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Age Estimation Using Cameriere's Method in South Kerala Children

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Abstract

Dental age estimation is considered the most reliable means of chronological age estimation for criminal, anthropological and forensic purposes. Objectives: To estimate dental age and to develop a regression model for the study population. Methods: A retrospective cross-sectional study was done using Panoramic radiographs (n=113) of children aged 5-15 years. Dental age was assessed by using Cameriere's method based on seven permanent left mandibular teeth. Result: The mean chronological age was 10.96±2.94 and estimated age by Cameriere's method was found to be 10.98±2.57 which showed no significant difference between the two methods (p=0.924). A regression model was developed for this population. Conclusion: In our study, the Cameriere's method of age determination was found to be approximately accurate to the chronological age.

Keywords: Age estimation, Cameriere's method, Dental age, Forensic.

Introduction

The chronological age of an individual plays an important role in clinical, forensic, medico-legal, and anthropological applications. During the growth period of an individual, the skeletal, odontological,

anthropological and psychological methods can be applied for age assessment.[1] Age estimation is done in many situations. In the living, it is done to assess whether the child is of legal age of criminal responsibility in cases such as rape, kidnapping, employment, marriage, premature births, adoption and illegal immigration. In cadavers, age determination is carried out also in criminal cases and very mutilated victims of mass disasters, such as fires, crashes, accidents, homicides, feticides and infanticides, etc. [2] It is also done in situations where the chronological age is unknown, undocumented or missing. Several growth parameters based on skeletal indicators such as changes in pubic symphysis fusion of cranial sutures, hand-wrist bone, dental maturation, ossification, and somatic indicators (like menarche and endocrinal changes) are utilized for probable age estimation. [3]

Teeth are considered as the least variable bio-indicator for age assessment and the most accurate and reliable means of age estimation from infancy to adolescence.[4,5] The formation of the deciduous teeth begins at four months in utero and complete formation of the permanent teeth occurs around 25 years of age. The development of teeth is a complex sequence of events from initial mineralization of tooth, crown formation, root growth, eruption of tooth into the oral cavity and maturation of the root apex. The well-defined and unique nature of incremental formation and periodic mineralization of the developing tooth is independent of somatic growth as well as environmental and local factors.[6] The sustainability of dental hard tissues against environmental insults also adds to reliability of age estimation.[7]

The most common method of age estimation was proposed by Demirjan, Goldstein and Tanner in 1973 based on development of seven teeth from the left side of the mandible.[8-10] In 2006, Cameriere et.al., assessed chronological age in children based on relationship between age and measurement of open apices in teeth in the European population.[11,12] The reliability of Cameriere's method tested on several sample groups from different countries showed that it is not always suitable for other countries as tooth development differed among populations. Variations among ethnic groups and regional locations were found, which may be due to influencing factors such as dietary practice, nutritional habits, socioeconomic status, and lifestyle.[10,13] Hence, the Cameriere's regression model was modified by few authors to suit their population and found Cameriere's method to be the most accurate method for the population of the current compared to other methods of Demirijan and William's.[1,11,14,15] As such, this study was done to estimate dental age and to develop a regression model for the study population of south Kerala.

Method

A retrospective cross-sectional study was done using Panoramic radiographs (n=113) of children who attended the outpatient department of a Dental College. Children aged between 5 to 15 years at the time of panoramic radiographs with no history of extractions or agenesis in left lower quadrant was included in the study. The patients who had incomplete dental or medical history, hypodontia of permanent teeth (except third molars), hyperdontia and those who underwent orthodontic treatment were excluded from the study. Demographic details along with the brief clinical findings were recorded from the medical charts. The chronological age was calculated by subtracting the date of birth from the date of radiograph taken. Patients were subjected to panoramic radiograph (Planmeca ProMax) by using PSP plates as image receptor system, these PSP

plates were later digitized in Agfa laser scanner (CR30-X) and images were recorded by Computerized-aided drafting program system. Then the measurements of individual tooth-root ratio (A/L) were linearly desired using Agfa-nx software. Radiographic evaluation was done using the computer program SIDEXIS provided along with the system. Dental age was assessed using Cameriere's method based on seven permanent left mandibular teeth.

Table 1: Distribution of patients according to age group and gender.

Age group (in years)	Gender		Total (%)
	Male (%)	Female (%)	
5.0-.7.0	11(9.7)	5(4.4)	16(14.2)
7.1-9.0	10(8.8)	10(8.8)	20(17.7)
9.1-11.0	11(9.7)	8(7.0)	19(16.8)
11.1-13.0	10(8.8)	24(21.2)	34(34.1)
13.1-15.0	5(4.4)	19(16.6)	24(21.2)
Total	47(41.6)	66(58.4)	113(100)

All the measurements were carried out by a single observer and dental age estimation was calculated using the Cameriere's regression formula:

Age = 9.402-0.879c+0.663No-0.711s-0.106sNo, [11]

Where c is a variable; 1 for boys and 0 for girls

N_o = Teeth with apical ends of the roots completely closed.

s = sum of A/L ratio for every tooth at open apex, where A= radiographic distance between inner sides of the open apex and L is the radiographic tooth length.

For teeth with one root, the distance (Ai, where i= tooth 1,...,5) between the inner sides of the open apex was measured (Figure 1). For teeth with two roots (Ai), where, i=6, 7), the sum of the distances between the inner sides of the two open apices was evaluated:

Aim+ Aid, where i = tooth 6,7 and m = mesial root, d = distal root,

After recording the distance in digital panoramic radiograph, it was divided by the magnification factor 1.2.

