

Age Estimation using Cameriere's Seven Teeth Method with Indian Specific Formula in South Indian Children

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Abstract

Introduction: Teeth formation is widely used to assess maturity and predict age. This information aids in diagnosis and treatment planning in clinical as well as in forensic dentistry. Dental age estimation is based on morphological, histological, biochemical and radiological assessment of teeth. Radiographic age estimation using teeth rely on developmental stages of teeth especially in children. This makes utilization of radiographic methods for age estimation a practical method especially in living individuals as it is a simple, nondestructive and a reliable method. Moreover, it can also be used in dead persons as well as in skeletal remains.

Aim: To evaluate an Indian sample by means of modified Cameriere's European Formula and to correlate the efficacy of chronological and dental age by using this formula. An attempt was made to estimate the chronologic age of an individual by using dental radiograph in Mangalorian children.

Materials and Method: The present study comprised of 25 subjects ranging from 5-15 years. Dental age was assessed by using Cameriere method based on 7 permanent left mandibular teeth. Panoramic radiographs were taken for the measurement of open apices of individual tooth root. Data were analyzed by using Student's t-test.

Results: The mean chronological age of our sample were 9.83 ± 2.83 years and by Cameriere method 9.88 ± 2.15 years, showed no statically difference between the two methods. For the Intra class correlation coefficient showed (ICC = 0.971) excellent agreement between Chronological age and ages estimated by Cameriere method.

Conclusion: The present study indicated that, Cameriere method was reliable for age estimation in our sample. Age of subjects can therefore be estimated with a good degree of accuracy using this specific formula.

Keywords: Cameriere et al. Regression Equation, Dental Age, Forensic Dentistry, Panoramic Radiograph

Introduction:

In humans age determination is done for various reasons. Age determination of cadavers is carried out in victims of mass disasters such as fires, crashes, accidents, homicides, feticides and infanticides etc. In living person, the age estimation is done to assess whether the child has attained the age of criminal

responsibility such as rape, kidnapping, employment, marriage, premature births, adoption, illegal immigration, paediatric endocrinopathy, orthodontic malocclusion and when the birth certificate is not available and records are suspect for reasons such as criminal cases. The present study deals with the dental implications in human age determination using radiological methods.

Dental age is one of the few measures of physiologic development that is uniformly applicable from infancy to late adolescence. After attaining maturity, teeth continue to undergo changes; making age estimation possible in adults.³ The study of morphological parameters of teeth on dental radiograph of children is more reliable than other methods for age estimation. The most common method for age estimation was published in 1973 by Demirjian, Goldstein and Tanner, and subsequently modified by other authors.⁴ A common finding is that Demirjian overestimated age although an underestimation has also been reported.

To improve the method, several authors have developed alternative approaches based on the measurement of some significant tooth parameters, such as the degree of racemization of aspartic acid in tooth enamel.^{5,6,7} Crown height, apex width root and pulp length⁸ of teeth observed in radiographs. A new method was published by Cameriere involving measurement of open apices of left mandibular permanent teeth.^{9,13} The aim of the present study was to assess the dental age of Indian children using Cameriere method and to check its efficacy in south Indian children.

Materials and Methods:

Before starting the study, the synopsis of the study was presented in front of the ethical committee of Dental College, Yenepoya University and the clearance was taken from the ethical committee before starting the study.

The present study included 25 patients (11 females, 14 males) with age group between 5-15 years [Table-1] who were advised for panoramic radiograph selected by using simple random sampling technique for the study. Nature of the study was explained to the patients and written consent was taken from the participants. Brief clinical findings along with personal details of the patient were recorded using a standard format. The inclusion criteria were age between 5 to 15 years at the time of panoramic radiographs were obtained, good quality radiographs, no agenesis or extractions in the left lower quadrant and teeth in their developmental path. Exclusion criteria were incomplete dental or medical

history, previously orthodontic treatment, evident systemic diseases and congenital anomalies, premature birth, hypodontia of permanent teeth except third molars and hyperdontia. 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. Mandibular left teeth were examined and Cameriere method was applied. Age was estimated, which was then compared with the chronological age. (Chronological age= date of radiograph taken – date of birth).

