WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 5.990
Volume 4, Issue 10, 2720-2728. Research Article ISSN 2277– 7105

AGE ESTIMATION BASED ON VARIATION IN THE PULP CAVITY OF MAXILLARY INCISORS - A RADIOGRAPHIC STUDY

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Article Received on
19 Aug 2015,

Revised on 09 Aug 2015,
Accepted on 29 Sep 2015,

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ABSTRACT

Aim and objectives: To estimate the age of the patients belonging to the age 15-65 yrs, attending the department of Oral Medicine and Radiology, St Joseph dental college and hospital, Eluru based on radiographic evaluation of pulp cavity width of maxillary central and lateral incisors. **Materials and methods:** The study group comprises of 200 subjects of age 15-65yrs. Intraoral periapical radiographs of maxillary incisors are taken for all subjects using conventional paralleling angle technique and pulp cavity width is measured at cervical and middle third using digital vernier caliper. The recorded data is subjected for statistical analysis. Regression analysis was carried out to obtain the estimated age using pulp cavity width. **Results:** Student t-test showed statistical significant difference in cervical and middle third pulpal widths in males and females. Anegative linear relationship was obtained between age and pulp cavity width in males and females. Cubic regression analysis was done and regression formulas were obtained. The mean real age of males and females are 40.83 years and 41.17 years respectively. The mean estimated ages are 40.53 years and 40.96 years in males and

females respectively. **Interpretation and Conclusion:** Our study revealed a negative linear relationship between age and pulp cavity width. Accordingly, regression formulas were derived for males and females. The estimated age showed an average difference of 0.30 years in males and 0.21 years in females, supporting the applicability of regression formula in the adult Eluru population.

KEYWORDS: Forensic dentistry; Age determination; Pulp cavity; Maxillary central incisor; Regression analysis.

INTRODUCTION

Age is one of the essential factors of Forensic Odontology and is essential in establishing the identity of the person. Estimation of the human age at time of death is often an important step in identification of human remains.[1] This also helps in both civil as well as criminal cases like in consent juvenile offenders, kidnaps, rape, marriage, attainment of majority, competency as a witness, senior citizen concession, retirement benefits, etc.[2]

Age estimation from teeth are frequently used because teeth may be preserved longer than all other tissues, even bone.[3] The teeth are the hardest substances in the human body and, depending upon ambient conditions, characteristics associated to the teeth may provide an important and effective method to identify a person. They show the best resistance against postmortem alterations caused by humidity, high temperature, microbial activities, and mechanical forces.[4]

Radiology plays an indispensable role in human age determination. The application of radiology in forensic sciences was introduced in 1896, just one year after the discovery of X-ray by Roentgen, to demonstrate the presence of lead bullets inside the head of a victim. Since 1982, dental radiology has been employed in methods of age estimation.[5]

Age-related changes occur in teeth between approximately 10 weeks in utero to old age.[6] As the age advances, the volume of the pulp cavity gradually decreases because of the secondary dentin deposition in the pulp cavity wall.[4] These morphological changes in the pulp cavity or/and dentin accumulation serve as one of the most promising predictors for age estimation.

MATERIALS AND METHODS

A total of 200 patients belonging to both the genders (100 males and 100 females) between age group of 16-65 yrs attending the outpatient department of Oral Medicine and Radiology, St Joseph Dental College and Hospital, Eluru were selected randomly.

The importance and need for the study was explained to each individual and the study sample was selected only on voluntarily basis. An informed consent was obtained from the patients and the approval from the institution ethical committee was obtained.

Patients with full complement of sound maxillary central and lateral incisors with an integrated dentition and good occlusion were considered for the study. Patients with history of parafunctional habits, developmental anomalies of teeth, impacted anterior teeth, trauma from occlusion and other trauma related disorders; malocclusion, fracture, caries and restorations, systemic diseases like renal diseases, thyroid and parathyroid diseases were excluded from the study.

The selected sample were then subjected to three conventional intraoral periapical radiographs (1 for maxillary central incisors and 2 for maxillary lateral incisors) using conventional paralleling angle technique taken at standard parameters with proper radiation protection measures. Following which, the radiographs were processed with the constant strength of developing and fixing solutions as recommended by the manufacturer. Then the dried radiographs were labeled with patient's details and stored. The pulpal cavity width (mesiodistal diameter) was measured at cervical portion of tooth and middle third of root for maxillary central and lateral incisors using a magnifying glass, radiographic viewer and a digital vernier calliper with 0.01 mm calibration.

