

Applicability of Chaillet-Demirjian's and Willem's age assessment methods in Chhattisgarh population: proposing Chhattisgarh population specific formula

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Abstract

Context: Age estimation plays an important role in forensic medicine, paediatric endocrinology, archaeology, and clinical dentistry. Of the various methods which use stages of tooth calcification to predict age, Chaillet-Demirjian's and Willem's methods are most commonly used. But, as variations in dental development exist between different ethnic groups and populations, the foreign dental standards and data might not be applicable to local population. Thus, every method should be tested over the local population to assess its applicability & accuracy, and the necessary modifications should be suggested for its greatest accuracy.

Aims: To evaluate the applicability of dental age estimation methods, and if necessitates, to derive a Chhattisgarh population specific formula for the highest accuracy.

Settings and Design: Prospective and observational correlation study.

Methods and Material: Orthopantomograms of 103 males & 107 females, in age group 7-16 years, from Chhattisgarh population, were taken and evaluated by Chaillet-Demirjian's and Willem's methods for dental age estimation.

Statistical analysis used: Paired student's t- test, Pearson's correlation and regression analysis.

Results: An underestimation of age by Chaillet-Demirjian's method, and an overestimation of age by Willem's method were observed in Chhattisgarh population. Therefore, the Regression analysis was carried out to develop a formula for Chhattisgarh population for estimation of their accurate age.

Conclusions: Though both the methods showed close correlation with the chronological age (CA), there was a remarkable difference from the actual age. Hence, a Chhattisgarh population specific formula for the highest accuracy has been derived and proposed.

Keywords: Forensic medicine, Chronological age, Stages of tooth calcification, Dental age estimation, Chhattisgarh population specific formula.

Introduction

Age estimation not only plays an important role in forensic medicine,⁽¹⁾ but is also important from the medicolegal perspective, suggesting its importance for the living and deceased. Though several methods have been developed to assess the age according to the degree of tooth calcification,⁽²⁾ Chaillet-Demirjian's⁽³⁾ and Willem's⁽⁴⁾ methods are being widely used. Variations in dental maturity are specific to each population, thereby, necessitating the need to validate their applicability in local population. Therefore, the present study is aimed to test the applicability of Chaillet-Demirjian's, and Willem's methods in Chhattisgarh population, and if needed, to derive a local population specific formulae.

Subjects and Methods

Source of Data: 284 individuals of local Chhattisgarh population, of age group 7-16 years were selected for the present study from Department of Oral medicine and Radiology, Chhattisgarh Dental College and Research Institute, Rajnandgaon with written consent from parents.

Methodology

Case Selection:

Inclusion Criteria:

- Individuals of Chhattisgarh population.
- Individuals of age group 7-16 years.

Exclusion criteria:

- Individuals with any congenital/developmental anomalies of jaws and teeth.
- Individuals with any history of craniofacial trauma.
- Individuals with any history of jaw lesion/disorder.
- Individuals with any history of/clinical feature suggestive of endocranial/hereditary/ nutritional disturbances.
- Individuals with any history of skeletal malocclusion.
- Individuals with partial anodontia.
- Individuals who have undergone orthodontic treatment.
- Individuals with missing third molar tooth.

Ethical Considerations: The protocol of the study was approved by Scientific and Ethical Committee of Chhattisgarh Dental College and Research Institute, Rajnandgaon (Chhattisgarh), India.

A total of 284 individuals of age group between 7-16 years of local Chhattisgarh population were examined, out of which 13 having skeletal mal-occlusion, and 2 who had history of craniofacial trauma, were excluded during clinical examination. Then, after written consent from the parents, their digital panoramic radiographs were taken on Sirona orthophos-XG5 machine (with exposure parameters being 64kV, 8mA and 11.5s). Again, 59 subjects who had missing mandibular third molars were excluded from the study. The selected individuals (103 males and 107 females) were distributed in 4 different age groups in either sex i.e. 7.00- 9.99, 10.00- 11.99, 12.00- 13.99 and 14.00- 16.00 years separately (Table 1).

Table 1: Showing distribution of subjects in different age groups

Gender	Number of subjects in different Age groups				Total	
	7.00- 9.99 years	10.00- 11.99 years	12.00- 13.99 years	14.00- 16.00 years	N	%
Male	26	25	26	26	103	49.05
Female	26	27	27	27	107	50.95
Total	52	52	53	53	210	100

The teeth of the third quadrant were traced and given scores according to their stages of development using Chaillet-Demirjian's and Willem's age estimation methods by two observers and the mean was used for estimating the dental age. The chronological age was calculated as per their birth-date.

Results

Descriptive and inferential statistical analysis was carried out and Paired student's t- test, Pearson's correlation and regression analysis were performed in the present study.