Dental age estimation:

Dental age estimation was done by using Cameriere's Regression formula: **Age = 9.402-0.879c+0.663N₀-0.711s-0.106sN₀**, C = variable boys (1) and girls (0) Where N₀: teeth with apical ends of the roots completely closed. s: sum of A/L ratio for every tooth at open apex. A_i: radiographic distance between inner sides of the open apex. L_i: radiographic tooth length. (L_i, i= 1... 7). An example of tooth measurement. A_i, i = 1 . . . 5 (teeth with one root), is distance between inner sides of open apex; A_i, i = 6 and 7 (teeth with two roots: A₇ is the sum of the distances (A₇=A_{7a}+A_{7b}) between inner sides of the two open apices, and L₇ is the length of second molar) and L_i, i = 1 . . . 7, is length of seven teeth and N₀ = tooth with a closed root: A₆. Once the measurements were recorded in digital panoramic radiograph, it is calculated by dividing magnification factor 1.2, which was applied in Cameriere's Indian formula. Dental maturity was evaluated with the normalized measurements of the 7 left permanent mandibular teeth. (x_i= A_i/L_i, i = 1.....7), the sum of the normalized open apices (s = x₁+x₂+x₃+x₄+x₅+x₆+x₇)[Figure 1]¹³

An Example of a Panoramic radiograph (male) of our study group: Chronological age was 8.7y and by Cameriere Method: [N₀: total no of teeth with apical ends of the roots completely closed; (central incisor, lateral incisor and first molar) 31,32, 36 = 3, the length

of the teeth to size of open apex of canine, first premolar, second premolar and second molar were measured; $x_3 = A_3 / L_3$ (0.41/1.70 with dividing by Magnification factor: $1.2 = 0.24$), $x_4 = A_4 / L_4$ (0.43/1.30 = 0.33), $x_5 = A_5 / L_5$ (0.76/1.02 = 0.74), $x_7 = A_7 / L_7$ (0.82/0.95 = 0.86), $s = X_3 + X_4 + X_5 + X_7 = 0.24 + 0.33 + 0.74 + 0.86 = 2.17$. [Figure no. 2 & 3].

$$\text{Dental age} = 9.402 - 0.879c + 0.663N_0 - 0.711s - 0.106sN_0$$

$$= 9.402 - 0.879 \times 1 + 0.663 \times 3 - 0.711 \times 2.17 - 0.106 \times 2.17 \times 3 = 6.53 + 2.23 = 8.76 \text{ y}$$

Statistical analysis and data management:

Statistical analysis was performed with SPSS version 18.0 statistical program. Student’s t-test was used to compare the morphological variables of males with those of females and to compare observed age with estimated age.

Table No. 1: Cross Tabulation between Age and Sex Group

Age groups	Sex		Total
	Females	Males	
5-7 y	2 (8%)	3 (12%)	5 (20%)
8-9 y	3 (12%)	4 (16%)	7 (28%)
10-11 y	4 (16%)	5 (20%)	9 (36%)
12-13 y	1 (4%)	2 (8%)	3 (12%)
14-15 y	1 (4%)	0 (0%)	1 (4%)
Total	11 (44%)	14 (56 %)	25 (100%)

Figure No. 1: An Example of Tooth Measurement from Mandibular Left Permanent Canine to Second Molar

