Applicability of Demirjian's Method and Modified Cameriere's Methods for Dental Age Assessment in Children

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ABSTRACT

Introduction: Tooth development is extensively used for age estimation as a part of forensic science.

Aim: The purpose of this study was to evaluate the reliability of Demirjian's, Cameriere's and modified Cameriere's population-specific regression equation methods in the dental age estimation of West Godavari children.

Materials and Methods: The study included ortho-pantomograms (OPG) of 60 children of West Godavari district with age group between 9 to 14 years on whom all the three methods were used for age estimation. The OPG were traced with the help of a tracing paper and lead pencil and the appropriate dimensions were measured. Age estimation was done based on canine calcification stage as per Demirjian's method and measurements of the seven permanent left mandibular teeth using Cameriere's formula and modified population-specific regression equation obtained for the South Indian population from Cameriere's formula. The resultant data were subjected to statistical analysis by student's paired t-test.

Results: The estimated age was closer to the chronological age when the modified Cameriere's population-specific regression equation was used (p=0.68); whereas, the difference was more in Demirjian's method (p=0.008) followed by Cameriere's method (p<0.001).

Conclusion: The method using modified Cameriere's population-specific regression equation exhibited a least significant difference in chronological and dental age assessment in children of West Godavari district as compared to the other two methods.

INTRODUCTION

Age estimation assumes an imperative part in forensic medicine, as well as in clinical dentistry and archeology. From a legal point of view, adequately exact and dependable determination of age is required. There is an expanding interest by the courts for proper estimation of age in living people, associated with being minors without legitimate documentation of age in criminal cases, appropriations, asylum seekers, refugees, and immigrants. Different strategies have been utilized to estimate age for medicolegal purposes; however, the radiological assessment of dental age is considered as the most precise strategy [1].

The most often used method for age estimation in children is the investigation of radiographs of teeth and hand/wrist. Various methods have been proposed to assess dental age, but the method introduced by Demirjian's has wider acceptance. For chronological age assessment in children, a linear regression formula that utilizes the measurements of open apices in teeth was suggested by Cameriere et al., [2].

The previous European formula could not be applied to an Indian population because the genetic factors, environmental factors, nutritional factors and geographical factors vary between the two populations, so a new formula was necessary that can be applied to the Indian population. Hence, Rai et al., formulated a regression equation for age estimation in Indian children by measurement of open apices in teeth based on Cameriere's method [3]. By using the regression equation given by Rai B et al., [3] for the Indian population, a pilot study was performed and the following modified population-specific regression equation was formulated for West Godavari district children and age was estimated.

Age=11.2+0.33(C) +0.114(No)-1.38(S)+0.15(sNo)

Hence, the aim of the present study was to analyze the correlation between the dental age and the chronological age among males

and females of 9 to 14-year-old children of West Godavari district by Demirjian's method, Cameriere's method and modified Cameriere's population specific regression equation method and also to compare the accuracy of these three methods in dental age estimation.
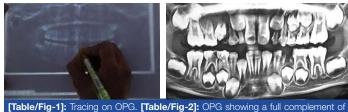
MATERIALS AND METHODS

A retrospective study comprising of 60 (9 to 14 year old) West Godavari district, Andhra Pradesh, India children with equal distribution of males and females (30 males, 30 females) for whom OPG were taken to compare reliable accuracy of Demirjian's method, Cameriere's method and Modified Cameriere's population-specific regression equation method for age estimation [Table/Fig-1,2]. The research strategy was approved by the Institutional Ethical Committee, St. Joseph Dental College, Eluru, Andhra Pradesh, India.

Group 1 - Demirjian's method [4]

Group 2 - Cameriere's method [3]

Group 3 - Modified Cameriere's population-specific regression equation method [3]

Inclusion criteria: Children of West Godavari district of age between 9 and 14 years, requiring OPG for orthodontic treatment purpose, without any developmental anomalies and systemic diseases affecting the growth were selected. The selected OPG

[Table/Fig-1]: Tracing on OPG. [Table/Fig-2]: OPG showing a full complement of left mandibular permanent teeth.

were free of distortions with a full complement of teeth on the mandibular left side.

Exclusion criteria: OPG of children with developmental anomalies, image deformity affecting visualization of mandibular canine and with gross pathology pertaining to teeth were excluded from the study.

OPG of children were traced with the help of tracing paper and lead pencil for measuring the required dimensions. Age estimation was done based on canine calcification stage as per Demirjian's method (Group 1), measurements of the seven permanent left mandibular teeth by using Cameriere's formula (Group 2) and modified population-specific regression equation obtained for the South Indian population from Cameriere's formula (Group 3).

Procedure: Subtracting the date of birth from the date when the OPG was taken gives the chronological age of that particular individual [3].

Demirjian's method: Demirjian's stages were assessed for the evaluation of the degree of maturation of canine. The Demirjian's method is a staging system with only eight stages of tooth development and requires only relative measurements. In this left mandibular teeth were selected as they were seen more clearly on OPG and they have been widely used to assess the level of calcification. The canine was assigned a rating from "A" to "H". Conversion tables specific to gender were used to convert stages to score. The total maturity was derived by adding the scores for each individual tooth and then transforming the obtained scores into dental age using standard tables given for each gender separately [4].

