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AGE ESTIMATION FROM ROOT DIAMETER AND ROOT CANAL DIAMETER OF MAXILLARY CENTRAL INCISORS IN CHENNAI POPULATION USING CONE-BEAM COMPUTED TOMOGRAPHY

Subasree Soundarajan[1], *Sreedevi Dharman*[2]

[1]Department of PeriodonticsSaveetha Dental College and HospitalsSaveetha Institute of Medical and Technical Sciences, Saveetha UniversityChennai,Tamil Nadu,India.

[2]ReaderDept. of Oral Medicine and RadiologySaveetha Dental College and HospitalsSaveetha Institute of Medical and Technical SciencesSaveetha University, Chennai,Tamil Nadu,India.

[1]151905002.sdc@saveetha.com,[2]sreedevi@saveetha.com

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ABSTRACT

The aim of this study is to evaluate the possibility of age estimation from root diameter and root canal diameter of maxillary central incisors using 100 CBCT images collected from the Department of Radiology, Saveetha Dental College.A total of 100 cone-beam computed tomography images were taken from the Department of Radiology, Saveetha Dental College and Hospitals, consisting of 50 males and 50 females aged between 15 and 64 years with individuals' chronological age.Group I (15-24 years), group II (25-34 years), group III (35-44 years), group IV (45-54 years), group V (55-64 years).The points used to locate root canal diameter and root diameter in maxillary central incisors were marked. Root diameter and root canal diameter were measured and the ratios of root canal diameter and root diameter were calculated. Correlation coefficient and linear regression analysis was performed for both the sexes in the Chennai population. Root canal diameter/root diameter ratios showed higher correlation with age than root diameter, which was used to estimate age for both sex in different age groups from 15 to 64 years.The SEE ranged from 1.67 to 3.70 years for age estimation from total sample. Dental age estimation is possible using cone-beam computed tomography from root diameter and root canal diameter of maxillary central incisors in the South Indian population.

INTRODUCTION

Age identification in anthropology and forensics is at times difficult, yet it is important.Several methods have been reported in the literature for age estimation by analysis of teeth. The most widely accepted methods include the Gustafson and Johanson index, and assessment of dentin translucency and cementum annulation [1–5]. Some of these methods are invasive and are not suitable for living individuals. The analysis of dental wear is the most commonly used method in anthropology [6,7]

Assessment of the pulp chamber space provides better opportunities in dental age estimation. This is based on the evaluation of secondary dentin apposition [8]. This apposition is effective in age estimation as it is a continuous, age associated process that alters the size of the pulp chamber.Various techniques have been developed to study the size of the pulp chamber, including radiographs and tooth cross sections. Since cross sectioning of the tooth is destructive, radiographic assessment is a better option. Usually periapical and panoramic radiographs have been used for assessing the pulp to tooth area ratio [9,10]. The major disadvantage of these radiographs is that they are two dimensional and may show distortion or magnification errors. To avoid this, computed tomography can be used as it is a more accurate and ideal method for evaluating the pulp/tooth ratio [11].

With advancements in technology, cone-beam computed tomography is widely used in forensic odontology with better contrast resolution and lower dose.Yang et al studied the age through the volume of teeth imaged by CBCT, by evaluating the pulp/tooth ratio [11].Recent studies have been promoted to enhance age prediction into consideration population specific data [12].

Our recent research portfolio slides numerous articles in reputed journals [13–17]. Based on this experience we planned to pursue age estimation from root diameter and root canal diameter of maxillary central incisors radiographs in Chennai population using cone-beam computed tomography in this current study.

MATERIALS AND METHOD

A total of 100 cone-beam computed tomography images were taken from the Department of Radiology, Saveetha Dental College and Hospitals, consisting of 50 males and 50 females aged between 15 and 64 years with individuals' chronological age. The exclusion criteria were: missing right maxillary central incisor, root canal treated right maxillary central incisor, with large areas of enamel overlap between neighbouring teeth, patients with severe periodontitis, with root curvature, with radio-opaque dental restorative materials visible on the CBCT images.