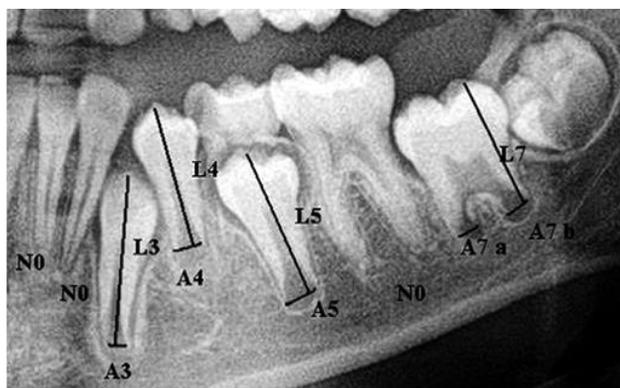


Figure No. 2 & 3: An Example of a Panoramic Radiograph from our Study Group (Male) Before and after Measurement of Teeth

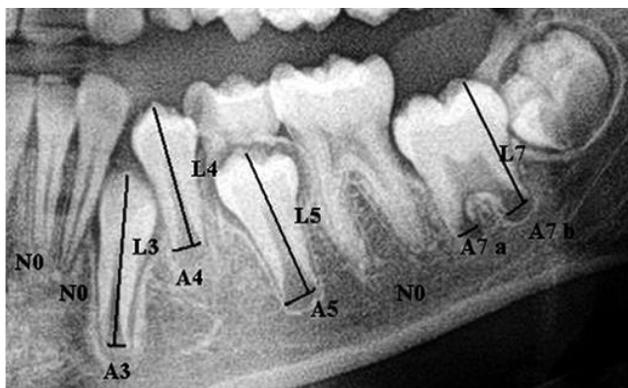


Figure No. 2

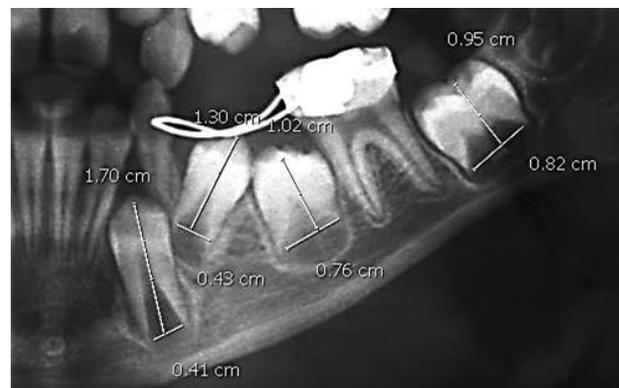


Figure No. 3

Results:

Results of the present study showed, age of the collected sample size 25 out of which 11 female (44%) and 14 male (56%) ranges between 5-7y(20%),8-9y(28%),10-11y(36%),12-13y(12%),14-15y(4%) [Table -1]. Comparison between ages estimated by Cameriere's method and Chronological age in total study group [Table-2]. On an average chronological age was 9.83 ± 2.38 y and by Cameriere method 9.88 ± 2.15 y, showed no statistical difference between the two methods as $p = 0.728$ ($p < 0.05$ for significance). For Intraclass correlation coefficient showed (ICC = 0.971) excellent agreement between the two methods [Table-3 & Graph-1]. Analyses were performed among the males and females separately, showed no significant difference between Chronological age and Cameriere method ($p > 0.05$). For Intraclass correlation coefficient was above 0.959 for both males and females, showed no gender influence on the level of agreement between the two methods. Finally an attempt was made to establish Regression equation to estimate the actual age by finding out age by Cameriere Method. The equation is: Chronological age = $-1.137 + 1.078 * \text{Age by Cameriere method} + 0.554 * \text{Gender}$ (Gender: Male substitute as 1, for female substitute as 0) [Table- 4 & 5] Model-1 explained 91.0% of variance ($R^2 = 0.910$).

Our method, based on the normalized open apices of the seven permanent left mandibular teeth, employed a second-degree polynomial function [Model summary]

Discussion:

The aim of the present study is to estimate chronological and dental age in individuals from Mangalore between 5-15 years of age. The age range from 5-15 years remains the most critical with regard to estimating a child's dental age and consequently to determine the proper timing for orthodontic therapy. This age group is commonly accepted for dental age estimation in children as teeth development passes through various stages during this age group. Teeth development depends upon number of factors such as genetic factor, environmental factors, nutritional factors and geographical factors. Tooth eruption is influenced by other factors also such as space in the dental arch, extraction of deciduous predecessors tipping or impaction of teeth. During developmental stages particularly in root formation, a notable difference between sexes arises with females being advanced when compared with males. Hence the dental age estimation using developmental stages of teeth in this age group is acceptable as it is less influenced by environmental factors.