The recorded measurements were entered in the proforma specially designed for the study and the final data was subjected to statistical analysis using SPSS software 17.0 version. Pearson's correlation test was performed in our study to determine the correlation between pulp cavity width and age. Regression analysis was carried out to obtain the estimated age using width of pulp cavity. Student's t-test was performed to compare the mean estimated age with the known mean age of the individual.

RESULTS

The mean real age is 40.83 years in males and 41.17 years in females. The mean values of cervical third pulp cavity width in males and females are 6.18 mm and 5.82 mm respectively. The mean values of middle third pulp cavity width in males and females are 3.33 mm and 3.15 mm respectively. Student t-test was performed for comparing the mean values of pulp cavity width at cervical and middle third in males and females. Statistical significant difference was observed in cervical and middle third pulpal widths in males and females (Table 1).This is suggestive of a definitive sex difference regarding width of pulp cavity. Hence, we have determined the correlation and cubic regressions for males and females separately.

Table 1: Comparison of mean age, cervical and middle third pulp cavity widths in males and females

VARIABLES	MALE		FEMALE		PVALUE
	MEAN	SD	MEAN	SD	
AGE(Years)	40.83	13.45	41.17	13.43	0.858 NS
Cervical third pulp cavity width (mm)	6.18	1.26	5.82	0.91	0.023 S
Middle third pulp cavity width (mm)	3.33	0.65	3.15	0.58	0.044 S

Statistical Analysis: Student- test. Statistically significant if P<0.05

NS: Non significant; S: Significant

Pearson correlation was performed between the mesiodistal diameters of cervical third and middle third of pulp cavity and age in both males and females. A negative linear relationship was obtained between age and pulp cavity width in males (cervical third, r = - 0.575 and middle third, r = -0.737). Similar results were obtained in females (cervical third, r = -0.452 and middle third, r = -0.715). This is suggestive of the fact that as age increases, pulp cavity width decreases. Strong correlation was observed with middle third of root canal when compared to cervical third of pulp cavity in both males and females. (Fig 1, Fig 2, Fig 3, Fig 4).

