

## AGE ESTIMATION USING ORTHOPANTOMOGRAPHS- A FORENSIC STUDY

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### ABSTRACT

**Background:** Chronological age assessment is an integral part of forensic sciences including dentistry. It is one of the indicators used in forensic identification and teeth are biological markers for human age estimation. The aim of the study was to estimate chronologic age in South Asians using orthopantomographs and correlate with the actual age. **Materials & Methods:** The crown height (CH) and coronal pulp cavity height (CPCH) were measured for premolars and molars. The tooth coronal index (TCI) was computed for each tooth. Data obtained was subjected to correlation and regression analysis. **Results:** Significant correlation was demonstrated between dental age and chronologic age ( $p < 0.000$ ). The age estimation was more accurate for the premolar equation as compared to the molar equation. **Conclusion:** This study highlights the potential value of little known but precise age estimation method that can be effectively employed in both living and unknown dead.

**KEYWORDS:** Age estimation; OPGs; forensic odontology

### INTRODUCTION

Chronological age assessment is an important part of medico legal practice. The procedures for age determination are complex and involve the consideration of many factors.<sup>[1]</sup> Several methods of age estimation using teeth are available, with the most widely applied being rather time consuming and in many cases requiring sophisticated laboratory equipment for preparing longitudinal sections. Other methods based on the dynamics of the tooth eruption process are limited

to the short period of odontogenesis.<sup>[2-7]</sup> Dental age estimation makes use of morphologic, radiographic, histological and biochemical methods to examine age dependent changes in teeth.<sup>[8]</sup> In living persons, any or all of the above methods can be used to determine age, in cases where the actual age is not known or is to be confirmed. However, in case of a dead person, post-mortem changes such as decomposition, mutilation or skeletisation may make identification progressively more difficult, almost to the point of 'impossibility'.<sup>[9]</sup> The lesser known but easily applied method of age estimation is based on secondary dentin deposition clearly seen on dental radiographs since with advancing age the size of the dental pulp cavity is reduced as a sequence of secondary dentin concernments.<sup>[5,7,10,11]</sup> The height of the coronal pulp cavity has been shown to have a significant correlation with chronological age.<sup>[4]</sup> An alternative and precise age estimation method using, Tooth Coronal Index (TCI) is also one of the most widely applied and acknowledged procedures.<sup>[12]</sup> Hence, the purpose of the present study was to present a simple, reliable, non-invasive and inexpensive method combining the above two dynamics for assessing the chronological age using orthopantomographs.

### MATERIALS AND METHODS

The present retrospective study was carried out in the Department of Oral Pathology and Microbiology, Terna Dental College, Nerul, Navi Mumbai. The study protocol was approved by the Institutional Ethical Committee. A total of 115 orthopantomographs (OPGs) were retrieved from the archives (43 M, 72 F, range 13 -32 years) with a mean age of 20.43 years. Using digital Vernier calliper, radiographs were assessed by taking two

**Table 1: Age and gender distribution**

Gender	N	Age range (yrs)	Mean (SD)
Male	43	13-31	20.51(4.4)
Female	72	14-32	20.38(3.9)
Combined	115	13-32	20.43(4.1)

**Table 2: TCI and gender distribution**

Gender	TCI (Premolar) range	Mean±SD
Male	15.88-36.06	26.02±6.09
Female	17.62-39.13	26.60±5.4
Combined	15.88-39.13	26.38±5.6
	TCI (Molar) range	Mean ± SD
Male	24.14-38.78	29.96±4.6
Female	24.15-41.14	30.25±4.3
Combined	24.14-41.41	30.14±4.4

**Table 3: Correlation coefficient between age and TCI by age and gender and tooth type**

Gender	R	t value	Df	p value
<b>PREMOLAR</b>				
Male	-.944	-18.27	42	0.000(s)
Female	-.223	-1.862	67	0.000(s)
Total	-0.917	-24.49	114	0.000(s)
<b>MOLAR</b>				
Male	-.943	-17.82	41	0.000(s)
Female	0.032	0.260	67	0.000(s)
Total	-.938	-28.60	114	0.000(s)