Table No. 2: Comparison between Ages Estimated by Cameriere's Method and Chronological Age in Total Sample

S. No.	Gender	Age By Cameriere Method	Chronological Age (In Years)
1	Male	10.83333	11.14
2	Male	9.416667	8.29
3	Male	7.5	7.14
4	Male	9.416667	8.14
5	Male	11.66667	11.07
6	Male	11.16667	10.79
7	Male	8.583333	8.36
8	Male	10.33333	10.07
9	Male	15.66667	16
10	Male	12.33333	12.07
11	Male	7.833333	8.14
12	Male	11.5	11.21
13	Male	7.833333	7.21
14	Male	8.166667	10.07
15	Female	12.33333	13.07
16	Female	8.5	8.36
17	Female	9.25	9.07
18	Female	6.083333	5.07
19	Female	8.666667	8.57
20	Female	11.58333	11.43
21	Female	11.33333	11.21
22	Female	7.833333	7.29
23	Female	8.25	10.07
24	Female	8.583333	8.5
25	Female	12.33333	13.29

Table No. 3: Mean and Standard Deviation of Chronological Age (In Years) and Ages Estimated by Cameriere Method in Total Study Group. Intraclass Correlation Coefficient: Icc between Chronological Age and Cameriere Method

Methods		N		Min.	Max.	Mean	Std. deviation	Diff	t value	P value
Chronological age	Range Mean ±SD	25	9.83 ± 2.83	5.07	16.00	9.83	2.38	.05	0.352	0.728
Dental age (Cameriere method)	Range mean± SD	25	9.88 ± 2.15	6.08	15.67	9.88	2.15			

ICC: Intraclass Correlation

Intraclass Correlation	95% confidence interval		P value	
	Low Bound	Upper bound		
	0.935	0.987	0.000	HS

*HS=highly significant

Graph No. 1: Correlation between Ages Estimated by Cameriere's Method and Chronological Age in Total Sample. (P=0.000)

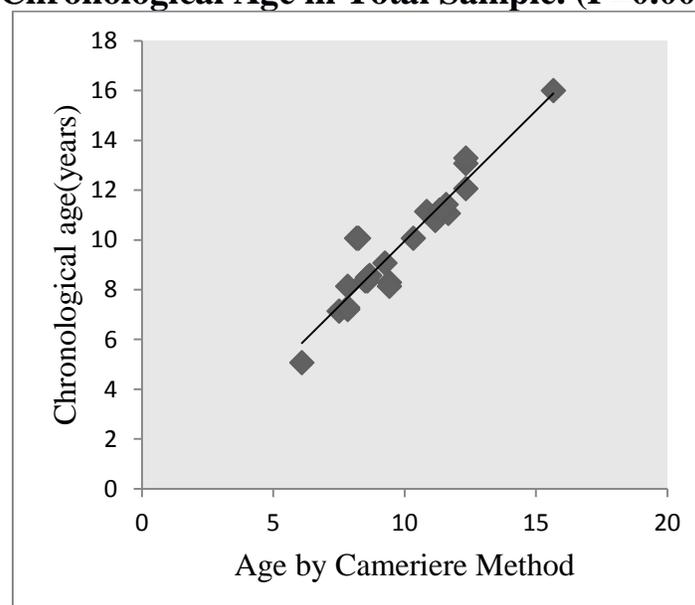


Table No. 4: Mean and Standard Deviation of Chronological Age and Ages Estimated by Cameriere Method in Both Males and Females Group Separately