The mean chronological age in males in 7.00- 9.99 years age group was 8.26±0.91, in 10.00- 11.99 years age group was 10.96±0.55, in 12.00- 13.99 years age group was 13.06±0.64 and in 14.00- 16.00 years age group was 14.85±0.51. The corresponding mean ages by Chaillet-Demirjian's method were 7.78±0.92, 9.90±1.01, 12.44±1.53 and 14.28±1.28 years respectively. While in Willem's method the corresponding mean ages were 8.52±1.04, 10.87±1.19, 13.29±1.30 and 15.06±1.25 years respectively. The P value was found to be highly significant (P<0.001) for each of the methods used, indicating significant difference between the age groups in both the methods.

On close observation, Chaillet-Demirjian's method seem to under estimate the age by 0.68years in every age group, while the Willem's method showed overestimation of 0.11 years (Table 2).

The mean Chronological age in females in 7.00- 9.99 years age group was 8.53±0.88, in 10.00- 11.99 years age group was 11.08±0.48, in 12.00- 13.99 years age group was 13.05±0.51 and in 14.00- 16.00 years age group was 14.69±0.48. The corresponding mean ages by Chaillet-Demirjian's method were 7.73±1.02, 10.28±1.06, 12.63±1.37 and 13.47±0.94 years respectively. While in Willem's method the corresponding mean ages were 8.44±1.18, 11.15±1.18, 13.63±1.54 and 14.57±1.17 years respectively. The P value was found to be highly significant (P<0.001) for each of the methods used, indicating significant difference between the age groups in both the methods. On close observation, Chaillet-Demirjian's method seem to under estimate the age by 0.81years in every age group, while the Willem's method showed slight overestimation of the age by 0.33years in two groups (10.00- 11.99 & 12.00- 13.99 years) and slight underestimation of age by 0.1year in other two groups (7.00- 9.99 & 14.00- 16.0 years) (Table 2).

Table 2: Showing mean ages in both the genders, by different methods of age estimation

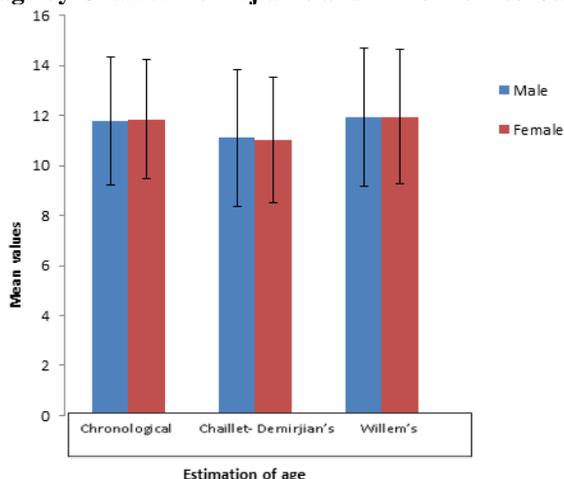
Estimation of age	7.00- 9.99 years		10.00- 11.99 years		12.00- 13.99 years		14.00- 16.00 years		P value	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Chronological age	8.26±0.91	8.53±0.88	10.96±0.55	11.08±0.48	13.06±0.64	13.05±0.51	14.85±0.51	14.69±0.48	<0.001**	<0.001**
Chaillet-Demirjian's method	7.78±0.92	7.73±1.02	9.90±1.01	10.28±1.06	12.44±1.53	12.63±1.37	14.28±1.28	13.47±0.94	<0.001**	<0.001**
Willem's method	8.52±1.04	8.44±1.18	10.87±1.19	11.15±1.18	13.29±1.30	13.63±1.54	15.06±1.25	14.57±1.17	<0.001**	<0.001**

Table 3: Showing mean ages by different methods of age estimation

Method of estimation of age	Overall mean age with SD	P value
Chronological age	11.81±2.47	0.871
Chaillet-Demirjian's method	11.06±2.62	0.844
Willem's method	11.94±2.72	0.971

The overall mean ages by CA, Chaillet-Demirjian's method and Willem's method were calculated as 11.81± 2.47, 11.06± 2.62 & 11.94± 2.72 years respectively (Table 3), suggesting overall underestimation of age by Chaillet-Demirjian's method and overestimation of age by Willem's method (Graph 1).

Graph 1: Showing mean Chronological age, dental age by Chaillet-Demirjian's and Willem's methods



The p value was found to be significant (p< 0.001) for the both genders by Chaillet-Demirjian's method while it was insignificant in Willem's method indicating significant gender difference by Chaillet-Demirjian's method and no significant gender difference by Willem's method (Table 4).

Table 4: Showing gender differences in both the dental age estimation methods on comparing them with Chronological age

Significance with Chronological age	Gender		Total
	Male	Female	
Chaillet-Demirjian's method	<0.001**	<0.001**	<0.001**
Willem's method	0.207	0.362	0.123

Pearson's correlation showed near close correlation between CA and Chaillet-Demirjian's method (r= 0.901) and also between CA and Willem's age estimation method (r= 0.898) for overall population (Table 5).