Images were taken by Galileo cone-beam computed tomography and grouped into 7 age groups each sex: group I (15-24 years), group II (25-34 years), group III (35-44 years), group IV (45-54 years), group V (55-64 years). Kvaal et al found that there was no significant difference from the right and left side of the jaw. And so in the present study, the right central incisor was chosen [7].

The points used to locate root canal diameter and root diameter in maxillary central incisors were marked (Figure 1). CD was marked as root diameter, EF was marked as root canal diameter, root diameter and root canal diameter were

measured with cone-beam computed tomography, the ratios of root canal diameter and root diameter were calculated.

Gender difference was evaluated through analysis of covariance (ANCOVA) using SPSS 23.0. Correlation coefficient was calculated to ascertain the association between age and root canal diameter as well as the association between age and root canal diameter/root diameter ratios. A linear regression model for age estimation for South Indian population was developed, and regression equations for both the sex separately were performed along with standard error of estimate (SEE).

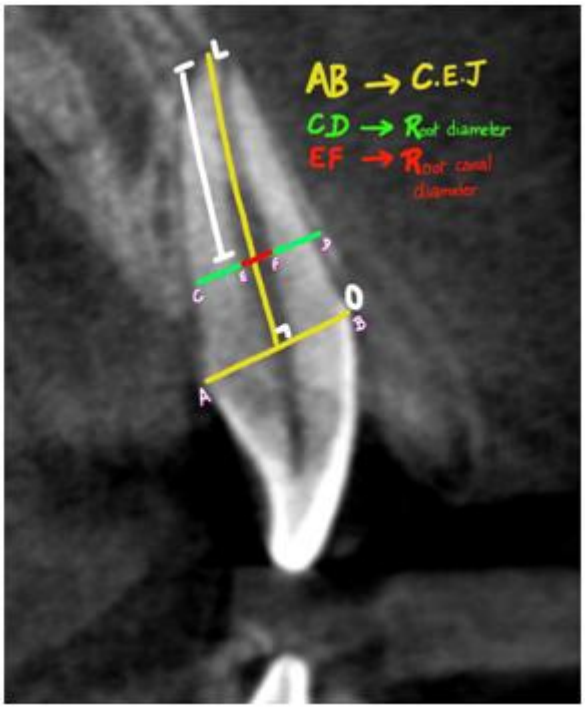

Figure 1 - The point O is the cemento enamel junction, draw a line A through point O which is perpendicular to line L. L is a line from centre of AO to root apex, CD is root diameter, and EF is root canal diameter.

RESULTS AND DISCUSSION

Age and sex distribution of individuals are tabulated in Tables 1 and 2. The descriptive statistics for different age groups, for root diameter, for root canal diameter and ratios of root canal diameter/root diameter of maxillary central incisors are shown in Table 3, respectively. Figure 2 represents a scatter diagram which shows the correlation between age and root canal diameter/root diameter ratio. Linear regression analysis, where age was the dependent variable and root canal diameter/root diameter ratios were the independent variables, showed a coefficient of determination (R^2= 0.818 for total sample, R^2= 0.808 for male and R^2=0.830 for female).

Root canal diameter/root diameter ratios showed higher correlation with age than root diameter, which was used to estimate age for both sex in different age groups from 15 to 64 years. Linear regression equations for age estimation from root canal diameter/root diameter ratios were presented in Table 4. Regression equations along with standard error of estimate (SEE) have been

computed separately for each age group both sexes in Table 5. The SEE ranged from 1.67 to 3.70 years for age estimation from the total sample.

