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ORIGINAL RESEARCH

Adult Age Estimation from Dental Pulp in Jouf Population: A Digital Radiographic Study

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ABSTRACT

Aim: To develop an independent, noninvasive procedure for age estimation (AE) in the Saudi population using mandibular first molar tooth (MFM) by digital panoramic radiographs. To determine and compare the accuracy of pulp/tooth ratio method in MFM tooth in forensic AE.

Materials and methods: A total of 120 digital orthopantomographs (OPG) of the Saudi population were studied. The measurements of pulp chamber height (PCH) and crown root trunk height (CRTH) were performed on the MFM teeth. The acquired data was subjected to correlation and regression analysis.

Results: The pulp chamber crown root trunk height ratio (PCTHR) of the studied age groups were (0.365), (0.561), (0.040), and (0.002) respectively for (21–30 years), (31–40 years), (41–50 years), and (51–60 years) age groups, significantly correlated with the age of the individual. Individual regression formulae derived were tested on control age groups to calculate the age. The standard errors estimate (SEE) for the control age groups were (26.09 ± 1.43), (37.61 ± 1.08), (45.66 ± 0.18) and (55.85 ± 0.60) respectively. There was no statistically significant age difference between chronological and calculated age.

Conclusion: An independent, noninvasive and cost-effective procedure was developed which employed, PCH was found to be fairly accurate to perform forensic age prediction in Saudi populations.

Clinical significance: Accurate AE from MFM tooth is possible in the Saudi population.

Keywords: Age estimation, Mandibular first molar, Orthopantomograph, Pulp/tooth ratio.

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INTRODUCTION

Age is one of the essential factors of forensic odontology and is essential in establishing the identity of the person.[1] AE is of utmost importance for the identification of unknown dead bodies or cadaverous remains of crime and causalities as well in mass disaster sufferers. In case of the living people who have no acceptable identification documents, like orphans, foster children of unknown age, confirmation of chronological age is must in order to be qualified for civil rights and social welfare aids.[2] Once a tooth is fully mineralized and erupts in to the oral cavity, it becomes a very stable entity. Therefore, teeth can be considered as the most reliable parameter for dental AE[3,4] By nature the mineralized teeth are highly resistant to mechanical, chemical or physical impacts and also time. Therefore, the age-related changes of the tooth are minimally influenced by nutrition, environment and living conditions that an individual could be subjected to.[4]

Most individuals would have visited a dentist at least once in their lifetime; therefore, the antemortem details of their dental tissues would be available to match with the victim with high probability.[3] In forensic literature, several authors have advocated different techniques for dental AE. Two techniques among those are morphological and radiological techniques. Morphological techniques are further sub-grouped into clinical, histological and biochemical examination techniques.[3-5] Subjecting the teeth for radiographic investigation is a safe and simpler process which can be applied to both living and deceased individuals, whereas the other techniques are time-consuming, expensive, less reliable and destructive methods. Hence these techniques may not be acceptable for ethical, religious, cultural or scientific reasons.[5] Tooth pulp can be used as a predictor of age as it undergoes a consistent reduction in size, with increasing age due to continuous secondary dentin deposition. As this appears to be a continuous process it can be used as a parameter of AE even beyond a 3rd decade of age.[5]

The digital OPGs with their computerized storage are currently available. It has eased the image analysis and obtaining of the metric measurements considerably, and forensic experts can now adopt these techniques that are relatively precise and accurate.[3-6] In addition to this, computer-assisted image analysis, and it eradicates the bias inherent in observer subjectivity. It also improves

the reliability and consequently the statistical analysis of the data. It is therefore cost-effective study to perform morphometric analysis of dental pulp utilizing the digital radiographic method.[1,3] The aims of the present study is to develop the regression equations for AE and to develop an independent procedure to estimate an age for the Saudi population using digital OPGs for a mandibular first molar tooth.

MATERIALS AND METHODS

The present clinical study was planned and designed in the Department of Oral Maxillofacial Surgery, Oral Radiology division, College of Dentistry, Jouf University, Sakaka, Kingdom of Saudi Arabia. Ethical clearance was obtained from the institutional ethical committee (LCBE #10-16-8/39).

All the subjects participating in the study were recruited from patients attending the outpatient department of College of Dentistry for their needs. A detailed case history was recorded in a specially designed proforma for the study. 120 healthy adult subjects were recruited based on the following:

Inclusion Criteria

The digital OPGs were obtained for the study subjects, aged between 20 and 60 years. The mandibular first molar (MFM) tooth was selected from the OPGs obtained. The obtained OPGs showing good morphological features of the study teeth were selected for assessing the coronal PCH.

