ORIGINAL RESEARCH

Age Determination in Children Using Camirere's Indian Specific Formula: A Radiographic Study Using Orthopantomographs

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Abstract

Aim: Determination of age is a pivotal part of forensic dentistry. Since many dental age determination methods are invasive, Cameriere introduced a radiographic method where age evaluation was carried out using an orthopantomogram (OPG). An adaptation of the same formula was later formulated by Rai et al. for the Indian population. The aim of the study was to assess the age and to dictate the efficiency of the Indian version of Cameriere's formula in the Chennai subpopulation.

Materials and methods: This study consisted of radiographs belonging to 50 individuals with an age range of 5–15 years. Radiographs were taken using the OPG and the soft copies obtained were analyzed. The variables such as seven left and right permanent mandibular teeth and the number of teeth with closed apical, and with open apical, ends of roots were examined and measured. The obtained data, after substituting in the formula was statistically analyzed using paired and unpaired *t*-test and Pearson's correlation coefficient test.

Results: On comparing dental age and chronological age, statistically significant results were obtained on both sides of the radiograph. Between genders, both sides of the radiograph showed non-significant results. On correlating the sides, the left side showed greater accuracy in age determination compared to the right side of the OPG.

Conclusion: Age estimation using Indian-specified formula provides a near good estimate and hence can be a reliable method to measure the chronological age of the participants.

Clinical significance: The Indian version of the Cameriere's formula can be used as a rational tool to assess the age of young children and adolescents.

Keywords: Age determination, Cameriere's formula, Chronological age, Orthopantomogram.

The Journal of Contemporary Dental Practice (2022): 10.5005/jp-journals-10024-3370

Introduction

The appropriate approach and assessment of dental evince plays a fundamental role in forensic dentistry, which is popularly utilized for the identification of the living and deceased individuals.[1,2] Age determination is a decisive component and fundamental in forensic sciences with applications pertaining to medico–legal issues, orthodontic management, adoption, criminal accountability, sexual exploitation, pediatric endocrinology, and illegal immigration.[3]

A person's growth can be analyzed by the implementation of skeletal, odontological, ethnological, and intellectual methods. Hand–wrist radiographs and assessment of dental maturity are the customary means for age determination in children.[4] However, the existing downside to the use of skeletal methods for age determination is that bone progression and transformation are greatly controlled by environmental characteristics and peak radiation exposure. Hence, a possible proposition established on dental evolution is acceptable, as the rate of calcification is exceedingly guided by genes rather than circumstantial factors.[5,6] Besides, tooth development is less governed by malnutrition and endocrinal pathologies and thus can be a dependable measure for age determination.[7] Many archaic methods of dental determination are based on morphological and histological alterations of the teeth.[8] A greater number of these procedures necessitate the removal or crumbling of the specimen teeth which is a major limitation.

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How to cite this article: Sruthi MA, Ravindran V, Jeevanandan G, *et al*. Age Determination in Children Using Camirere's Indian Specific Formula: A Radiographic Study Using Orthopantomographs. J Contemp Dent Pract 2022;23(7):739–742.

Source of support: Nil

Conflict of interest: None

Demirjian and Goldsteiner pioneered in exhibiting the first radiographic method of age determination for it was contemplated upon that tooth mineralization is a measure of age, thereby instituting a system for scoring.[9] Evidently, Cameriere et al. instigated a constructive radiographic method that ascertains age by evaluating immature young permanent mandibular teeth.[4] Multiple research works have been carried out based on this formula. This has proved authenticity and is unambiguous in determining the age of children.[3]

A study by Rai et al.[10] presented that "Cameriere's formula yielding correct value for the European sample could not be applied to the Indian population." Hence, a novel formula was composed for the Indian representatives by accounting for the contrasting nature of the North, South, and Central Indian populations. The aim of the present study was to assess the age and to dictate the efficiency of the Indianized version of Cameriere's formula in the Chennai subpopulation.

Materials and Methods

The study included 50 individuals visiting a private Dental College in Chennai, Tamil Nadu, India, between the age groups 5 and 15 years. To ascertain the influence of gender, 25 males and 25 female participants were chosen. The inclusion criteria involved healthy patients with no systemic diseases, dental anomalies, and other comorbidities and only those patients who required digital radiography either due to multiple carious lesions or orthodontic purposes. The ethnicity of the participants was confirmed using their birth certificates issued by The Government of India as belonging to South India. The exclusion criteria include missing one or more permanent mandibular teeth and low-resolution radiographs. Ethical approval was granted by the review board of the institution and written consent from the parents/guardians of the participating children was obtained by explaining to them the need for the study.