Cameriere's Methodology: The left permanent mandibular teeth from 31-37 were analyzed. The total number of teeth with completely closed apices (N0) was calculated. For teeth with a single root, the width of the open apex was measured (A1-A5). For teeth with two roots, the sum of the widths of the two open apices was measured (A5-A7). The measurements (A) were normalized by dividing the tooth length (L1-L7) to take into account the effect of possible differences in magnification and angulations among radiographs. The normalized measurements of the seven left permanent mandibular teeth ($x_i = A_i/L_i$, i=1… 7), the sum of the normalized open apices (s) and the number of teeth with closed apices (N0) was used to estimate dental maturity. All the measurements were carried out by the same observer [3].

Based on Cameriere's method, a regression equation was developed by Rai B et al., for estimation of age in Indian children [3]:

Age = 9.402 – 0.879 C + 0.663 N0 – 0.711 s - 0.106s N0

Where C is a dummy variable equal to 0 for North India and 1 for South India [3].

Modified Cameriere's Population-Specific Regression Equation Methodology: By using the regression equation given by Rai B et al., [3] for the Indian population, a pilot study was performed and the following modified population-specific regression equation was formulated and age was estimated for West Godavari district children.

Age=11.2+0.33(C)+0.114(No)-1.38(S)+0.15(sNo)

Where, C is a variable 1 for females and 2 for males.

STATISTICAL ANALYSIS

The obtained data were subjected to statistical analysis using SPSS version 16 software for comparing the accuracy of the above three methods by student's paired t- test.

RESULTS

The present study consisted of 60 children of West Godavari district of age group between 9 to 14 years and the correlation between Demirjian's method, Cameriere's method and modified Cameriere's population specific regression equation method was calculated statistically using a student's paired t-test.

[Table/Fig-3], represents the average age difference between chronologic age and estimated age for the three methods using student's paired t-test. The difference obtained between estimated age and chronological age after statistical analysis was highly significant (p< 0.001) by Cameriere's method, in case of Demirjian's method the difference obtained was significant (p=0.008) but in case of modified Cameriere's population specific regression equation method there was no significant (p=0.68) difference obtained between estimated age and chronological age supporting the accuracy of this method in estimating the chronlogical age from the dental age in 9-14-year-old children of West Godavari district.

The data tabulated in the [Table/Fig-4] represents the difference of the mean values and standard deviations obtained between the chronological age and estimated age in 9-14-year-old children of West Godavari district, both boys and girls using paired t-test. After statistical analysis the difference between chronological age and estimated age for both the sexes by three methods was not significant. The p-values for females and males in Demirjian's method was 0.00 and 0.13 respectively; whereas, for Cameriere's method was 0.5 and 0.49 and for modified Cameriere's population-specific regression equation method was 0.48 and 0.49 respectively. From the data, the most reliable method for dental age assessment, for both boys and girls was modified Cameriere's population-specific regression equation method followed by Demirjian's method and the Cameriere's method was the least reliable method when compared to the other two methods.

The data tabulated in the [Table/Fig-5] gives the year wise differences in percentage between the chronological age and estimated age for the three methods. The difference between the estimated age and chronological age was less than one year in 68.3% according to modified Cameriere's population specific regression equation

	Chrono-logical Age (Yr)	Demirjian's Method Age (Yr)	Cameriere's Method Age (Yr)	Cameriere's Population-Specific Regression Equation Method Age (Yr)
Mean±SD	11.40±1.10	11.85±1.73	10.41±1.44	11.35±0.75
Mean Difference from Chronological Age	-	-0.46	0.99	0.04
T-value	-	2.68	5.97	0.41
Significance	-	0.008, S	< 0.001, HS	0.68, NS

[Table/Fig-3]: Average age difference between chronological age and estimated age for the three methods.
* Paired t-test; * S-significant; * HS-highly significant; * NS-not significant

	Chronological Age (Yr)		Demirjian's Method Age (Yr)		Cameriere's Method Age (Yr)		Cameriere's Population-Specific Regression Equation Method Age(Yr)	
	Female	Male	Female	Male	Female	Male	Female	Male
Mean±S.D.	11.34+1.01	11.45+1.20	12.03+1.69	11.68+1.79	11.04+1.42	9.77+1.17	11.30+0.71	11.41+0.80
Mean Difference From Chronological Age	_	_	-0.69	-0.23	0.30	1.68	0.04	0.05
T-value	_	_	-3.79	-1.13	0.00	-0.00	0.04	-0.01
Significance	_	_	0.00	0.13	0.5	0.49	0.48	0.49

[Table/Fig-4]: Gender wise differences between the chronological age and estimated age for the three methods.
* Paired t-test; SD=Standard deviation

