Original Article

Validation of demirjian's 8-teeth method of age estimation in the population of Bengaluru

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Abstract

Introduction: Demirjian's method of dental age assessment estimates the overall dental age by scoring based on the stage of tooth formation, using panoramic radiographs. This method was primarily based on data acquired from individuals of French-Canadian origin. It has since been applied and modified for the Indian population. Therefore, the aim of the present study is to assess the reliability of the Indian formula in the population of Bengaluru.

Materials and Methods: Dental maturity of 297 subjects between 9 and 17 years was assessed using the India-specific formula of Demirjian *et al*.'s 8-teeth method and the chronological age of each subject was calculated. Pearson's correlation, Independent student test/Mann–Whitney test and Chi-square test were used for statistical analysis of the results obtained.

Results and Discussion: A very strong correlation ($P < 0.001$) between the chronological and estimated age by Demirjian's method was obtained. The mean absolute error among the total samples was not significant and majority of the error in the estimated age was <1 year in males and females, indicating that the India specific formula gave nearly accurate estimation of the chronological age of the sample subjects.

Conclusion: Demirjian's Indian formula is relaible in the population of Bengaluru

Keywords: Demirjian's method, dental age, dental maturity, panoramic radiographs

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INTRODUCTION

Living organisms have two different ages: chronological and biological.

Chronological age is the actual amount of time an individual has been alive and it does not change, regardless of lifestyle and environmental factors.

Biological age, also known as physiological age, takes many lifestyle factors into consideration and is estimated based on the degree of maturation of various tissue systems.[1]

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The biological age of an organism is essential to determine the degree of physiological maturity of the individual. Some widely accepted methods of biological age estimation of an organism include skeletal age using intervertebral discs, ribs and pubic symphysis and dental age.[2]

Dental age estimation is used in medico-legal cases. Teeth aid in the identification and age estimation of individuals as they are durable and resist putrefaction, fire and chemicals.[3]

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Dental age estimation in the living is mostly based on noninvasive methods, which evaluate the timing and sequence of defined growth stages of the developing dentition and the sequence or modification of traits in the mature dentition and the surrounding tissues, giving more precise information than other anthropometric measurements. Tooth structures can be used for age estimation even after death.[4]

Dental age estimation based on the developing dentition is less affected than skeletal development by malnutrition and hormonal disorders and is used predominantly in the fields of:

- Orthodontics to correct malocclusions based on the degree of maxillofacial and dental growth that has occurred and is expected to occur
- Pedodontics, where diagnosis, as well as preventive and interceptive treatment plans, are designed according to the dental age of the child or adolescent patient
- Pediatric medicine, where dental age is an important maturity indicator, among others, in the diagnosis and management of disorders which impair the growth and development of the child
- Forensic science, to determine the age of the deceased individual and thereby aid in establishing the identity of the corpse
- Age assessment in anthropological and archaeological studies.[4-6]

Several methods of dental age estimation based of tooth analysis have been used to determine the unknown age of individuals.

There are two general techniques of dental age assessment: By clinical visualization of eruption of teeth, and radiographic determination of tooth development.[4,7,8]

Clinical dental age assessment is based on the emergence of teeth in the mouth. The eruption of teeth is one of the changes observed easily among the various dynamic changes that occur from the formation of teeth to the final shedding of teeth. The times of eruption of teeth are fairly constant and assessment of the age of an individual by examination of teeth is one of the accepted methods of age determination. It does not require any special equipment, expertise is easily observable among various orofacial changes and is economical. Eruption timings of teeth are fairly constant and can be used in ascertaining the average age of the individual.[2,4,8]

The drawbacks of this method are that gingival emergence, which is only one stage in the continuous process of dental eruption is the only clinically observable stage and is incorrectly generalized as dental eruption. Gingival emergence may be affected by ankylosis, tooth extraction, impaction and crowding of teeth.[5]

Clinical emergence can be used for dental age assessment only in certain age periods during which dental eruption occurs, which is up to 30 months of age (deciduous dentition) and above 6 years of age (permanent dentition).

Among the various methods used to determine dental age using dental eruption, varying definitions of tooth formation and eruption are used, and there is large variation in the association between formation and emergence of different teeth resulting in a lack of uniformity in the technique of dental age assessment.[4,9] Therefore, tooth formation is considered a more reliable indicator of dental maturity than gingival emergence of eruption.

Tooth formation is the best choice for age estimation due to minimal variations compared to other development factors and maturity indicators and is assessed radiographically. The formation rate of permanent teeth remains unaffected by premature tooth loss.[4,10] Tooth formation can be assessed at any age of the patient, unlike estimation based on the dental eruption.

There are two methods of dental age estimation based on the stages of tooth formation:

- A standard profile is developed for each stage of tooth formation and any new set of readings is compared with the standard age series and the closest range is accepted as the best match and assigned to the new reading
- A scoring system is developed where a score is assigned to each tooth based on its stage of development and a summation of the individual scores of the teeth gives a total maturity. Score of the individual is translated into a dental age based on a table of standards.[5]

Demirjian's method of dental age assessment estimates the overall dental age by scoring based on the stage of tooth formation observed in each tooth, with separate scoring systems for each gender.

