AGE ESTIMATION BY MEASURING OPEN APICES OF PERMANENT TEETH AMONG 6-10 YEARS OLD - A DIGITAL ORTHOPANTOMOGRAPH STUDY IN HARAUTI REGION

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ABSTRACT:

Background: To calculate maturity andage estimation, stages of teeth formation is commonly used tool for age estimation of a individual. This evidence assist in diagnosis and treatment planning in clinical as well as in forensic dentistry. Dental age estimation is based on morphological, histological, biochemical and radiological measurement of teeth.

Materials and Methods: A retrospective observational study included - a total of 96 panoramic radiographs of patients aged 6 - 10 years. The mean length of teeth and width of open apices of seven right or left mandibular teeth were calculated using radiovisiography and adobe photoshop software.

Results: The linear regression equation derived for estimation of age, from the variables X1, X2, X3, X4, X5, X6, X7, s & N, was $10.145–0.703S+0.208S.N–0.600X5$.

Conclusion:Cameriere's method can be used for age assessment in children in case of forensic as well as legal contexts and based on these variables a reliable age estimation equation was proposed specifically for Rohilkhand region population.

INTRODUCTION

Assessment of age in children is the elementary query in forensic medicine, paediatric and in orthodontic treatment. Age is defined as a period of human life, measured by years from birth; it is an important religious, social, and cultural phenomenon. Forensic dentistry plays a vital role in the implementing dental knowledge to those criminal and civil laws who are captured by police agencies in a criminal justice system. [1] In judiciary forensic dentistry plays a vital role in implementing dental knowledge on criminals captured by police agencies. It is more relevant in our country, where significant number of children and adolescents don't own any identification entity. [2,3]

In a growing individual, to estimate the age - skeletal, odontological, anthropological and psychological methods are used. The commonly used for skeletal maturity are those concerning the left hand-wrist area (e.g. Tanner–Whitehouse[4] and FELS[5] methods), which can estimates the age up to 16 years, at which time wrist maturation is complete in 90% of subjects.[3]

Among the various system developed to determine dental age, Demirjian[6] system has gained wide acceptance. Earlier, Koshy S et al., and Anand K et al., checked the applicability of this method in Indian population and found an overestimation of age, hence they concluded that it cannot be applied for Indian children.[7,8] In 2006, Cameriere et al developed a new method for assessing chronological age in children based on the relationship between age and measurement of open apices in teeth.[9] Bagh T et al., conducted a study by using the aforementioned method and a Cameriere's formula specific for Indian children was established.[10] But due to its rich culture variability & mixed ethnicity, in India there is need for region specific formula. Hence the present study was designed to evaluate the viability of Cameriere's specific formula for India population at Kota district of Harauti region.

Research Hypothesis

There will be a correlation between the age estimated by measuring the open apices of teeth and the chronological age of the patient.

Materials and Methods

A total of 96 Orthopantomographs (OPGs) of age groups 6 - 10 years comprising both sexes were selected from the department of Pedodontics and preventive dentistry.

Inclusion Criteria:

- Healthy children of Kota district of Harauti regionorigin in the age group of 6-10 years

- All teeth on the right or left lower jaw should be present,

- Accurate Orthopantomograph showing full complement of teeth without any pathologies.

Exclusion Criteria:

- Children with any systemic diseases, hereditary diseases affecting the dentofacial complex, congenital anomalies and presenting with any syndromes and under any medication which affect development.

- Children un co-operative for radiographic procedures.

- Patients undergoing radio/chemo therapy for head and neck malignances.

- Radiographs that are unclear and show any pathology on the concerned side of the lower jaw like developmental abnormalities, grossly decayed teeth, tooth fractures, cysts or tumors.