Difference from Chronological Age	Demirjian's Method	Cameriere's Method	Modified Cameriere's Population Specific Regression Equation Method
	Number (%)	Number (%)	Number (%)
< 1 Yr	36 (60.0)	19 (31.7)	41 (68.3)
1-2 Yr	14 (23.3)	26 (43.3)	19 (31.7)
>2 Yr	10 (16.7)	15 (25.0)	0 (0.0)
Total	60 (100)	60 (100)	60 (100)

[Table/Fig-5]: Year wise age differences in percentage between the chronological age and estimated age for the three methods.

method, 60% in Demirjian's method; whereas, for Cameriere's method it was 31.7%. A difference of one to two years was observed in 31.7% according to modified Cameriere's population specific regression equation method, 23.3% in Demirjian's method; whereas, for Cameriere's method it was 43.3% and a difference of more than two years was not recorded according to modified Cameriere's population specific regression equation method whereas in Demirjian's method it was 16.7% and for Cameriere's method it was 25%.

DISCUSSION

Various methods have been developed in forensic medicine for medico-legal purposes for estimation of age. Dental age, skeletal age, morphological features, and sexual development were the most routinely used maturity indicators for estimating age in sub-adults [1]. Stage of tooth eruption or stage of tooth formation helps us to determine the dental maturity of an individual more accurately [5].

Among the various methods developed for estimating the age, evaluation of tooth development by the radiographic method has been considered to be more accurate when compared with other maturity indicators because the development of teeth is controlled by genes and it is independent of factors like malnutrition and endocrine status as compared to other maturity indicators. Moreover, the different methods developed for age estimation based on tooth development do not provide a common formula for the whole world [2]. So, the present study was undertaken to estimate the dental age of the West Godavari district children with age ranges from 9-14 years.

The Demirjian's method affirms that dental maturation is rather independent of overall skeletal maturation [6]. In the present study, dental age was overestimated by Demirjian's method with a mean difference of 0.69 for girls and 0.23 for boys. Eid RM et al., checked the applicability of Demirjian method in Brazilian children and they concluded that dental age was overestimated in Brazilian children when compared to the French-Canadian population [7]. Similar results of overestimating the dental age were found in studies done by Koshy S and Tandon S in South Indian children [8] and Prabhakar AR et al., in children of Davanagere (Karnataka) [9]. Patnana AK et al., also found overestimation of age by Demirjian's method with a mean difference of 0.55 years [10]; whereas in a study done by Mohammed RB et al., Demirjian's method reported an underestimation of the Dental Age (DA) by 1.66 years for boys and 1.55 years for girls and 1.61 years in total in 9-20-year-old South Indian children [11].

Contrary to the present study high accuracy and precision were found in Swedish children when using Demirjian's method of age determination [12]. In a study by Hegde RJ and Sood PB, they found high accuracy by the Demirjian method of age assessment in Belgaum children [13]. Whereas, more advanced dental development was seen in British children by Liversidge et al., [14] Hegde RJ et al., found a positive correlation between chronological age and DA for both the sexes using the Demirjian method in children of Navi Mumbai [15].

The justifications for DA overestimation in Demirjian's method were that the dental maturation is a poor indicator of pubertal growth spurt as it indicates only a few pubertal changes and the original study was done in French-Canadian population thus it may not be applicable to all the population groups [6]. In the present study, the inaccuracy of Demirjian's method in precise estimation of dental age for West Godavari district children may be attributed to these reasons.

Cameriere R et al., compared the accuracy of age estimation of Cameriere's method with other popular methods like Demirjian method and Willems method and found that Demirjian method was less accurate than the Willems method and concluded that Cameriere's method was superior to both Demirjian and Willem's method [16].

Cameriere R et al., estimated the age of children in Italian population based on the width of open apices, considering the seven mandibular left healthy permanent teeth [17]. A study was conducted by Rai et al., on age estimation in Indian children aged between 3-15 years by modifying Cameriere's European formula for Indian population and the results showed a significant correlation with chronological age, except gender and second premolar [3].

In the present study, Cameriere's population-specific regression equation method showed a minimal difference between chronological and estimated age. The mean difference between chronological and estimated age for girls was lesser compared to boys. The original Cameriere's method showed a greater difference between both the ages.

Kaur J et al., studied panoramic radiographs of healthy children aged between 5-15 years in Haryana sub-population by Cameriere's method and observed underestimation of age in boys and overestimation in girls as compared to their chronological age [18].

Balwant R et al., conducted a study on Haryana population to test the accuracy of Cameriere R et al., regression equation and found that 20% of the females and 25% of the males showed a one-year increase in estimated age [19].

LIMITATION

This present study sample comprised of a small population and further studies are warranted on a large sample of South Indian children to prove the reliability of the modified Cameriere's population-specific regression equation.

CONCLUSION

From the above discussion, it can be concluded that out of the evaluated three methods, chronological age was close to dental age for West Godavari district children in modified Cameriere's population specific regression equation method compared to Demirjian method and Cameriere's method. For medico-legal cases and in clinical dentistry modified Cameriere's population specific regression equation may be utilized as a diagnostic tool for age estimation in South Indian children.

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