Exclusion Criteria

The individuals receiving prolonged corticosteroid therapy, individuals who had a severe systemic illness such as vitamin D-resistant rickets, and dentinogenesis imperfecta associated with osteogenesis imperfect were excluded from the study. Root canal treated teeth, impacted teeth, teeth with visible periapical pathologies, caries, severe attrition, radioopaque fillings and crowns, Pregnant ladies and those not willing to undergo radiographic procedures were all excluded from the study.

Digital OPGs were made for recruited 120 subjects. The subjects were distributed into two subsets. The first subset; study subset (n = 80) will be used to find the regression formula to calculate the age from PCH. The second subset; test subset (n = 40) will be used to test the efficiency of the regression equation. The age of the subjects ranged from twenty to sixty years. The subjects in each subset would be grouped into the 3rd decade (21–30 years), 4th decade (31–40 years), 5th decade (41–50 years), 6th decade (51–60 years). In the study subset, each group had 20 subjects and in test subset, each group had 10 subjects. In each subject's OPG an MFM tooth was randomly selected.

Radiographic Measurements

The Scanora 5.2.6 software system was used to conduct radiographic measurements of this study. The digital tools of the software allow linear measurements between multiple points. Two linear measurements were recorded. In the first measurement, a line was drawn connecting two points one marked on the central fossa and another on the highest point on the root furcation, measurement shown was entered in the performa (Fig. 1). In the second measurement, two points were marked, one on the floor and another on the rooftop of the pulp chamber (PC), the line was completed joining the two points. The measurement obtained was entered in the performa (Fig. 2). The length between the central fossa and the highest point on the root furcation was recorded as CRTH, and the length between points on the roof and the floor of the PC was

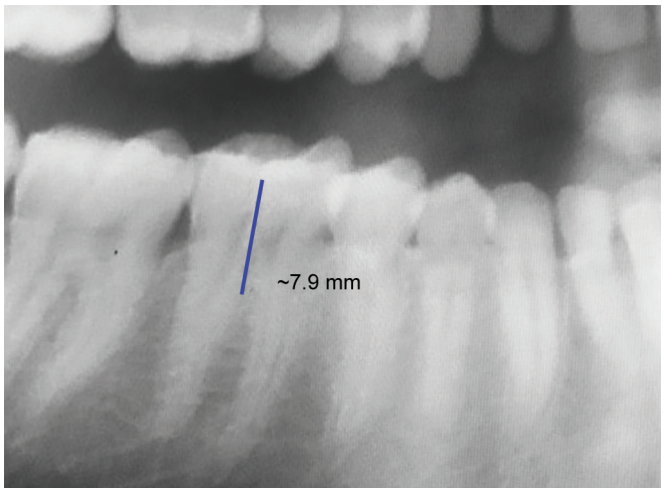

Fig. 1: Points marked on the central fossa and the highest point on the root furcation. A line drawn connecting these points

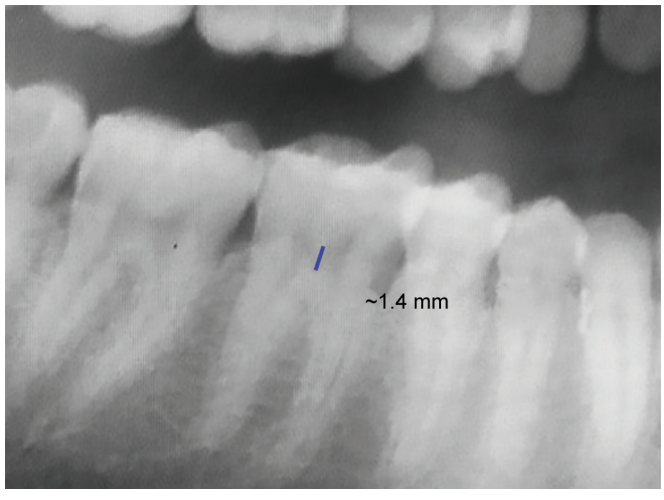

Fig. 2: Points marked on the roof of the pulp chamber and the floor of the pulp. A line drawn connecting these points

recorded as PCH. A ratio is derived from the difference between PCH and CRTH; pulp chamber crown root trunk height ratio (CRTH-PCH = PCTHR). All dimensions were recorded by a single observer and twenty randomly selected radiographs were measured after one month to access intraobserver agreement.