Gender	N	Minimum	Maximum	Mean	Std. Deviation	Diff.	t value	p value
Females								0.075
Chronological age	11	7.14	16.00	10.11	2.53			
Cameriere Method	11	7.50	15.67	10.43	2.33	0.32	1.985	NS
Males								0.517
Chronological age	14	5.07	13.29	9.60	2.33			
Cameriere Method	14	6.08	12.33	9.45	1.98	0.16	0.665	NS

*NS: Not significant

Interpretation of ICC	
< 0.40	Poor agreement
.4 -- .75	Fair agreement
.75 -- .85	Good agreement
> 0.85	Excellent agreement

Table No. 5: Regression Analysis with Selected Morphological Variables (Predictors) and Age as the Dependent Variable in the Total Study Sample

Model	Unstandardized Coefficients		Standardized Coefficients	Significance	
	B	Std. error	Beta	t value	p value
1					
Constant	- 1.137	0.791		- 1.438	0.164
Cameriere Method	1.078	0.073	0.975	14.837	0.000
Gender	0.554	0.308	0.118	1.797	0.086

^a dependent Variable: Chronological age

^a Predictors: Constant, gender, cameriere

Model summary

Model	R	R ²
1	0.954 ^a	0.910

Present study is a Cross-sectional study taking a sample of 25 subjects with distribution between male and female. The radiological method is among one of the most reliable method available for age estimation which is widely used for both dental and skeletal method.^{11,12,15} In our study dental age has 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.^{9,13}

A 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% ($R^2=0.836$).⁹ In our study, statistical analysis indicated that gender does not have a significant influence on age estimation. ($R^2= 0.910$).

The same author Cameriere L et al was done a study in a large sample of children from various European states, providing a common formula. The results showed that the median of the absolute value of residual errors were 0.035 years.¹⁰ In our study results showed that the median residual errors were 0.05 years.

Another study was carried out by Rai B et al on a large sample of Indian children aged between 4-16years. Results showed correlation coefficient between dental age and chronological ages were highly significant.¹¹ The present study showed the accuracy of Cameriere method and it's not influenced by any factors.

A study was done by Rai B et al on a large sample of Indian children aged between 3-15 years by applying modified Cameriere's European formula. Results showed a significant correlation with chronological age except gender and second premolar, these morphological variables explain 89.7% ($R^2= 0.897$) variations in estimated dental age.¹³

The present study showed gender does not have a significant influence on age estimation. ($R^2= 0.910$). A study was done by Kaur J et al on Haryana population aged between 5-15 years and applied Cameriere's regression equation. The concordance

correlation coefficient was 0.89 between two observers rating.¹⁴ In present study the intraclass correlation coefficient showed excellent agreement ($ICC= > 0.85$).

Another study was conducted by Cameriere, L et al to determine the accuracy of the Cameriere method for assessing chronological age in children based on the relationship between age and measurement of open apices in teeth and to compare with widely used Demirjian and Willems method.¹⁶ In Cameriere method, the difference between two mean prediction errors was not statistically significant. Demirjian method was significantly less accurate ($p = 0.024$). Willems method was better than that of Demirjian but was significantly less accurate than that of Cameriere ($p < 0.001$). However in present sample Cameriere method showed highly significant ($p = 0.000$).

A study was done by Marques MF et al showed the great accuracy of Cameriere method in a Brazilian sample of 160 children aged between 5 and 15 years. The results showed with a median residual errors were 0.014 years ($p = 0.603$).¹⁷ In the present sample showed highly significant (p value = 0.000).

A study was conducted in Haryana sub-population by the same author Kaur J et al Panoramic radiographs of healthy children aged between 5-15 years were selected and Cameriere's regression equation was applied. Authors observed underestimation of age in boys and overestimation in girls as compared to their chronological age.¹⁸ But in present study showed, gender does not have a significant influence on age estimation.

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 (N_0) 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 from Indian children. This equation can be applied in various condition of Indian judiciary till Indian Population specific studies are developed.

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