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Dental Age Estimation of 6-14-Year-Old Guilanian Children Using Demirjian's Method

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Abstract

Background: Developing teeth may be evaluated based on the degree of tooth development or the stage of tooth eruption.
Objectives: This study aimed to assess the accuracy of Demirjian's method for dental age estimation in a group of Guilanian children.
Methods: Panoramic radiographs of 390 Guilanian children aged 6 - 14 years were analyzed based on Demirjian's method. Dental age was compared with chronological age using a paired t-test. The difference between the estimated age and chronological age was examined by Mann Whitney test in males and females.
Results: The mean difference between the dental age and chronological age was 0.84 in females and 0.82 in males (about 8 months). The difference in this regard between males and females was not significant. The difference between the chronological and dental age was significant in all age groups except for 13 - 13.99 years old.
Conclusions: Demirjian's method may not be accurate enough for dental age estimation of Guilanian children and specific standards for dental age assessment should be developed for this population.

Keywords: Dental Age, Chronological Age, Demirjian's Method

1. Background

Dental age is important to orthodontists and pedodontists for treatment of malocclusions related to maxillofacial growth (1). In addition, dental age estimation methods may be used for identification of deceased children (2).

Developing teeth may be evaluated based on the degree of tooth development or the stage of tooth eruption. Tooth eruption is a variable parameter influenced by factors such as inappropriate nutrition, early loss of primary teeth, crowding, and dental caries. On the other hand, tooth shape appears to be a more suitable index for dental age estimation with high reliability and seems to be less influenced by the environmental factors (3). Dental age is estimated by the assessment of the developmental stage of teeth in individuals with unknown chronological age. Most techniques used for the assessment of dental age are based on the comparison of the radiographic development of teeth with standard charts. These charts are designed following the assessment of a large number of individuals residing in specific geographical locations (1).

Several methods have been described for dental age estimation based on the level of tooth formation on radiographs (4). Demirjian's method, a widely used technique, was first described by Demirjian and his associates in 1973 (5). This method was first tested on a large number of French-Canadian children (6). This method evaluates the development of seven mandibular teeth on panoramic radiographs to estimate the patient's dental age (4). The accuracy of the Demirjian's method has been tested in different populations. The use of the dental maturity scale (DMS) according to the Demirjian's method reveals differences between different ethnic groups and populations residing in different geographical locations (4). Demirjian's method is based on the eight stages of calcification, from the time of formation of crown and root to the apex closure of the mandibular teeth. The scores allocated to each stage are recorded and the sum of all scores is calculated to assess DMS. Using the available tables for this purpose (drawn for the respective population), DMS can be converted to dental age. The difference between the dental and chronological age may show an enhancement or delay in

dental maturity (7).

2. Objectives

Considering the lack of information on the efficacy of Demirjian's method for dental age estimation in Guilanian children and adolescents, this study aimed to assess the efficacy of the Demirjian's method for dental age estimation in a group of 6 - 14-year-old Guilanian children.

3. Methods

In this cross-sectional study, a total of 390 panoramic radiographs of patients aged 6 - 14 years (206 females and 184 males) presenting to the dental clinic of school of dentistry, Guilan University of Medical Sciences, Rasht, Iran, from January 2009 to August 2011 were evaluated. The sample size was calculated based on the study of Bagherpour et al. (3) with d = 0.1, $\delta = 0.1 \times 0.81 = 0.08, 1 - \alpha = 0.95$