The OPGs were obtained and later digitalized in the ImageJ software. This was done with due contemplation with regard to the age of the participating subjects and the consequences of radiation subjection. The variables to be substituted in the formula were derived from the OPGs separately by two independent observers to overcome inter-observer bias.

In the radiograph, the date of birth was subtracted from the date, the radiograph was taken in order to quantify the chronological age of every subject. The teeth to be evaluated for this study are the seven left and right permanent mandibular teeth. The number of teeth with closed root apices was calculated as N_0. The teeth with incomplete root development were assessed and the space connecting the inmost borders of the open apex was measured as A_i (where $i = 1, 2, 3, \ldots, 7$ is the number of the tooth). With respect to multiple rooted teeth, the sum of the widths between the innermost borders of the two open apices was evaluated (e.g., $A_2 = A_{2a} + A_{2b}$). All measurements obtained were normalized by dividing A_i with tooth length L_i, (where $i = 1, 2, 3, \ldots, 7$) to bypass angulation and magnification errors (Fig. 1).

Ultimately, the dental development outcome for each tooth was acquired by computing the X_i, where ($X_i = A_i/L_i$). The sum of the cumulative open apices is represented as "s" which is the sum of X_1, X_2, X_3, X_4, X_5, X_6, and X_7). The values were then replaced in the Indianized Cameriere's formula as follows: Age $= 9.402 - 0.879c + 0.663N_0 - 0.711S - 0.106SN_0$, where c is a constant variable. The value of c for the South Indian population is considered as 1 and hence the same was substituted for the study. The Statistical Package for the Social Sciences (SPSS) software, version 22, was used to perform paired and unpaired t-tests and Pearson correlation coefficient on the collected data.

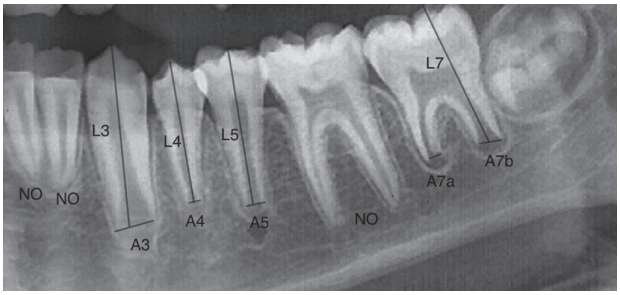

Fig 1: Measuring of various variables from OPG

Table 1: Comparison of estimated age and chronological age in males on the left and right sides using paired t-test

Methods	*Mean*	*SD*	*p-value*
Chronological age	10.09	2.44	<0.001
Cameriere's method (LS)	9.33	2.39	
Chronological age	10.09	2.44	<0.001
Cameriere's method (RS)	9.23	2.40	
Cameriere's method (LS)	9.33	2.39	0.001
Cameriere's method (RS)	9.23	2.40	

LS, left side; RS, right side; SD, standard deviation

Table 2: Comparison of estimated age and chronological age in females on left and right sides using paired t-test

Methods	*Mean*	*SD*	*p-value*
Chronological age	10.70	2.28	<0.001
Cameriere's method (LS)	9.84	2.37	
Chronological age	10.70	2.28	<0.001
Cameriere's method (RS)	9.79	2.35	
Cameriere's method (LS)	9.84	2.37	0.005
Cameriere's method (RS)	9.79	2.35	

LS, left side; RS, right side; SD, standard deviation

Results

In this study, the mean chronological age for males was 10.09 years; estimated mean age on left side of the OPG was 9.33 and that on the right side was 9.23. On comparing both, a significant p-value of 0.001 was obtained (Table 1). Similarly, the mean chronological age for females was 10.70 years; the estimated mean age on the left side of the OPG was 9.84 and that on the right side was 9.79 which in comparison also demonstrated a significant p-value of 0.005 (Table 2). In comparison of age on the basis of gender, no significant difference was obtained for both left and right sides of the OPG ($p > 0.05$) (Table 3). Karl Pearson correlation revealed that age determination on the left side of the OPG was better than on the right side in both genders (Table 4).