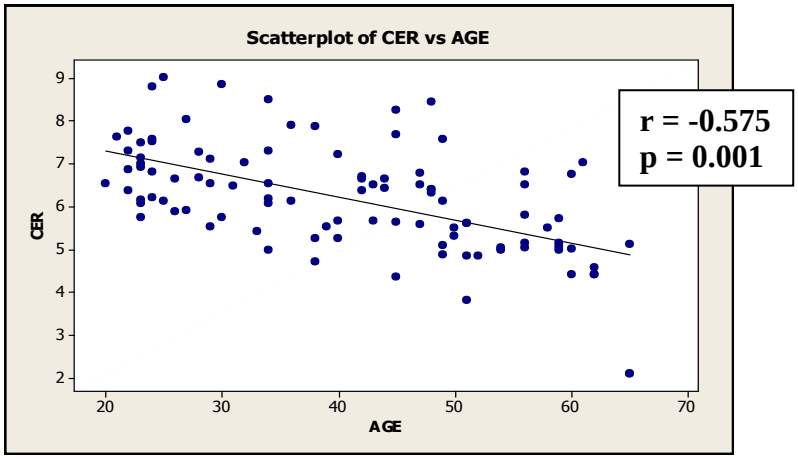

Fig 1: Correlation of age Vs cervical third pulp cavity width in males

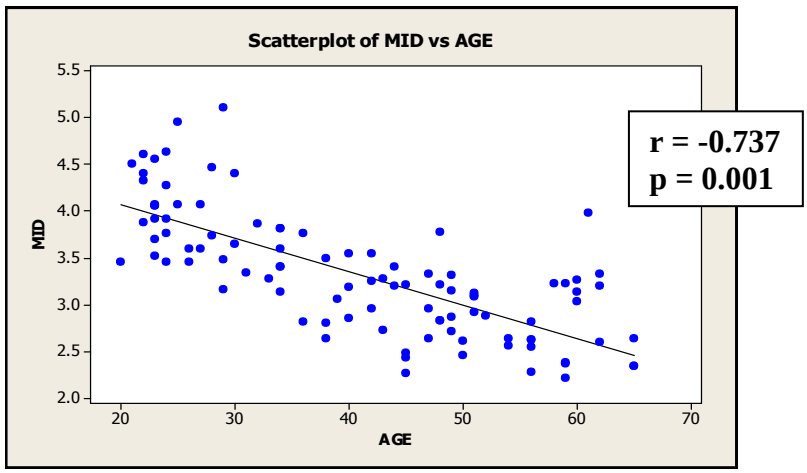

Fig 2: Correlation of age Vs middle third pulp cavity width in males

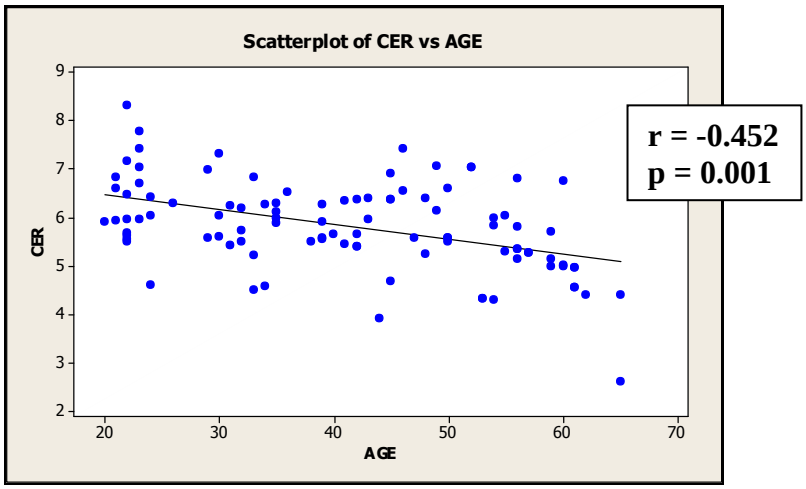

Fig 3: Correlation of age Vs cervical third pulp cavity width in females

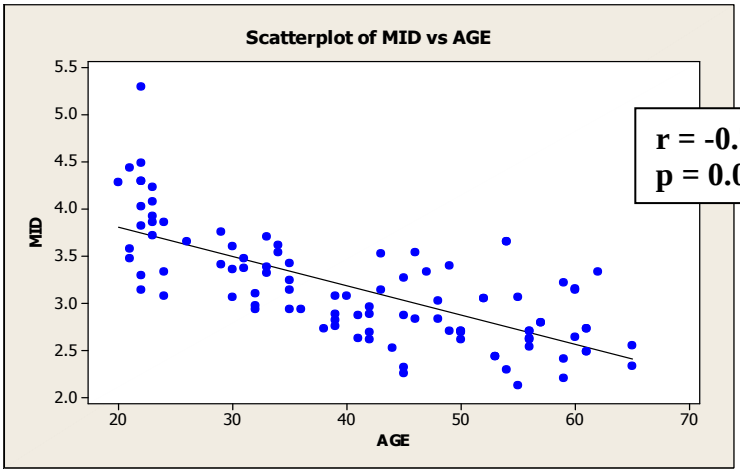

Fig 4: Correlation of age Vs middle third pulp cavity width in females

Cubic regression analysis was performed with age as a dependent factor and pulp cavity width as an independent factor. In order to obtain an estimated age, the cubic functions were calculated using the formula $y = ax^3+bx^2+cx+d$, Where, y is estimated age and x is corresponding pulp width, considering age as a dependent variable and pulp width as the independent variable. Regression formula in males for sum of cervical and middle third of pulp cavity of incisors is - $AGE= (0.147*x^3) + (-3.773*x^2) + (25.085*x) + 15.506$. Regression formula in females for sum of cervical and middle third of pulp cavity of incisors is - $AGE= (0.143*x^3) + (-3.693*x^2) + (23.865*x) + 20.479$.

The mean real age of males and females are 40.83 years and 41.17 years respectively. The mean estimated ages are 40.53 years and 40.96 years in males and females respectively. The mean age differences were found to be 0.30 years in males and 0.21 years in females. Student t- test revealed no significant difference (p = 0.998) between the estimated age and real age (Table 2, 3, 4).