Table 1 : Distribution for age and gender of cone-beam computed tomography images among the studied samples

Age category	**Number of males**	**Number of females**	**Total**
Group I (15-24)	10	10	20
Group II (25-34)	10	10	20
Group III (35-44)	10	10	20
Group IV (45-54)	10	10	20
Group V (55-64)	10	10	20
Total	50	50	100

Table 2 : Descriptive statistics for the chronological age of the Chennai population sample

Age group	**Gender**	**Age (years)**				
		N	**Minimum**	**Maximum**	**Mean**	**Standard deviation**

15 - 24 years	Male	10	16	23	18.90	2.13
	Female	10	15	24	20.40	2.95
25 - 34 years	Male	10	25	34	29.30	3.50
	Female	10	25	34	28.80	3.58
35 - 44 years	Male	10	35	43	39.50	2.95
	Female	10	36	44	39.50	2.68
45 - 54 years	Male	10	46	54	48.80	2.86
	Female	10	45	52	48.00	2.40
55 - 64 years	Male	10	55	64	58.80	3.65
	Female	10	55	62	57.50	2.46

Table 3 : Descriptive statistics of South Indian population

Age groups	Root diameter (mm)				Root canal diameter (mm)				Ratio			
	Gender				Gender				Gender			
	Male		Female		Male		Female		Male		Female	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
15 - 24 years	6.53	0.53	6.06	0.63	1.97	0.07	1.82	0.17	0.30	0.01	0.30	0.02
25 - 34 years	6.05	0.61	5.76	0.66	1.69	0.29	1.57	0.13	0.28	0.03	0.27	0.02

35 - 44 years	5.56	0.21	5.69	0.30	1.39	0.07	1.46	0.08	0.25	0.01	0.26	0.02
45 - 54 years	5.79	0.58	5.61	0.24	1.32	0.22	1.32	0.10	0.22	0.03	0.23	0.01
55 - 64 years	5.55	0.22	5.64	0.29	1.05	0.02	1.06	0.06	0.19	0.01	0.19	0.02

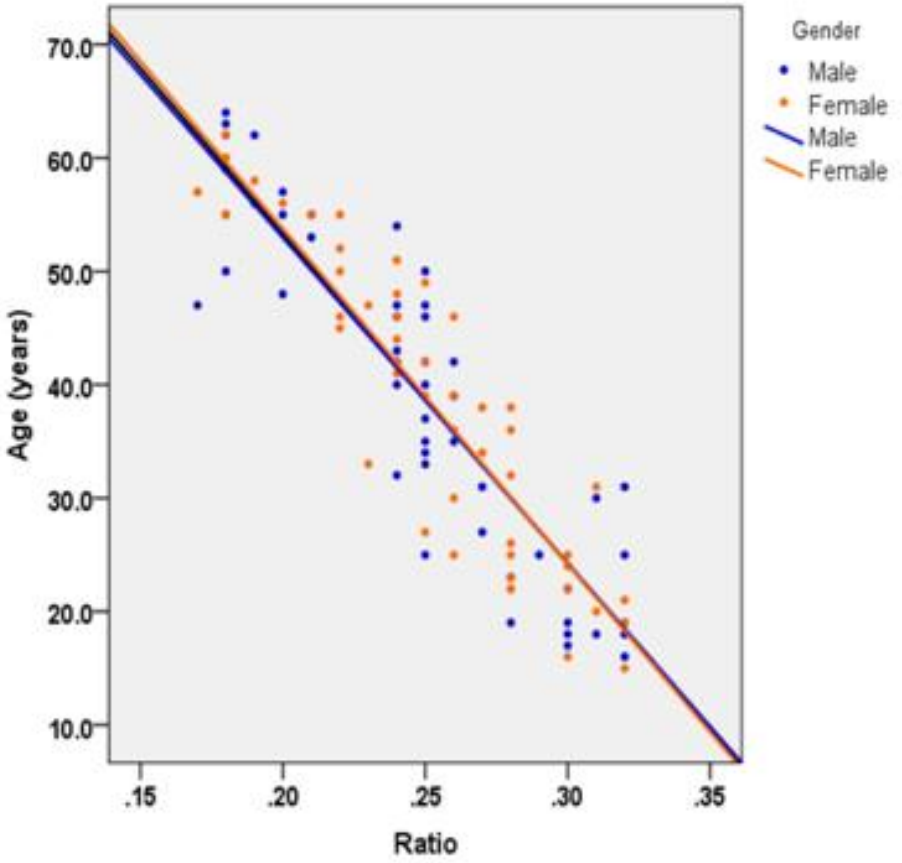

Figure 2 : Scatter diagram which shows the correlation between age and root canal diameter/root diameter ratio. Blue represents males and red represents females. Linear regression analysis shows that age was the dependent variable and root canal diameter/root diameter ratios were the independent variables, with a coefficient of determination (R2= 0.818 for total sample, R2= 0.808 for male and R2=0.830 for female)