Procedure:

As per indication, OPG were taken as a part of routine investigation. Approval from the ethical committee of the institution was obtained and the study was designed in accordance to the revised Helsinki declaration (2013). After elaborate case history taking for each individual ,date of birth was cross confirmed with the appropriate certificate. For each individual the chronological age was calculated by subtracting the birth date from the date on which radiograph was exposed for that particular patient. The images were processed using a computer-aided drafting program, Adobe Photoshop Software (version 7.0) and the following parameters were calculated with the measuring tool present on the drop-down column on the left-hand side of the screen.

Images of seven left or right permanent mandibular teeth were assessed. Number of teeth with complete root development and completely closed apices of the roots (N) were calculated. Also, teeth with incomplete root development and therefore with open apices were also examined. For teeth with one root,

distance Ai, where (i = 1, 2, 3, 4, 5): 1 – central incisor, 2 – lateral incisor, 3 – canine, 4 – first premolar, 5 – second premolar. For teeth with two roots, the sum of distance between inner sides of two open apices was calculated and denoted as Ai (i = 6, 7); 6 – first molar, 7 – second molar.(Figure 1)

In the present study, two observers had estimated and calculated the open apices of all the seven left or right permanent mandibular teeth.

Due to possible difference in magnification and angulation among X-ray measurements, Ai was normalized by dividing it with tooth length. Tooth length was measured from point of highest cusp to the root apex and was denoted as Li. Dental maturity was evaluated using normalized measurements of seven right or left mandibular teeth as Xi = Ai/Li; i = 1 to 7. Therefore, sum of normalized open apices was calculated as S = X1 + X2 + X3 + … + X7.

Statistical Analysis

All the morphologic variables were entered in an Excel file and were used as predictive variables for age estimation in sequential statistical analysis. To obtain an estimate of age as a function of the morphological variables and subjects' gender and nationality, a multiple linear regression model with first-order interactions was developed by selecting those variables that contributed significantly to age estimations using the stepwise selection method. Analysis of covariance was then applied to study, possible interactions between significant morphological variables and gender. Statistical analysis was performed with S-PLUS 6 statistical programs (S-PLUS 6.1 for Windows). The significance threshold was set at 5%.

RESULTS

A total of 96 Orthopantomographs (OPGs) of age groups 6 to 10 years comprising both sexes were selected. (Table 1)

There were no statistically significant intra-observer differences between the paired sets of measurements carried out on the re-examined panoramic radiographs. All correlation coefficients between age and morphological variables were significant and negative. (Table 2). Subjects' age was modelled as a function of the morphological variables (predictors), and to optimize the model, a stepwise regression procedure was applied.

The results (Table 3) show that the variables X5 (second premolar), S, N and the first order interaction between S and N

contributed significantly to the fit. Thus, only these variables were included in the regression model, yielding the following linear regression formula:

$$Age = 10.145 - 0.703\ S + 0.208\ S.N - 0.600\ X5$$

The residual plot (Graph 1) shows no obvious pattern, and Scatter Plot of Observed cumulative probability Value and expected cumulative probability value showing that regression model fits the trend of data very well.

The Scatter Plot (Graph 2) of fitted value and observed value again showing that regression model fits the trend of data reasonably well and Scatter Plot (Graph 3) of Residuals against fitted value showing no obvious pattern.

DISCUSSION

The growth of child is affected by various factors (ethnic, nutritional, socioeconomic status etc.). Nevertheless, the different methods of age estimation based on teeth do not provide a common formula for the whole world. [10]

Eruption of tooth is influenced by many factors such as space in the dental arch, extraction of deciduous predecessors tipping or impaction of teeth. It is commonly seen during the developmental stages particularly in root formation, a distinguish difference exist between sexes ; females being ahead when equated with males. Hence the dental age assessment using developmental stages of teeth in this age group is acceptable as it is less influenced by environmental factors .[11]