$\delta = 0.81$ n $\geq$ (Z21-α/2 $\times \delta^2$)/d^2 n $\geq$ (1.962 $\times$ 0.812)/0.0812 $\rightarrow$ n $\geq$ 384. The panoramic radiographs of patients who were Guilanian for at least two generations were included in the study. Patients and/or their parents were questioned in this regard and those who had Guilanian parents and grandparents were included. All patients had taken panoramic radiographs prescribed by their dentist for diagnostic purposes as part of their diagnostic workup (not related to this study). We originally obtained the approval of the ethical board of the institutional ethics committee of Guilan University of Medical Sciences research foundation in Rasht, Iran, before conducting this investigation (ethics approval number 1328) to ensure our compliance with the recommendations of the Declaration of Helsinki and Tokyo for humans. Accordingly, our protocol complied with these guidelines. Moreover, we obtained written consent of the participating patients to use their panoramic images for this study. All panoramic radiographs had been taken by Planmeca 2002 EC proline dental X-ray unit (Planmeca, Helsinki, Finland) with appropriate exposure settings adjusted based on the age and size of patients. Poor quality radiographs and those showing hypodontia or specific pathological conditions were excluded. Also, radiographs of patients with a systemic, metabolic, or genetic disease or a history of malignancy, chemotherapy, or radiotherapy, radiographs with technical errors or poor processing (not observable right or left mandibular tooth buds), and radiographs showing acquired developmental dental anomalies were all excluded.

The chronological age of each patient was calculated by subtracting the date of birth of the patient from the date of taking the radiograph. All radiographs were evaluated in a semi-dark room on a view box by an oral and maxillofacial radiologist. In case of absence of any of the mandibular left teeth, the corresponding tooth on the right quadrant was used.

To prevent bias, each panoramic radiograph was coded. Thus, the examiner was blinded to the age and sex of patients. The dental age of each patient was calculated using the Demirjian's method. All mandibular left teeth (except for the third molars) were evaluated and the dental age was calculated using the tables introduced by Demirjian et al. (5). In the Demirjian's method, eight stages from A to H are considered. A to D stages indicate dentin formation and E to H stages indicate root formation from the initial furcation to closure of the apex. Radiographic view of this classification is shown in Figures 1-3. A form was filled out for each patient asking for the patient's demographics including name, sex, date of birth, date of radiography, and the teeth numbers scored (from 31 to 37). The developmental stage of each tooth according to the Demirjian's method was recorded for each patient in the respective form based on the panoramic radiograph of the patient and the score of each stage was determined based on the patient's age and sex using the Demirjian's table (Tables 1 and 2). The scores allocated to the developmental stage of each tooth (#31 to 37) were added and by using the sum of scores, the dental age was estimated for each of the male and female groups using the Demirjian's DMS. The same examiner performed all the assessments. To evaluate the intra-observer agreement, 36 radiographs were randomly selected among the study sample and scored again by the same observer one month later. Data were entered into SPSS version 19 and the mean age of subjects was determined for each developmental stage according to the Demirjian's method.

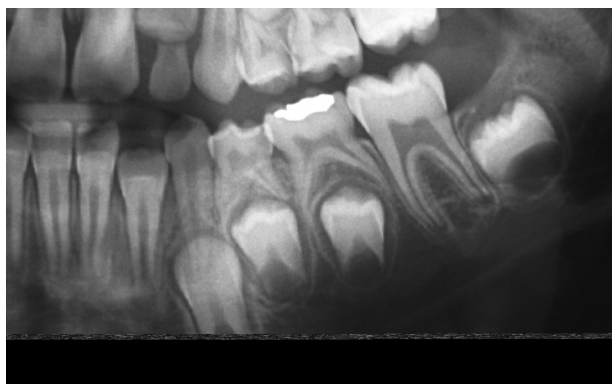

Figure 1. Representative Stages of Demirjian's Method; Tooth 31: Stage H, Tooth 32: Stage G, Tooth 33: Stage F, Tooth 34: Stage E, Tooth 35: Stage E, Tooth 36: Stage G and Tooth 37: Stage D

Table 4. Comparison Between Chronological and Dental Age in Males and Females

	Group	Number	Mean ± Standard Deviation	95% Confidence Interval	Test/P Value
Difference of chronological and estimated dental age	Females	206	0.84 ± 1.12	-0.23 ± 0.194	Mann-Whitney Z = -0.046 P value = 0.96
	Males	184	0.82 ± 0.96		
Estimated dental age	Females	206	9.51 ± 1.97	-0.289	Independent Sample test t = 0.51 P value = 0.61
	Males	184	9.61 ±1.96	0.492	
Chronological age	Females	206	8.67 ± 1.671	-0.23	Independent Sample test t = 0.663 P value = 0.508
	Males	184	8.79 ± 1.865	0.47	

square to 1, the lower the variance of data and the closer the data to the cut-off point (Table 2 and Figure 5).

