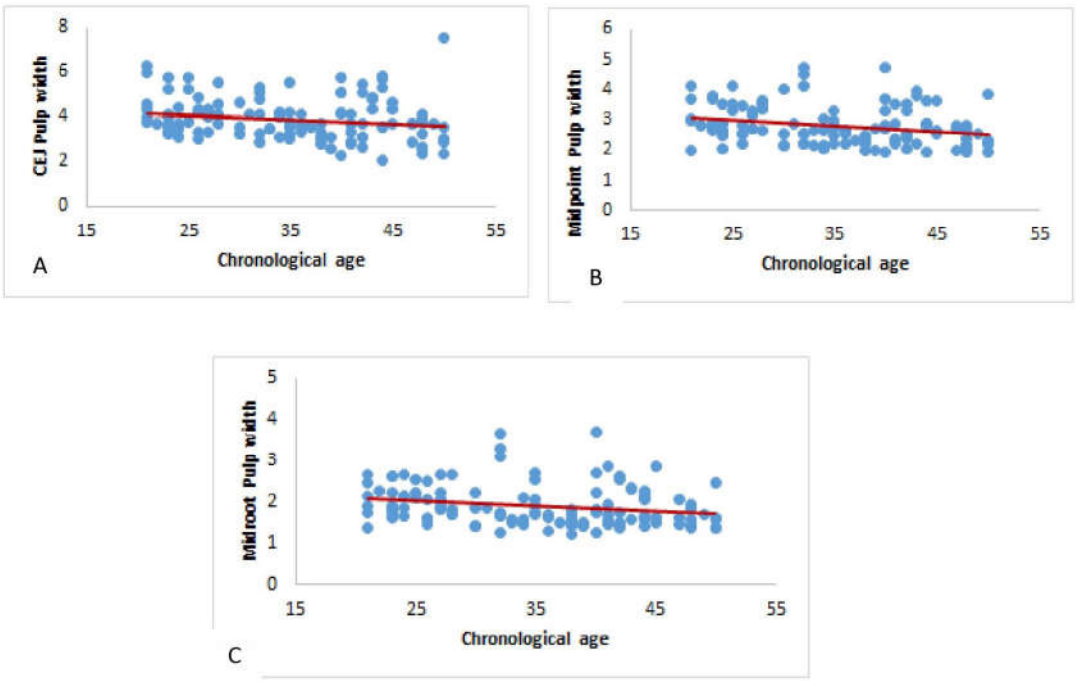
Males: AGE= 51.688 + (0.903* X_1) + (0.743* X_2) + (-11.57* X_3)

Females: AGE= 45.199 + (–0.131* X_1) + (–2.95* X_2) + (–0.683* X_3)

The effect of gender on age estimation was determined and found to have no significant influence on age (Tables 2 and 3) i.e., no significant difference was noted between the chronological age and estimated age in both males and females.



Graph 1: Scatterplot showing a) Correlation of chronological age Vs CEJ pulp cavity width in males. b) Correlation of chronological age Vs midpoint of CEJ and midroot pulp cavity width in males. c) Correlation of chronological age Vs midroot pulp cavity width in males.



Graph 2: Scatterplot showing a) Correlation of chronological age Vs CEJ pulp cavity width in females. b) Correlation of chronological age Vs midpoint of CEJ and midroot pulp cavity width in females. c) Correlation of chronological age Vs midroot pulp cavity width in females.

Discussion

Age estimation constitutes a key factor in the identification of an individual in forensic odontology. Teeth are the most useful biological markers for human age estimation because they may be preserved for long time after death. They show great resistance to post-mortem alterations caused by humidity, high temperature, microbial activities and mechanical forces.[7] Hence, for these reasons teeth can be better predictors of age.

The study of morphological parameters of the teeth on radiographs are considered to be more reliable than most other methods of age estimation available like Gustafson's parameters, Nolla's method, Johanson's grading, dental translucency etc which require extraction and a destructive approach which is unethical for scientific reasons.[8] Hence radiographs were considered in our study.

With an increase in age, marked changes occur in pulpal cavity width i.e pulpal cavity width recedes with secondary dentin deposition which is more prominent in maxillary central incisors as compared to other single rooted teeth. The amount of secondary dentin varies according to various factors like race, ethnicity, diet and lifestyle.[9]

In the Maxillary arch, central incisors in particular were employed in our study because they are single-rooted teeth with the largest pulp area. Additionally, angulation errors in radiography are avoided while recording central incisors compared to canines. Also, Maxillary anterior teeth show considerably less crowding and attrition as compared to their mandibular counterpart, and encompass more secondary dentin tissue than canines[10] which make them the preferred teeth for such investigations as ours.

Digital intraoral periapical radiography was used in current study considering plethora of advantages like Superior gray scale resolution, reduced exposure to radiation, increased speed of image viewing, increased efficiency, enhancement of diagnostic image, effective patient education tool and teleradiology.[11] Paralleling technique was followed in this study because it minimizes image distortion and best incorporates all the intraoral imaging principles.[11,12]

Kvaal et. al.[4] conducted a study to find a method to estimate the chronological age of an individual from measurements of size of the pulp(pulp/root length, tooth/root length, and pulp/root width) on full mouth dental radiographs of six different teeth at 3 levels and found pulp width to have a strong correlation with age. Hence the width of pulp at 3 different levels was considered as our predictors of age.

Bodrumlu and co-authors in 2013 from their study on 200 OPGs concluded that the pulp chamber can be more readily exposed in female patients compared to males, as the pulp chamber is shallower in the former.[13] Chandler

et. al. reported that the pulp chambers in male mandibular molars were larger and they also suggested that the human first molar pulps exhibit sexual dimorphism.[14] In current study we found statistically significant difference in mean pulpal widths between males and females with females having lesser pulpal width when compared to males. This indicates strong sexual dimorphism in pulpal widths of maxillary central incisors.

A negative linear relationship between the width of pulp cavity and age was obtained in present study which was suggestive of the fact that pulpal width reduces in size as age progresses. These results are in similarity with Du C and co-investigators, Ginjupally et. al., Zaher and co-authors.[15,16,17]

The midroot pulp cavity had strong correlation in current study when compared to midpoint and CEJ pulp cavity in males and this is in accordance with Ginjupally et. al.,[16] whereas in females a strong correlation was noted in midpoint of CEJ and midroot level.

The mean chronological age of males was 35.56 years and estimated age was found to be 35.55 years with a mean difference of 0.01 yrs. The mean chronological age of females was 35.17 years and estimated age was found to be 35.16 years with a mean difference of 0.01 yrs. Similarly results obtained in studies by Zaher et. al.,[17] Ginjupally et. al.,[16] showed a mean difference of 0.1 years between the estimated age and real age. In this study mean difference was opinioned to be very much minimal when compared to the above studies.

Student's t-test revealed no statistical significant difference between mean chronological and estimated age in males and females indicating the reliability of the derived formula.

Conclusion

The present study suggested that it is reasonable to derive a regression formula based on data of pulp cavity width and substantiate the estimated age. The estimated age showed an average difference of 0.01 years in both males and females, supporting the accuracy of pulp width in age estimation and hence further could serve as an introducing scope for new avenues in forensic odontology.

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