Table 4 - Linear regression equations for both sexes and total in South Indian population

Sexes	Number	Linear regression equation	R^2	SE
Male	50	110.50 - 287.60 * Ratio	0.808	20.25
Female	50	112.88 - 295.71 * Ratio	0.830	19.30
Total	100	111.59 - 291.25 * Ratio	0.818	13.88

Table 5. Linear regression equations for each age group both sex for South Indian population

Age category (groups)	Gender	Linear regression equation	SEE	R^2
Group I (15 - 24years)	Males	Age = 44.08 - 83.09 * Ratio	1.83	0.34
	Females	Age = 44.08 - 83.09 * Ratio	2.60	0.30
Group II (25 - 34 years)	Males	Age = 40.59 - 40.77 * Ratio	3.46	0.13
	Females	Age = 44.08 - 83.09 * Ratio	3.70	0.04
Group III (35 - 44 years)	Males	Age = 77.00 - 150.0 * Ratio	2.85	0.17
	Females	Age = 44.08 - 83.09 * Ratio	1.67	0.65
Group IV (45 - 54 years)	Males	Age = 50.76 - 8.80 * Ratio	3.01	0.09
	Females	Age = 44.08 - 83.09 * Ratio	2.52	0.01
Group V (55 - 64 years)	Males	Age = 97.29 - 203.7 * Ratio	3.04	0.37
	Females	Age = 44.08 - 83.09 * Ratio	2.24	0.25

A number of methods can be used for age estimation through analysis of the morphological parameters and biological indicators of the teeth. These include dentin translucency, cementum annulations, dental nuclear tests, and amino acid racemization. Some of these methods are time consuming, invasive and unethical. So with rapid development of imaging techniques, age estimation

has become easier and more reliable. Nowadays, CBCT has been introduced providing a new approach for age estimation [18].

In this study, maxillary teeth were chosen as Brkic et al described that the teeth in the upper jaw showed stronger correlation than mandibular teeth for dental age estimation [19]. Also, the root canal systems, anatomical characteristics of central incisors are not much complicated even compared to other teeth in the same jaw. The reason behind measuring the root diameter and root canal diameter at the ¾ level from root apex is that area is more stable and reliable as it is encased by alveolar bone that helps in avoiding the impact of environmental factors like abrasion, food and saliva.
The ratio between root canal diameter to root diameter was considered in this study so as to reduce the effects of variation in the size of the tooth and also to nullify the errors in magnification and angulations of the radiographs. Results obtained through correlation and regression analysis reveals that the ratio showed higher correlation with age when compared to root diameter. From the results it is found that there is no significant gender difference on dental age estimation in the Chennai population. This is in accordance with Zaher JF et al and Cameriere et al [20,21] .
However, it is in contrast with Babshet et al [22]. Along with linear regression equations, standard error of estimate was computed in order to predict the deviation of the age that is estimated from the actual age. Lower the value of SEE, greater is the reliability of the equation. In this study, SEE ranged from 1.67 to 3.70 which is smaller and considered more stable than Zaher et al who found SEE to be 1.2 to 5.08 [20,21]. The present study reveals a statistically significant correlation between age and root canal to root diameter ratios in the Chennai population with age ranging from 15 to64 years using CBCT.

CONCLUSION

Thus it can be concluded that dental age estimation using CBCT from maxillary incisor teeth in the Chennai population showed promising results. Hence, it can be stated that dental age estimation using CBCT is a reliable method in age estimation. Also, since there is an obvious correlation between the ratio and age, the ratio in maxillary central incisors is an age dependent variable which can be used in age estimation with reasonable accuracy. It is also desirable that ethnic difference should be taken into account in the studies done in age estimation. However, further research has to be done with a larger sample size with different types of teeth to improve the accuracy of age estimation.

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CONFLICT OF INTEREST

All authors have no conflict of interest

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