Table 2: Comparison of mean estimated age and mean real age in males and females

Gender	N	Mean real age Years)	Mean estimated age (Years)	Mean age difference (Years)
Males	100	40.83	40.53	0.30
Females	100	41.17	40.96	0.21

N: Sample size

Table 3: Student's t-test between mean estimated age and mean real age in males

	Mean	N	Std. Deviation	Std. Error Mean	p-value
Real age	40.8300	100	13.37988	1.33135	
Estimated age	40.539594	100	9.6333278	.9585519	0.757

P value <0.01 significant

N: Sample size

Table 4: Student's t-test between mean estimated age and mean real age in females

	Mean	N	Std. Deviation	Std. Error Mean	P value
Real age	41.1700	100	13.36118	1.32949	
Estimated age	40.957992	100	8.8137320	.8769991	0.834

P value <0.01 significant

N: Sample size

DISCUSSION

Age estimation forms an important aspect in establishing a profile in forensic investigations. Although several parts of the body can be used for age estimation, the poor condition of the remains often prevents their use. However, the teeth are usually more resistant to peri- and post-mortem tissue altering effects. In addition, teeth can be examined clinically and radiographs prepared with minimal radiation exposure to living individuals.[2] The study of morphological parameters of the teeth on radiographs is considered to be more reliable than most other methods of age estimation.[7]

It is known that under physiological conditions the volume of the pulp cavity gradually decreases with age because of secondary dentin deposition. In the present study, we have determined the age related morphological changes in the human incisor pulp cavity by measuring the mesiodistal diameters of pulp cavity at cervical part of pulp chamber and middle parts of root canal. We did not consider the crown pulp chamber, because it has a crescent shape in transverse section, which is easily subject to variation in its width when the mesiodistal plane of tooth is not parallel to the film. The radiographic depiction of tooth morphology is highly dependent on image geometry.

In the previous studies, the ratios between the tooth and pulp measurements, such as the pulp/tooth length and the pulp/tooth width at the different levels, were calculated and used in the analyses to reduce the possible variation because of the angulation of the radiographs. In the present study, we chose the mesiodistal diameters of the pulp cavity (rather than the ratio of pulp/root width) at the two levels as the predictors for age estimation. This is because the transverse sections of the cervical pulp chamber and the root canal are near-round, but those of the cervix and the root are oval or near-triangular in shape. Thus, an angulation of the

radiograph may have little to do with the width of the cervical chamber and root canal, but cause a variation in the tooth width at the corresponding level, leading to greater error.

In our study, maxillary teeth were used as they are more convenient for age determination than mandibular teeth. Brkic et al. (2006) found that teeth of both jaws are reliable for the dental age estimation, but the correlation coefficient was stronger for all of the types of teeth in the upper jaw. In addition, Fancy et al. (1980), stated that growth layers of maxillary teeth are more regular and distinct than those of mandibular teeth.[8]

We found statistically significant difference in mean pulpal widths between males and females. This indicates strong sexual dimorphism in pulpal widths. In our study, a negative linear relationship between the width of pulp cavity and age was obtained. The middle part of root canal has strong correlation when compared to cervical part of pulp cavity. These results are in agreement with Du C et al (2011) who utilized mesiodistal diameters of pulp cavity in maxillary and mandibular incisors.[4] Agematsu H et al (2010) evaluated a three dimensional decrease in the volume of pulp chamber caused by age related secondary dentin deposition using micro CT.[9] Zaher JF et al (2011) obtained similar negative correlation between pulp/tooth area ratio and chronological age in Egyptian sample.[8]

In our study the mean real age of males was 40.83yrs and estimated age for the sum of the cervical and middle third of the pulp cavity width was found to be 40.53yrs with a mean difference of 0.30yrs. The mean real age of females was 41.17yrs and estimated age for the sum of the cervical and middle third of the pulp cavity width was found to be 40.96yrs with a mean difference of 0.21yrs. The mean age difference in both the genders is observed to be much less when compared to other studies. Student's t-test revealed no statistical significant difference between mean real and estimated age in males and females.

Singh A et al (2004) evaluated physiological changes in the teeth with the advancing age and found a mean difference ± 2.16 years between actual and calculated age.[10] Zaher JF et al (2011) proved that the estimated ages were very close to the chronological age with insignificant difference in between.[8] Shrigiriwar M (2013) estimated age from physiological changes of teeth by Gustafson's method and average age difference between known and estimated age in was found to be ±4.43 years which was statistically not significant.[11]

Within the limitations of the study, it can be concluded that the derived regression formulas can be used to estimate the age of adult Eluru population with minimum age difference, using pulp cavity width.

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