Table 5: Showing Pearson correlation of both the dental age estimation methods with the chronological age

Pair: Overall	r value	P value
Chronological vs Chaillet-Demirjian's method	0.901	<0.001**
Chronological age vs Willem's method	0.898	<0.001**

As underestimation and overestimation of the age was observed by Chaillet-Demirjian's and Willem's methods respectively, the need to carry out regression analysis to derive a regression equations/ formulae with increased accuracy was necessitated. So, the modifications in original formulae were made for Chhattisgarh children and adolescent population, which are derived as a separate equations for males and females as well as a combined equation for overall population as follows:

For Males:

Chr.age=2.55+0.835 × Age by Chaillet-Demirjian's method

Chr.age=1.79+0.837 × Age by Willem's method

For Females:

Chr.age=2.26+0.87 × Age by Chaillet-Demirjian's method

Chr.age=2.37+0.793 × Age by Willem's method

For Overall population:

Chr.age=2.43+0.85 × Age by Chaillet-Demirjian's method

Chr.age=2.07+0.82 × Age by Willem's method

Discussion

Dental age, an indicator of somatic maturation, is of utmost importance in the fields of law (medicolegal perspective), forensic medicine and in clinical dentistry, especially in treatment planning for the growing children. Several methods have been proposed and used for dental age assessment with varying results.⁽⁵⁾

In 1973, Demirjian⁽⁶⁾ introduced a method which estimated chronological age based on developments of seven teeth from the left side of the mandible. In 1976, Demirjian⁽⁷⁾ developed three more methods: First was based on the same seven teeth; second on 4 teeth, specifically the first premolar (PM1), second premolar (PM2), first molar (M1) and second molar (M2); and the third on 4 teeth, specifically the second incisor (I2), first premolar (PM1), second premolar (PM2) and second molar (M2). In the cases where a single tooth was missing or rating was not possible, Demirjian and Goldstein⁽⁷⁾ suggested creation of a separate scoring system for each combination of six remaining teeth; however, they selected two previously mentioned 4-teeth sub-systems. In all four methods, each tooth was scored based on its observed developmental stage, following which the sum of each tooth score are converted to maturity score according to standardized tables or 50th percentile to dental age. Original

Demirjian⁽⁶⁾ methods were based on so called French-Canadian standards (population), which many studies have shown to overestimate chronological age by over a year. Reasons for the overestimation are attributed to differences in environmental, habitual and nutritional characteristics of populations as well as different unreliable statistical procedures, manual matching of population curves, sample and scoring biases. Researchers have, therefore, suggested that dental age estimates of chronological ages be determined for each specific population. Although Demirjian⁽⁷⁾ methods published in 1976 were devised to overcome deficiencies and reliability of the Demirjian⁽⁶⁾ 1973 methods, modern studies still use them for evaluation and comparison with other dental age estimation methods.⁽⁸⁾ Over the course of time, various other authors too have tested the applicability of this formula in different populations and have proposed modifications in this method. Chaillet-Demirjian⁽³⁾ (2004) added the third molar in the original formula for assessment of age in French children and derived regression formulae for age assessment. Another major modification made in this study was that two additional stages were included to staging of teeth for easier calculation and to develop cubic equations with good reliability.⁽⁹⁾ This method has high reproducibility due to very clear and detailed description of stages proposed, that include relative lengths of crown and root.

Willem⁴ in the year 2001 proposed a new method based on Belgian children who adapted and simplified Demirjian scoring system, and showed increased accuracy of determining chronological ages. The accuracy of Willem's method can be contributed to its single step calculation from the gender specific chart. Another reason could be the influence of secular trend.

There are various study reports on Indian and foreign population which observed an over-estimation of age on applying Demirjian's age estimation method. It must, however, be noted that the previous studies utilized Demirjian's 7-teeth method, whereas the present study utilized the modified 8-teeth method. There are only few studies determining the accuracy of Chaillet-Demirjian's age estimation method. Therefore, the present study was undertaken to evaluate the accuracy and applicability of Chaillet-Demirjian's and Willem's method in Chhattisgarh population.

In the present study, an underestimation of age by Chaillet-Demirjian's method, and an overestimation of age by Willem's method was observed in Chhattisgarh population. Both the methods showed close relation with the chronological age, but with a remarkable difference between them. Hence, regression analysis was carried out to develop modified equations/formulae for Chhattisgarh population.

The proposed equations in this study are dependent directly upon the Chaillet-Demirjian's, and Willem's methods, and, thus, can be regarded as the modification

of these methods for the Chhattisgarh population. The R² value (i.e. percentage of accuracy) for each of the equation was found to be >80% which is considered statistically very good. The Beta value for each equation was in range of 0.895- 0.908, which implies a good sensitivity of all the equations in Chhattisgarh population. Therefore, we are herewith proposing dental age estimation formulae for Chhattisgarh population.

Conclusion

On regards to an increased need of perfection and accuracy in forensic investigation, this study was undertaken to compare the different age estimation methods in the given population. After discussing the shortcomings of the existing formulae, Chhattisgarh Region Specific formulae with higher accuracy have been derived and proposed through this paper.

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