The estimation of age for human identification, both for the living individuals and deceased is a vital issue.[12] It is important from a forensic perspective as well and useful in establishing the difference between the juvenile and the adult states of an individual in law suits. To estimate an age of child with unidentified identity may be of prime importance when the child is the victim of a crime, alleged of a crime, or when the child is a migrant of uncertain age, as well as in circumstances where the individuals do not have valid documentation of age. In these cases, it is relevant to employ non-invasive methods with advanced accuracy and meticulous, because of specific legal requirements.[2]

The study of the morphological parameters of teeth on dental x-rays of adult humans is more reliable than are

most other methods for age estimation and is most commonly used to determine age in living humans. [3]

Several studies show that morphological measurements can be consistently made in panoramic radiography, provided that some corrections are made to take into account the individual variability of tooth size and the differences in magnification of radiographs and angulation between x-ray beam and film.[3]

In Harauti region, the India-specific formula cannot be applied. Hence in current study OPGs have taken for the individual belonging to Harauti itself. The radiological method is amongst one of the most reliable method available for age estimation which is extensively used for both dental and skeletal method.[13,14,15] In the current study dental age had been assessed by using Panoramic radiograph, following the method described by Cameriere, which is widely accepted and has been studied extensively on various population by many authors.[3,10]

Study was done by Cameriere L et al on Italian population of children aged between 5-15 years. Study based on seven mandibular left healthy permanent teeth for assessing dental age by measurement of open apices in teeth. Statistical analysis showed a significant correlation with chronological age, morphological variables explain 83.6% (R2=0.836).[3] In our study, statistical analysis indicated that gender does not have a significant influence on age estimation. (R^2=0.956).

Cameriere L et al had derived a common formula for children from European background. Their results showed that the median of the absolute value of residual errors were 0.035 years.[16] In the present study ,results showed that the median residual errors were 0.0024 years.

In parallel to the current study in which gender did not have a significant influence on age estimation. (R^2= 0.956) ,Rai B et al showed a significant correlation with chronological age except gender and second premolar, these morphological variables explain 89.7 %(R2= 0.897) variations in estimated dental age[10]by using modified Cameriere's European formula.

By using Cameriere's regression equation on the age group of 5-15 years ,in Haryana sub-population Kaur J et al detected underestimation of age in boys and overestimation in girls as related to their chronological age.[17] But in present

study , gender did not have a significant influence on age estimation.

Resulting the current study showed that not all the variables used for the European and Indian models were significant predictors of age estimation in the Rohilkhand sample.

The results found in this work, indicates that more attention should be focused on the possible differences between children of different origins. Further studies will be carried out to apply Cameriere's formula to a new Indian sample, to test a new Asian sample, and to study the effects of the nutrition factor on the Indian formula.

Regression Analysis	t value	P
Intercept	70.797	<0.001
Gender	1.240	0.218
Dental maturity of second premolar (X5)	-1.945	0.055
Sum of normalized open apices (S)	-12.918	<0.001
Number of teeth with complete root development (N)	-0.021	0.983
Interaction between s and N	1.644	0.104

Table 2: Regression analysis predicting Chronological age for Rohilkhand region

Stepwise Regression Analysis	t value	P
Intercept	95.265	<0.001
Sum of normalized open apices (S)	-13.046	<0.001
Interaction between s and N	5.268	<0.001
Dental maturity of second premolar (X5)	-2.092	0.039