**Table 4: Equation prediction age (Y) from TCI method by gender and tooth type**

Gender	N	SE	R	Prediction equations
Premolars				
Male (M)	43	1.63	-.944	Y= 49.85-0.965X
Female (F)	72	1.454	-.223	Y= 51.08-1.025X
Male & Female (M&F)	115	1.43	-0.917	Y= 50.81-1.011X
Molars				
Male (M)	43	1.54	-.943	Y= 52.57-1.294X
Female (F)	72	1.708	0.032	Y= 52.11-1.252X
Male & Female (M&F)	115	1.639	-.938	Y= 52.35-1.271X

X represents value for TCI both for molars and premolars respectively

measurements, height of the crown (CH) and height of the coronal pulp cavity (CPCH). Two observers independently took the measurements (in mm) from mandibular second premolars and molars with fully visible pulp cavity. Teeth from either the left or right side were chosen, whichever were best suited for measurement. Impacted teeth, teeth with radiopaque fillings, root canal treatment, crowns, prostheses, severe

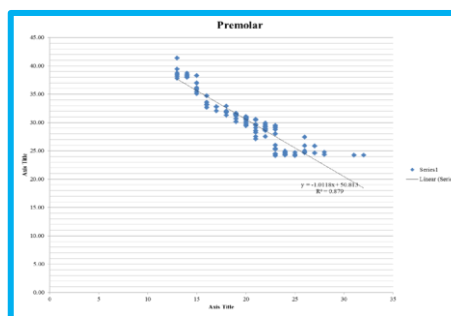
attrition and periapical lesions were not considered for the study. A straight line traced between the CEJ was considered as a division between the anatomical crown and the root. The crown height was measured vertically from cervical line to the tip of the highest cusp and the coronal pulp cavity height was measured vertically from the cervical line to the tip of the highest pulp horn. All the measurements were

**Table 5: Percentage of accuracy levels for age prediction testing equations from the TCI method**

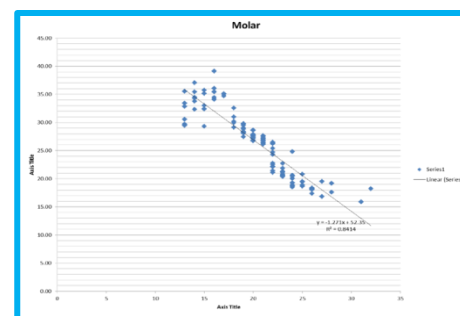
Gender	N	% of accuracy levels
Premolars		
Male (M)	43	99.48
Female (F)	72	99.16
Combined (M &F)	115	99.9
Molars		
Male(M)	43	90.56
Female(F)	72	88.34
Combined (M&F)	115	89.17

**Table 6: Comparison of percentage in accuracy levels between Caucasian, Malawians and Indian population**

Gender	Caucasians <sup>[12]</sup>	Malawians <sup>[2]</sup>	South Asian
Premolars			
Male (M)	41.67	49.35	99.48
Female (F)	35.48	40.35	99.16
Male & Female(M&F)	40.91	47.76	99.9
Molars			
Male (M)	30.06	53.25	90.56
Female (F)	22.54	28.07	88.34
Male & Female(M&F)	30.43	37.31	89.17



Graph 1: Regression equation of premolars for combined samples (male &amp; female)



Graph 2: Regression equation of molars for combined samples (male &amp; female)

carried out twice by two individuals and the mean was recorded to minimize intra and inter observer errors. Tooth coronal index (TCI) was then calculated for each tooth by using the mean values, applying formula,  $TCI = CPCH \times 100 / CH$ . The study sample was divided into premolar and molar groups. Simple linear regression analysis was carried out for each group using the Microsoft excel package for windows 2007 and age predicting equations were calculated. These equations were employed to estimate the patient's age and it was statistical analysed against the actual age by utilizing Pearson's coefficient test in SPSS version 16.

