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ORIGINAL ARTICLE

Applicability of the Demirjian method for dental age estimation in western Turkish children

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Abstract

Objective. The aim of this study was to examine whether the Demirjian method would be appropriate for estimation of the dental age of western Turkish children. ***Materials and methods.*** This study comprised 635 Turkish children (age = 7–16 years) from the western Aegean region who were chosen on the basis of radiological evidence from digital orthopantomograms. Their dental maturity was evaluated according to the stages proposed by Demirjian. A paired *t*-test was used for statistical analysis. ***Results.*** The mean difference between the chronological and dental ages ranged from 0.10–0.76 years for males and from 0.28–0.87 years for females. ***Conclusion.*** The applicability of the Demirjian method is not suitable for western Turkish children and western Turkish children have a lower degree of dental maturity than that observed in the eastern, northeastern and northern Turkish subjects.

Key Words: *Dental age, Demirjian method, forensic dentistry*

Introduction

Age estimation is an important procedure in forensic medicine. For humans, age estimation is carried out for various reasons. Age estimation of cadavers, for example, is performed in criminal cases, as well as for identification of mutilated victims of mass disasters, such as fires, crashes, accidents, feticides, homicides and infanticides. For living persons, age estimation is performed in order to assess whether a child has attained the age of criminal responsibility in scenarios involving rape, kidnapping, employment, marriage, premature births, adoption, illegal immigration, pediatric endocrinopathy and orthodontic malocclusion, as well as circumstances in which the birth certificate is not available or the records are suspect [1,2]. Teeth can be helpful in forensic and legal dentistry for age estimation. Age estimation depending on dental maturity is the most reliable method; thus teeth are the most indestructible part of the body and exhibit the least amount of turnover of their natural structure. Therefore, they both survive death and also their structure remains relatively unchanged, even after many thousands of years [1].

The dental age (DA) of children can be specified according to the tooth maturation stages observed in radiographs. Several methods have been used to determine DA according to the degree of calcification observed while performing radiographic examinations of permanent teeth [3–6]. The Demirjian method is based on the characteristics observed in French-Canadian children; this method evaluates the development of seven left-sided mandibular teeth from panoramic radiographs and calculates the DA [4]. The Demirjian method has been tested in different populations. These studies showed that dental development varies among different populations [7–12], as well as among geographical areas or cities within the same country [13]. Environmental, climatic, genetic, hormonal and nutritional factors can affect the development of each person's organs [14]. This situation necessitates population-specific studies.

A literature review revealed that little research exists regarding the applicability of the Demirjian method

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for age estimation in a Turkish population. To date, it has only been tested in a group of 900 northern [7], 419 northwestern (published in a national journal) [15], 756 northwestern [16], 671 northeastern [17] and 807 eastern [13] Turkish children. Therefore, the aim of this study was to evaluate the validity of the Demirjian method for DA estimation in western Turkish children.

Materials and methods

This retrospective study comprised the digital panoramic radiographs (OPG) of 685 children (340 male; 345 female) who ranged in age from 7–16 years. The radiographs were selected from patients' databases in the Izmir Educational Dental Hospital. An experienced X-ray technician obtained all radiographs by using an orthopantomography device (Planmeca® Proline CC 2011, 60–80 kVp, 8–10 mA, 12.8 s exposure time, Helsinki, Finland). This study included patients who underwent a radiological examination from 2011–2013. High-quality orthopantomograms from healthy western Turkish children who were between 7–16 years of age, were born after a normal gestation period and showed normal growth, development and dental conditions were selected and analyzed.

Fifty panoramic radiographs were excluded because they did not meet the above-mentioned inclusion criteria and the final samples consisted of images from 635 patients. The patients' names, genders and birth dates were recorded for each radiograph. Table I shows the age and gender distribution of the sample sets. Two examiners assessed all the images separately and any disagreement between them was discussed until a consensus was reached. The chronological age (CA) of each child was calculated by subtracting the date of birth from the date the radiograph was taken. The stage of tooth mineralization was evaluated for left permanent mandibular teeth (except third molar) according to the method proposed by Demirjian et al. [4]. The development and mineralization of the teeth were classified into eight stages, labeled A–H (Figure 1).

Table I. Distribution of age and gender in the study population.