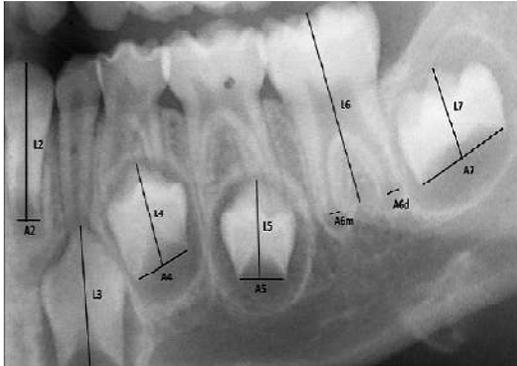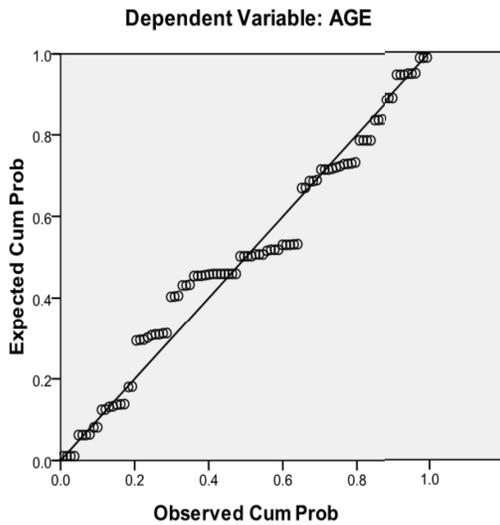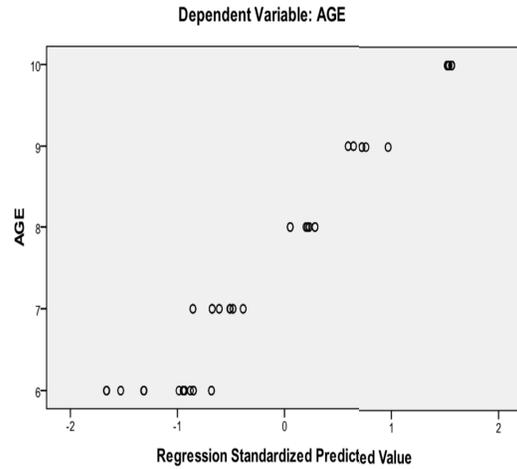Table 3: Stepwise Regression analysis for predicting chronological age for Rohilkhand region

Age (years)	Male	Female	Total
6	14	14	28
7	13	7	20
8	13	3	16
9	6	7	13
10	13	6	19
Total	59	37	96

Table 1: Distribution of study subjects in age and gender

Figure 1: An example of tooth measurement in Adobe Photoshop. Ai, i = 1, . . ., 5 (teeth with one root), is distance between inner sides of open apex; Ai, i = 6 and 7 (teeth with two roots), is sum of distances between inner sides of two open apices; and Li, i = 1, . . .,7, is length of seven teeth.
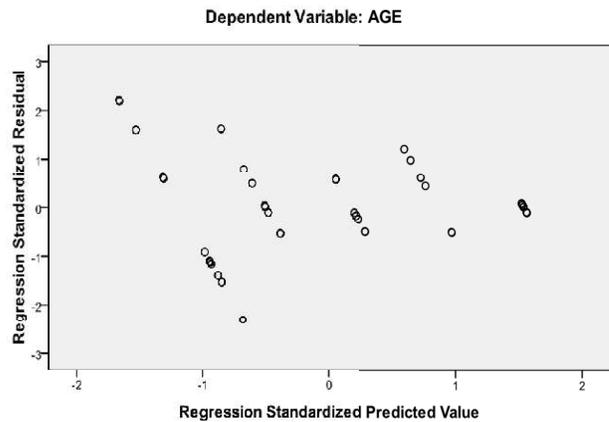

Graph 1
Graph 2

Graph 1 & 2: Plots of expected cum probability against observed cum probability, and age against regression standardized predicted value respectively.

Graph 3: Plots of regression standardized residuals against regression standardized predicted value.

CONCLUSION

In the present study we found a very good correlation between the Chronologic and dental age. Results indicated the suitability of the sum of normalized open apices (s) and number (N0) of teeth with complete root development as developmental markers. We have also come up with a linear regression equation for both males and females which can be used in order to decrease the gap between the Chronologic age and dental age, so that a relative approximate age can be obtained. Since our study has a small sample size we were not able to give the exact value of variation between each age group that the chronological and dental method assessed. The present Regression equation is derived for age estimation fromHarauti region, children.

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