STATISTICAL ANALYSIS

The collected data were entered in master charts and analyzed using statistical package for social science (SPSS) v.20.5 Chicago, Illinois, USA. In the study subset, the Pearson correlation was applied between chronological age and PCTHR. Regression analysis was done on PCTHR and formula was derived to estimate the age. The regression equation was then tested on the test subset to test its certainty in age prediction. Difference between the chronological age and estimated age was recorded as an error. Independent samples t-test was performed between chronological age and estimated age in the test subset; for total subjects. Standard errors estimate (SEE) was derived by calculating the mean of the absolute value of the errors. The percentage of cases with the calculated age < ± SEE and those falling within < ±10 years; the error acceptable in forensic age forecasting were calculated. The intraobserver reliability was assessed by inter class correlation coefficient (ICC). A $p < 0.05$ was considered to be statistically significant.

RESULTS

Error Study

After 1 month of the interval, 20% of samples were randomly selected; measurements were redone by the same investigator to test the error values. Interclass correlation coefficient (ICC) result value obtained was 0.913, which indicated excellent reliability of the technique.

Table 1 depicts the distribution of age groups in the study population. The mean age for the four study groups were 26.10, 35.92, 45.65 and 55.75 respectively.

One way ANOVA test was tested to find out differences in the sizes of the PC among the study groups. Table 2 depicts the differences in PC sizes of the study population. It can be made out from this table that as age increased the size of the PC decreased consistently (Table 2).

Post hoc test was applied to compare the PC sizes between the study groups. Table 3 depicts the comparison of PC sizes between the four study groups. Statistically significant differences existed between the age groups of 21–30 years and 51–60 years. The comparison between the other two groups didn't demonstrate any statistical significance (Table 3).

Pearson correlation test was applied to study linear regression analysis of study groups to find out R and R2 values. Based on these values regression formulae were derived for each study group. The regression formulae obtained from the study groups were used to calculate the estimated age from control groups (Table 4).

Table 1: Distribution of age groups in the study population

	MFM			
Age groups (years)	*Minimum*	*Maximum*	*Mean*	*SD*
21–30 (n = 20)	21.00	31.00	26.10	3.26
31–40 (n = 20)	31.00	40.00	35.92	2.86
41–50 (n = 20)	41.00	50.00w	45.65	3.31
51–60 (n = 20)	52.00	60.00	55.75	2.69

Table 2: Difference in pulp chamber size in study population

	MFM					
			95% CI			
Age groups (years)	*Mean*	*SD*	*Lower bound*	*Upper bound*	*Minimum*	*Maximum*
21–30 (n = 20)	6.47	0.43	6.26	6.67	5.80	7.10
31–40 (n = 20)	6.09	0.60	5.80	6.38	5.00	6.90
41–50 (n = 20)	6.06	0.83	5.66	6.45	4.80	7.60
51–60 (n = 20)	5.58	0.66	5.27	5.89	4.40	6.50

Table 3: Comparison of pulp chamber size among study groups

		MFM				
					95% CI	
Age groups (years)		*Age groups*	*MD*	*p-value*	*Lower bound*	*Upper bound*
21–30 (n = 20)	*VS*	31–40	–0.37	0.43	–0.93	0.18
		41–50	–0.41	0.30	–0.96	014
		51–60	–0.88	<0.001	–1.44	–0.32
31–40 (n = 20)	*VS*	41–50	–0.35	1.00	–0.59	0.52
		51–60	–0.51	0.09	–1.06	0.04
41–50 (n = 20)	*VS*	51–60	–0.47	0.14	–1.03	0.08

Table 4: Regression equations for study groups

Age groups (years)	*Regression equation*	*Tooth*
21–30	EA = 433.073-21.463 (X)	MFM
31–40	EA = 292.067-22.992 (X)	
41–50	EA = 563.726-2.613 (X)	
51–60	EA = 764.918-14.825 (X)	

Table 5: Actual and estimated age of control groups

	Age groups (years)							
	21–30		*31–40*		*41–50*		*51–60*	
	AA	*EA*	*AA*	*EA*	*AA*	*EA*	*AA*	*EA*
Mean	26.10	26.09	36.00	37.61	45.50	45.66	54.70	55.85
SD	4.20	1.43	2.67	1.08	3.37	0.18	2.67	0.60
p	0.9951		0.093		0.8812		0.2009	

Table 5 depicts the actual and estimated average age in tested age groups. The estimated age for all four groups was very much similar to the actual age. Age group 21–30 years and 41–50 years showed excellent similarity in the predicted age.

DISCUSSION

Dentition is one of the systems used for estimation of age. Size of the PC, which is expected to reduce with time, may show a consistent relationship with chronological age. Since these changes can be observed on the radiograph they can be used as a biomarker for chronological age. Many studies have been conducted in this regard, utilizing anterior teeth.[1] Although few studies conducted utilized molar tooth in other parts of the world, and we wished to establish data for MFM tooth in the Saudi population. Therefore, it instigated us to do a morphometric analysis of PCH for MFM tooth using digital OPG.