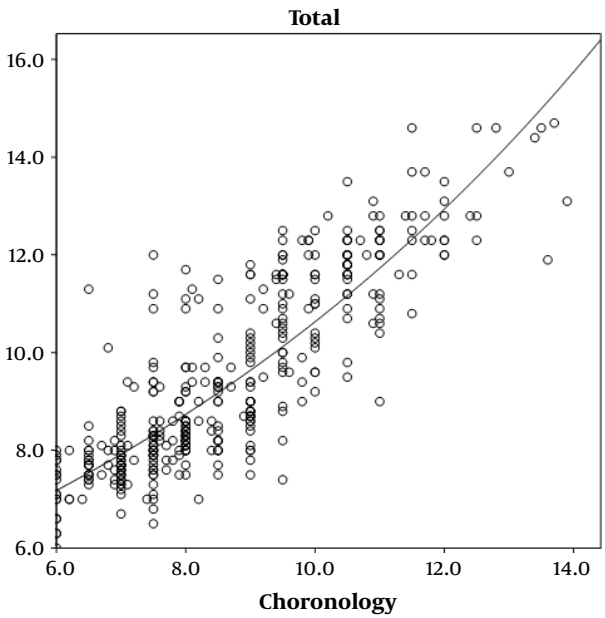

Figure 5. Dispersion Diagram of the Correlation of Dental Age and Chronological Age in Males and Females

To assess the intra-observer agreement, 36 out of 390 radiographs were randomly selected and re-evaluated after one month by the same examiner. The difference in the estimated dental age at the two time-points (for 36 radiographs) was analyzed and according to the paired t-test, this difference was not significant (Table 5).

5. Discussion

Methods used for estimation of growth and development of children are valuable in medicine and odontology (1). Tooth development has been widely used for the assessment of growth and maturity (puberty). Different methods have been recommended to estimate dental age and assess the maturity and puberty based on tooth development (4).

Demirjian's method is among the simplest and most widely used techniques for age estimation (8). Although this method is commonly used, geographical and nutritional conditions are not equal in different populations and age groups. Thus, the efficacy of this method for age estimation in different communities must be evaluated separately (7). Many previous studies have used the Demirjian's method for dental age estimation, reporting that this method tends to overestimate the dental age (1, 2, 4, 9-14). Similarly, our study showed that Demirjian's method overestimated the dental age of subjects. Liversidge et al. (15) believe that tendency of overestimation of dental age by Demirjian's method may be explained by the greater growth and development within the first 25 years of life.

In our study, a significant difference was observed between the estimated dental and chronological age in all age groups except for the 13 - 13.9 years old. However, it should be noted that the small sample size in the abovementioned age group might have contributed to this finding. In a study by Bagherpour et al. (3) in a group of children and adolescents in Mashhad, significant differences were reported in this regard in most age groups. In a study by Maia et al. (16) in northeastern Brazilian children, a significant difference was also noted between the chronological age and dental age. They showed advancements in the dental age in all age groups, which is in accordance with our findings. In studies by Lee et al. (10) in a Korean population, SenTunc et al. (4) in a Turkish population, and Koshy and Tandon (1) in a south Indian population, significant differences existed between the chronological and dental age. These findings indicate the need for a specific reference for each population. The mean age difference in our study was 0.82 years in boys and 0.84 years in girls. In the study by Bagherpour et al. (3), the mean age difference was 0.34 years in boys and 0.25 years in girls. The highest amount of overestimation was at the age of 6 years in boys

Table 5. Comparison of the Difference of Chronological Age and Dental Age in the Two Observations (for Assessment of Intra-Observer Agreement)