Panoramic radiographs are used in Demirjian's method as the stages of formation of 8 teeth need to be visualized, and the subject is exposed to less radiation for a full mouth radiograph than intraoral periapical radiographs. Mandibular distortion is less and despite a slight enlargement of the left side of the mandible, it is

not a major drawback, as the method relies on the shape and relative values as opposed to absolute measurements of the teeth.[5]

Demirjian's method of dental age estimation was primarily based on the data acquired from individuals of French-Canadian origin. Since the dental maturity scores are known to vary among different populations based on their dental advancement during biological growth, it becomes necessary to revise this method based on data from the indigenous population in order to accurately determine the dental age of the individuals of that population, as well as to contribute in creating a global database of the dental maturity rates of various populations around the world.[11]

Demirjian's system of dental age assessment had been applied and modified in the Indian population by Dr. Acharya in 2011. Therefore, the aim of the present study is to check the reliability of the Indian formula in the population of Bengaluru.[12]

MATERIALS AND METHODS

The study was conducted using the radiographic records of candidates of the city of Bengaluru, who reported to the Department of Forensic Odontology, Government Dental College and Research Institute, Bangalore for age verification, as a prerequisite to participate in state and national level sports tournaments during the years 2017–2019.

A total of 297 subjects (177 males and 120 females) of ages ranging from 9 to 17 years were included. Subjects selected were children and adolescents who had complete mandibular dentition and free from any kind of disorder affecting the growth was selected for this study.

Orthopantomograph (OPG) of the study participants were taken and analyzed using the Demirjian method. Dental maturity was assessed on OPG using the India-specific formula of Demirjian *et al.*'s 8 teeth method developed by Acharya.

The chronological age of each subject was calculated by subtracting the date of the radiograph from the date of birth.

Pearson correlation, Independent student test/Mann–Whitney test and Chi-square test was used for statistical analysis of the results obtained.

RESULTS

The distribution of gender among the sample population showed 59.6% of males and 40.4% of females among study samples [Table 1].

Sample distribution across different ages and sexes showed that the maximum sample population participants were from the 14 years' age group (19.2%).

Pearson's correlation was used to assess the relationship between chronological and Demirjian's estimated age. The correlation coefficient was 0.90 for the total sample and 0.89 for males and females, which showed a very strong correlation ($P < 0.001$) [Table 2]. The scatter plot indicates a linear progression suggesting positive correlation between chronological age and estimated age by Demirjian's method [Figure 1].

Gender-based comparison of mean estimated age (in years) among total samples showed males with a higher estimated age than females, with a mean difference of 0.99, which is statistically significant ($P < 0.05$).

Table 1: Distribution of gender among study samples

Distribution of study samples		
Variable	**Category**	***n* (%)**
Sex	Males	177 (59.6)
	Females	120 (40.4)

Table 2: Pearson correlation to assess the relationship between chronological and Demirjian's estimated age

The relationship between chronological and Demirjian's estimated age				
Variable	**Values**	**Total-EA**	**M-EA**	**F-EA**
CA	*r*	0.90	0.89	0.89
	P	<0.001*	<0.001*	<0.001*
	n	297	177	120

*Statistically significant. CA: Chronological age, EA: Estimated age for total samples, M–EA: Estimated age among males, F–EA: Estimated age among females

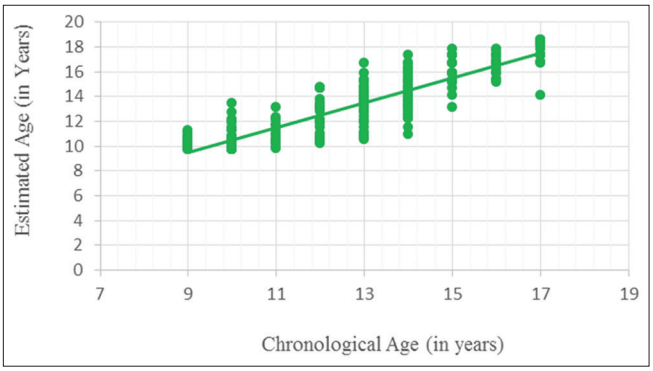

Figure 1: Scatterplot depicting the relationship between chronological and estimated age in overall samples

Independent Student's *t*-test/Mann–Whitney test was used for the gender-based comparison of mean estimated age (in years) with the different chronological ages. The year-wise distribution showed highly significant results in the 9 years' age group ($P < 0.001$), where males showed increased age estimation as compared to females, with a mean difference of 0.66 years.

Gender-based comparison of the mean absolute error in age estimation (in years) among total samples showed a mean difference of 0.16 between males and females, which was not significant.

Mann–Whitney test was used for gender-based comparison of mean absolute error based on the year-wise distribution of chronological age, which showed highly significant results in the age of 9 years ($P < 0.001$), and significant results in the ages of 10 years ($P < 0.05$) and 11 years ($P < 0.05$) were observed.

Chi-square test was used for the proportional comparison of different classes of absolute error intervals between males and females. It was seen that 52.0% of the males and 60% of females sample showed <1 year of error rate. Since majority of the study samples, in both males and females, indicated an error interval of <1 year, there is no significant difference between them.

DISCUSSION

Chaillet and Demirjian presented a revised method of dental age estimation, which included the third molar in addition to the original seven teeth, to enhance the age correlation of dental development. Demirjian's 8-teeth method also needs adaptation before use in diverse populations.[11]

The study conducted by Acharya assessed the revised 8-teeth method, which is applicable to a wider age-group, including juveniles and very young adults. India-specific regression formulas were developed, which giving better population-specific age estimates than the original formulas.[12]

The present study was conducted in the 9–17-year-old population of the city of Bangalore and corroborated the results of the previous study. The mean absolute error among the total samples was not significant and majority of the error in the estimated age was <1 year in males and females, indicating that the India specific formula gave nearly accurate estimation of the chronological age of the sample subjects.

The validation of the revised Demirjian's method, with Indian weighted scores can be done by conducting population-based sampling in various regions of the country, to account for the diversity of the country's population.

This will help establish a reliable and customized method of age estimation, which will be universally applicable for forensic studies in Indians.

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Conflicts of interest
There are no conflicts of interest.

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