For example, consider the central incisor of the 3rd quadrant. Then

A_1 =0.9mm, L_1=15.4; therefore A_1/L_1= 0.06mm

Divide this with the magnification factor 1.2; which gives 0.06/1.2 =0.05

Results

The Mean (SD) chronological age of the participants (n=113) was 10.96 (2.94) and 58.4% were females. Frequency distribution of age and gender is given in Table 1. The mean estimated age by Cameriere's method was found to be 10.98±2.57. The correlation coefficient (r) was 0.94 which was significant at p<0.001. This is shown in Table 2.

Table 2: Descriptive statistics and correlation coefficient of chronological age and dental age estimated by Cameriere's method.

Age	Mean ± SD	Median	IQR	r	p value
Chronological age	10.96±2.94	12.0	4	0.94	<0.001
Dental age estimated by Cameriere's method	10.98±2.57	11.6	3.7		

Table 3: Descriptive statistics and correlation coefficient of chronological age and dental age estimated by Cameriere's method according to gender

Gender	Chronological age		Dental Age		r	P value
	Mean ±SD	Median (IQR)	Mean ±sd	Median (IQR)		
Male (47)	9.8±3.0	10.0 (4)	9.4±2.5	9.8 (4.6)	0.943	<0.001
Female (66)	11.8±2.5	13.0 (4)	12.1±1.9	12.9 (2.8)	0.952	<0.001

Descriptive statistics of chronological age and dental age estimated by Cameriere's method for males and females are given in Table 3. These two ages in males and females were highly correlated (r=0.943 for males and r=0.952 for females) and both are statistically significant (p<0.001).

Multiple linear regression analysis showed that the no. of open apex (No), apical length (s) and gender (G) had significantly contributed in predicting the dental age. The regression equation obtained is

Dental age= 9.094+0.704 No – 0.648 s – 0.887 G

These variables explained 99.8% of the total variation (R^2=0.998, p <0.001). The stepwise Regression analysis, predicting dental age from the predictors is shown in Table 4. The median difference in chronological age and estimated dental age was -0.043 years with an interquartile range of 1.47 years.

Table 4: Stepwise Regression analysis, predicting dental age from the predictors

Coefficients	B	SE	t value	p
Intercept	9.094	0.046	198.39	<0.001
N_o	0.704	0.008	87.82	<0.001
s	-0.648	0.015	-42.88	<0.001
Gender	-0.887	0.022	-40.14	<0.001

R^2 = 0.998 (p<0.001)

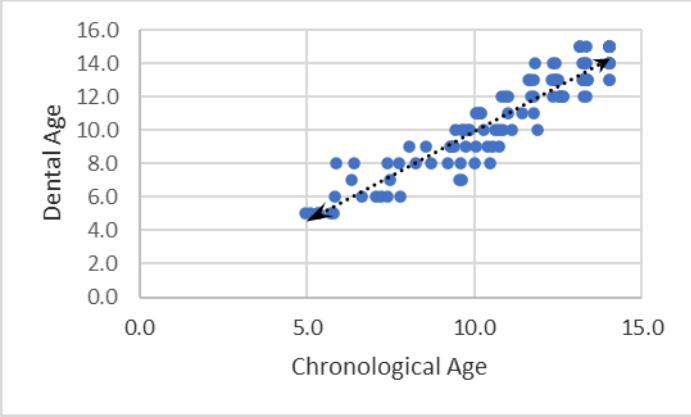

Fig 1: Correlation between dental age and chronological age.

Discussion

The estimated dental age by Cameriere's method and the chronological age according to our study was found to be 10.98±2.57 and 10.96±2.94 respectively.

A significant correlation between chronological age and dental age was obtained (r=0.94, p<0.001). Regression analysis showed that 99.8% of the variation in the dental age was explained by no. of open apex (No), apical length (s) and gender (G). This was similar to another study done in Mangalore, India which showed 91.0% using the same formula. [12] But, was found to be 83.6% on an Italian population done by Cameriere's.[1]

In the Indian context, age estimation is important at specific age groups: (1) Children below 12 years of age are not liable for certain offenses (doli incapax); (2) 14 years: a child cannot be employed below 14 years; (3) 18 years: determines the status of maturity and the legally permissible age for marriage in females; (4) 21 years: the legally permissible age of marriage in males. [16,17]

In our study, there was an underestimation of age by 0.2 years in males and 0.1 years in females (using median values). This was in contrast to the study by Rai et al. using Cameriere's method in Haryana population to show an overestimation of age by 0.6 years in girls and by 0.7 years in boys. [14] We found that in females, underestimation of age was found more in the age group of 5.0-7.0 years and overestimation in the age group of 9.1-11.0 years of age. In males, underestimation was found more in the age group of 13.1-15.0 years and overestimation in the age group of 5.0-7.0 years. According to Nair VV, males showed an overestimation for age groups 6-11 and underestimation for 12-14 years and females showed an overestimation for age groups from 6-10 and an underestimation in age groups 11-14. [15]

In our study, estimation of age was done by measuring the open apices of the teeth excluding third molars of healthy children between the ages 5 and 15 years using panoramic radiograph. The panoramic radiographs were chosen as intraoral radiographs are difficult to obtain without image distortion, inexpensive, readily available, provide unobstructed view of the entire dental arch and have less radiation exposure.[13]

The ability of an age estimation method to predict chronological ages with accuracy and reproducibility are important. Though the Cameriere's technique involved more steps in calculation, it produced reliable and reproducible measurements.

Conclusion

In the present study, the Cameriere's method of age determination was found to be accurate. A single age marker considered in isolation may not determine accurate age as it can ignore human variability such as genetic and environmental factors and growth patterns.[18] Hence a multifactorial approach (use of multiple indicators of age as bone development and dental status) increases accuracy and control variability.

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