Gender	Estimated Age in the 1st Observation	Estimated Age in the 2nd Observation	Test Result		
			Mean	t	P Value
Females	2.1431 ± 9.276	2.0686 ± 9a.39	0.1143	1.346	0.193
Males	1.6091 ± 9.193	1.5357 ± 9.26	0.0667	-1.323	0.207
Total	1.9136 ± 9.242	1.8419 ± 9.336	0.94	-1.772	0.085

Abbreviation: SD, standard deviation.

and at the age of 8 years in girls. Underestimation was only seen in boys at 11 years of age and in girls at 12 years of age. In a study by Eid et al. (17), the mean overestimation of dental age in Brazilian children was reported to be 0.68 years in boys and 0.62 years in girls. In the study by Koshy and Tandon (1) in Indian children, overestimation was 3.04 years in boys and 2.82 years in girls. SenTunc et al. (4) in their study in northern Turkish children reported a mean difference of 1.44 years between the dental and chronological age.

In the study by Lee et al. (10) in a group of Korean children, the mean difference was 0.288 years in boys and 0.313 years in girls and the maximum difference was at 11 years in girls and 15 years in boys. Nik-Hussein et al. (18) reported a mean difference of 0.7 years in boys and 0.5 years in girls. Such controversy in the mean difference between the dental and chronological age in different studies may be due to the ethnic and nutritional specifications of different populations, sample size, and the selected age range. However, in general, all studies have shown that Demirjian's method tends to overestimate the dental age.

Hägg and Matsson (19) showed that Demirjian's method had higher accuracy and precision at lower ages; however, SenTunc et al. (4) and Mentes et al. (20) in their studies on Turkish population as well as Nik-Hussein et al. (18) reported the maximum difference in the age range of 5 - 6.99 years. Liversidge et al. (21) and Lee et al. (10) also showed that Demirjian's method was less accurate at lower ages. Bagherpour et al. (3) reported a greater difference between the chronological and dental age in the age range of 6 - 9 years. Similarly, in our study, the maximum difference between the chronological and dental age in both males and females was in the age range of 6 - 6.99 years, which is justified by the unpredictable growth pattern at younger ages (22).

In our study, males and females were not significantly different with respect to the difference in the chronological and dental age. In the study by Chen et al. (7) in 8 - 16-year-olds, this difference only at 8 and 16 years was not significant. Cameriere et al. (23) also reported that the mean difference in females was significantly greater than that in males. In our study, the dispersion diagram of the mean chronological and dental age in boys and girls was almost similar (Table 1). From 6 - 7 years of age, the mean difference increased and then dropped after the age of 7 - 8 in both males and females followed by an increasing trend up to 11 years of age. At the age of 12, the mean difference decreased and only in the age range of 13 - 13.99 years, the difference in the mean values between males and females was significant (an increase in the mean value in girls and a decrease in boys). However, in the study by Bagherpour et al. (3), this pattern in boys and girls was different at 6 - 8 years and 12 years of age. In the age range of 6 - 8 years, the mean value decreased in boys and increased in girls. Nevertheless, the situation was reversed at 12 years of age. Liversidge et al. (21) showed that the mean difference between the chronological and dental age decreased in the age range of 4 - 9 years in boys and increased in the age range of 6 - 6.99 years in girls. In the study by Aissaoui et al. underestimation was reported in children aged between 9 and 16 years and the range of accuracy varied from -0.02 to 3 years. The progress in dental age as marked by Demirjian system when compared to chronological age ranged from 0.3 to 1.32 years for young males and from 0.26 to 1.37 years for young females (age ranged from 3 to 8 years) (24). Nour El Deen et al. stated that Saudi Arabian children were generally more mature than French Canadian reference population in dental maturity, with an overall mean difference between the dental and chronological age of 0.279 years in boys and 0.385 years in girls (25). Such variable patterns of change in studies are expected considering the differences in various populations.

5.1. Conclusions

Demirjian's method overestimated dental age in almost every age group for children of both genders. Thus, this method may not be accurate enough for dental age estimation of Guilanian children and specific standards for dental age assessment should be developed for this population.

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