Discussion

This cross-sectional study comprised of a sample population of 50 individuals ranging from 5–15 years of age. In order to overcome

Table 3: Comparison of estimated age and chronological age on right and left sides based on gender using unpaired *t*-test

Methods	*Gender*	*p-value*
Chronological age	Male	0.364
	Female	
Cameriere's method (LS)	Male	0.411
	Female	
Cameriere's method (RS)	Male	0.456
	Female	

LS, left side; RS, right side

Table 4: Correlation between estimated ages on both sides with gender using Pearson's correlation coefficient

	r-value		
Methods	*Male*	*Female*	*p-value*
Cameriere's method (LS)	0.972	0.941	0.000
Cameriere's method (RS)	0.894	0.858	0.000

LS, left side; RS, right side

gender bias, the sample was evenly divided into 25 males and 25 females. The focus on this age category is beneficial as the tooth undergoes different phases of growth and hence dental determination of age is noteworthy. Dental maturity is influenced by both genetic and environmental elements. Permanent tooth eruption is guided by certain determinants such as dental arch length, extraction of primary precursors, unfavorable movements, or impaction of teeth. During root development, a significant variation is viewed among the sexes, with males lagging in growth in comparison to females.[11]

Both skeletal and dental methods of age determination primarily depend on radiography and are considered dependable.[10,12] Dental indicators of maturity are highly acclaimed as they remain unaffected by circumstantial sources.[11,13] Dental age forms a part of the biological progress which is analogously apposite from childhood to post pubescence. The permanent dentition continues to undergo alterations even after reaching maturation. This makes age determination achievable even in adults.[14]

An advantageous method for age determination was constructed by Cameriere et al. wherein the gender, second premolar, N_0 and *s* are substantial variables in the equation explicitly for the European natives. Using this equation, a statistically significant association with chronological age was found wherein the morphological variables elucidate 83.6% of the differences ($R_2 = 0.836$).[4] India is a huge country that is diverse in its cultural, communal, and dietary aspects and it well impacts a child's development. Hence, a formula that provides precise estimates for an Italian populace cannot be subjected to an Indian population, making it obligatory to formulate a novel equation by taking into consideration the variability between the South, North, and Central India. Therefore, the inconstant variables *c*, N_0, and *s* were given ideal values in the derivational equation of age determination for the Indian population.[11] For our study, *c* was substituted as 1 as we had included a South Indian population sample.

In this study, significant results were seen in comparing chronological age with estimated age, for both sides of the OPG in both genders (Tables 1 and 2) This outcome is in accordance with the analysis performed by Pratyusha et al.[15] However, the results were in contrast to those performed by Bagh et al. and Rai et al.[10] Age underestimation was perceived in males by 0.76 and 0.86 on the left side and right side of the OPGs, respectively. Similarly, for females, underestimation was noted as 0.86 and 0.91 on the left side and right side of the OPGs, respectively. These results were in agreement with research carried out by Javadinejad et al.[16] who observed an underestimation of age for girls by 0.11 years and for boys by 0.27 years.

When the validity of the formula was based on gender, no statistically significant ($p > 0.05$) outcome was obtained on either side of the radiograph (Table 3). Studies conducted by Bagh et al. and Attiguppe et al. also provided congruent results.[11,17] The outcome confirms that age determination is not gender specific. Nevertheless, it is understood that dental maturity in females proceeds from that of males.[18] However, Rai et al. ascertained that malnourishment and strenuous workload anticipated from girls in India may counteract their rapid growth and development.[10]

In comparison of the sides on the OPG, the estimated age on the left side of the OPG exhibited a superior outcome than the right side in both genders (Table 4). This reliability could be owed to the fact that the left side of the mandible becomes lengthy by 6 years of age in both genders. However, only by the age of 12 years in females and 16 years in males, the right side of the mandible becomes lengthier establishing that the mandibular development is more rapid on the left side.[19] Also, an overriding deteriorating evolutionary form is detected on the right side of the mandible consequently providing paramount results of age determination on the left side of the OPG.[20]

Limitation

This study was carried out over a small-scale population necessitating future studies over a vast South Indian population to vindicate the authenticity of Cameriere's Indianized formula for age determination.

Conclusion

Our analysis using Cameriere's formula displays an acceptable estimate between the chronological age and estimated age in the included population. No correlation could be established on the basis of gender. A better estimation of age was derived from the left side of the OPG. Cameriere's Indian-specific formula is not particularly accurate, however, due to its near approximation to the chronological age, it can be used as a rational tool to assess the age of young children and adolescents.

Acknowledgment

Author extending his sincere gratitude to Dr Vignesh Ravindran for his constant guidance and support throughout the course of this study.

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