## RESULTS

Table 1 shows age and gender distribution of the studied population. The mean age and standard deviation (SD) in years for males was  $20.51 \pm 4.4$

while for females was  $20.38 \pm 3.9$ . Similarly, the mean age and SD for both gender was  $20.43 \pm 4.1$ . Table 2 depicts tooth coronal index (TCI) and gender distribution of the studied population with respect to molars and premolars. The mean TCI of premolars were found to be lower than molars in both genders separately and combined. Table 3 illustrates the correlation coefficient between age and TCI by gender and tooth type. The correlation was significant for both genders in premolars and molars ( $-.223$  to  $.032$ ;  $p < 0.000$ ). Table 4 shows the age prediction equations for males, females and combined population (Graph 1 & Graph 2). Table 5 shows the percentage of accuracy levels in age prediction testing equations from the TCI method. The highest accuracy was obtained for combined samples using premolar equation in 99.9% of cases. The premolar equation obtained

showed slightly higher levels of accuracy in males (99.48%) as compared to females (99.16%). Table 6 demonstrates the comparison of percentage in accuracy levels between Caucasians as reported by Zadzinskas *et al.*, Malawians by Igbigbi *et al.*, and the present study. The Indian population showed highest percentage levels of accuracy in both genders using premolar and molar equations.

## DISCUSSION

Age estimation from teeth is frequently used because they may be preserved long after all other tissues and bones have disintegrated.<sup>[2]</sup> Tooth mineralization stages are less affected by variation in endocrine and nutritional status unlike bone mineralization.<sup>[13]</sup> Extractions and microscopic preparations cannot be used in living individuals due to ethical, religious, cultural or scientific restraints. Radiographic assessment of age is a simple non-invasive and reproducible method that can be applied on living and unknown dead.<sup>[14]</sup> This method is based on relationship between age and pulp size.<sup>[2]</sup> Furthermore, a study has shown that age estimation based on Tooth coronal Index (TCI) instead of absolute measurement, excludes errors resulting from different scales of X-ray photos. Hence the basis of the study was age estimation using successive deposition of layers of secondary dentine in the pulp cavity supplemented with TCI method with OPGs. In the present study, the accurate age estimation percentage was higher in the male population. This may be an expression of size of the pulp cavity as males tend to have larger teeth. We observed higher percentage accuracy for age estimation in premolars for both males and females; however in Igbigbi *et al.*, study premolar equation was more accurate for males and molar equations for females. Gender may have significant influence on age estimation using the tooth coronal index method.<sup>[2]</sup> This highlights the necessity of designing sex specific formulae. The present analysis revealed high correlations between estimated age and chronological age, suggesting easy visibility of coronal pulp cavities in premolars and molars as described by Drusini *et al.*<sup>[4]</sup> According to Kvaal *et al.*, various studies have shown that with advancing age the size of dental pulp cavity is reduced as a result of secondary dentine deposition, so that

measurement of this reduction can be used as an age estimation criteria, which later was the basis for various estimation techniques.<sup>[10]</sup> Despite the fact that this method has received little attention in research, the height of the pulp cavity has shown to have a significant correlation with chronological age.<sup>[4,5,10]</sup> This correlation is observed to be high for molars, although it was higher for premolars in the present study. Compared to studies in Caucasian and Malawian populations, we observed higher accuracy in age estimation using tooth coronal index method.<sup>[2,12]</sup> Age estimation studies done on OPG by Cameriere *et al.*, and Bosmans *et al.*, indicated no significant differences between estimated and chronological age.<sup>[15,16]</sup> Similarly, Igbigbi *et al.* in validated age estimation method using OPGs from TCI method showed high degree correlation between age and TCI.<sup>[2]</sup> Agarwal *et al.*, demonstrated that there was no statistically significant difference between mean estimated age and actual mean age.<sup>[14]</sup> Reliability of age estimation using OPGs was more accurate in children and young patients compared to older age group in one of the similar study.<sup>[13]</sup> Present study population comprised predominantly of young individuals (13-32 years) and showed very high accuracy. This could be attributed to physiological wear due to increasing age and thus compromising crown height measurement, increasing the margin for error. In forensic odontology, reliability and adequate precision of dental age determination is very important in living person as legal consequences can be quite different if a subject of an unknown case is judged to be juvenile or an adult.<sup>[17]</sup> Such estimations of living individuals are made for refugees or other persons who arrive in a country without acceptable identification papers in order to be entitled to civil rights or social benefits in the present day society.<sup>[18]</sup>

## CONCLUSION

Age estimation based on the tooth coronal index method is reliable, lucid and less time consuming. Such studies should be performed on a larger sample size inclusive of all ages, races and sexes in order to reduce standard errors, achieve maximum reproducibility and derive a universal formula.

## CONFLICT OF INTEREST & SOURCE OF FUNDING

The author declares that there is no source of funding and there is no conflict of interest among all authors.

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