From Table 1 it can be noted that, initially, a mean value of PC, 6.47 mm was noted for the age group of 21–30 years, from thereon it has slowly decreased to a mean value of 5.58 mm for the age group of 51–60 years. After analyzing the data, it appears that the size of the PC has decreased consistently in MFM teeth, as age increased. In reality, the size of the PC is expected to decrease as age increases. The results observed above were in agreement with a study conducted by Sasidhar Singaraju and Sharada,[1] and Shah and Venkatesh.[7-10]

From Table 3 it can be observed that when the size of the PC was compared between the different study groups significant differences existed between 21 to 30 years and 51 to 60 years age groups. The comparison between other age groups did not demonstrate any significant differences. It means that, though the reduction in the size of the PC is present it is more evident in wider age ranges.

The formation of secondary dentin does not occur uniformly on all the surfaces of the tooth. In molar teeth, it appears to be in greater amounts on the roof and floor of the coronal PC.[7] Therefore we intended to develop an independent method in which the height of the PC and the height of crown root trunk were measured for estimating the age in the Saudi population. Deposition of secondary dentin is also influenced by genetic and environmental factors. Talreja et al.[11] demonstrated that more accurate results can be obtained by using population-specific formulae. Therefore, in the present study, a separate regression formula was derived for the Saudi population. In this study, we have developed a different procedure than other studies utilizing digital radiographs of MFM tooth to estimate the age. Distortion could be produced when a curved arch was projected on a flat film; therefore we have selected a single tooth for the study to create uniform distortion on all the samples.[12]

In the current study, the secondary dentine deposition was indirectly measured by measuring the reduction in the volume of the PC. It is being reported that secondary dentine deposition is not homogeneously spread all over the PC. In molar teeth as the age increases secondary dentine deposition happens preferentially on the roof and floor of the PC decreasing the height rather than the width of the PC.[4] Drusini et al.,[13] have used posterior teeth coronal PCH by measuring the distance between the highest point on the pulp horn and cervical line. We found Drusini et al.[13] measuring technique was inconvenient since superimposition of the adjacent pulp horns and thin cement-enamel junctions hinder the accurate measurement of these parameters.

In this study, we have adopted a new procedure where the PCH and CRTH were measured and ratio; PCTHR was obtained (Figs 1 and 2). This PCTHR ratio was correlated with the chronological age of the four study age group's subjects after obtaining correlation coefficient value (r) from linear regression. The correlation coefficient (r) values obtained were (0.365), (0.561), (0.040), and (0.002) respectively for (21–30), (31–40), (41–50), and (51–60) years age groups. They were suggestive of statistically insignificant correlation. This finding was

similar to the studies done by Shrestha J[14,15] and El Morsi et al.[9] while they were in contradiction with the studies done by Shah and Mathew et al.[7,8] From this finding it can be inferred that reduction in the PCH was not so consistent in MFM tooth as chronological age advanced. There was significant intraclass coefficient (ICC) value obtained (0.913), which indicated excellent reliability of the technique.

Following the linear regression analysis, regression equations were generated for all the four study age groups (Table 4). These regression equations were tested on control age groups to determine the estimated age. The mean and standard deviation error values obtained for four control age groups were (26.09 ± 1.43), (37.61 ± 1.08), (45.66 ± 0.18) and (55.85 ± 0.60) respectively (Table 5). From these findings, it was ascertained that there was no much statistically convincing age difference was present between estimated age and actual age. The age difference between the estimated and actual age was well within the standards of forensic AE (< ±10 years).[16] The above findings suggested the accuracy of this method of AE based on pulp tooth area ratio on Saudi population. In the present study, there was no convincing difference between the estimated age and actual age in subjects, which was similar to other AE studies done on other populations.[5-9,15]

This study included 120 male subjects, and digital OPG was employed; also the study involved only MFM tooth. All these appear to be the limitations of our study. We could not employ female subjects because of local rules and regulations. We advocate further studies with CBCT, recruiting a large sample size with narrow age group divisions with multiple teeth.

CONCLUSION

The existing linear relationship of pulp/tooth area ratio of the MFM with the chronological age of the Saudi population was confirmed by this study. An independent, noninvasive and cost-effective procedure was developed which employed, PCH was found to be fairly accurate to perform forensic age prediction in Saudi populations. We can probably improve the prediction accuracy of the existing technique by developing a multiple regression equation using multiple teeth.

The future studies can be performed by measuring pulp volume by using CBCT, curvilinear regression analysis, multiple regression formulae, and larger sample sizes to achieve more accurate results.

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