Chronological age, years	Male	Female	Total (%)
7–7.9	18	16	34 (5.3)
8–8.9	50	19	69 (10.8)
9–9.9	30	34	64 (10)
10–10.9	35	31	66 (10.3)
11–11.9	41	36	77 (12.1)
12–12.9	38	30	68 (10.7)
13–13.9	26	34	60 (9.4)
14–14.9	29	32	61 (9.6)
15–15.9	53	83	136 (21.4)
Total (%)	320 (50.4)	315 (49.6)	635 (100)

Each stage of mineralization was given a score, which provided an estimate of the dental maturity by using a scale of 0–100 on percentile charts. The dental maturity scores for each tooth was then converted to DA values according to standard tables and percentile curves that were obtained for each gender, separately.

Statistical analysis

All the data were analyzed by using the SPSS® software package (Statistical Package for Social Sciences, version 11.5, SPSS® Inc., Chicago, IL). Normality of data was performed using the Kolmogorov-Smirnov test. As the results of the Kolmogorov-Smirnov test showed a normal distribution, parametric tests were used. An independent *t*-test was performed for age and sex in order to determine the relationship between tooth developments. A regression analysis was performed in order to obtain regression formulae for the DA calculation with CA and to determine the coefficient of determination (r^2) for each gender. To test the reproducibility of the assessment of the dental development stage, the two observers re-examined 70 randomly selected panoramic radiographs 5 weeks after the first evaluation. All statistical analyses were performed at a significance level of $p < 0.05$.

Figure 1. Stages of tooth calcification as described Demirjian et al. [4].

Table II. Differences between chronological ages and dental ages determined by Demirjian method.

Age	Mean CA	Mean DA	DA–CA (Mean difference)	*p*
Males				
7–7.9	7.01	7.77	0.76	0.000*
8–8.9	8,03	8.4	0.37	0.000*
9–9.9	9.23	9.88	0.65	0.000*
10–10.9	10.08	10.18	0.10	0.373
11–11.9	11.10	11.62	0.52	0.012*
12–12.9	12.09	12.69	0.60	0.017*
13–13.9	13.34	13.89	0.55	0.024*
14–14.9	14.11	14.79	0.68	0.037*
15–15.9	15.23	15.73	0.50	0.000*
Females				
7–7.9	7.08	7.44	0.36	0.000*
8–8.9	8.21	8.67	0.46	0.016*
9–9.9	9.18	9.71	0.53	0.002*
10–10.9	10.20	10.90	0.70	0.002*
11–11.9	11.13	11.41	0.28	0.104
12–12.9	12.37	13.10	0.73	0.009*
13–13.9	13.41	13.98	0.57	0.010*
14–14.9	14.30	15.17	0.87	0.001*
15–15.9	15.02	15.56	0.54	0.000*

*$p < 0.05$; CA, chronological age; DA, dental age (years).

Results

The paired *t*-test showed no statistically significant differences between the two readings, indicating diagnostic reproducibility. Table II [t]insert Table II shows the differences between the mean chronological ages and estimated mean DAs according to the Demirjian method. Both genders had an advanced DA, as compared with their CAs. The mean difference between the CAs and the DAs ranged from 0.10–0.76 years for males and statistically significant differences existed between the DAs and the CAs for all groups, except for subjects aged 10–10.9 years ($p < 0.05$). For females, the mean difference between the CAs and the DAs ranged from 0.28–0.87 years and these differences between the DAs and the CAs were statistically significant, except for subjects aged 11–11.9 years ($p < 0.05$).

Pearson correlation coefficients were used to assess the correlation between DA and CA. There was a strong correlation between chronological age and teeth mineralization for both females ($r^2 = 0.90$) and males ($r^2 = 0.91$). The scatter plots of DA vs CA for males and females according to the Demirjian method are presented in Figure 2.

Discussion

Teeth are useful for age estimation in forensic and legal dentistry. Dental maturity also provides useful information for diagnosis and treatment planning, especially for pedodontists and orthodontists [7,18]. There are several DA estimation methods that involve evaluating dental development along with the CA. The Demirjian method is one of the most simple, practical and widely employed methods for predicting age and dental maturation [19,20]. This method was developed for age estimation in French-Canadian individuals by Demirjian et al. [4]. Therefore, although the Demirjian method is precise, as well as the most practical one, its reliability is questionable for populations other than the original reference population [21,22]. There are variations in dental development among individuals and among different population groups as not all individuals of similar CA achieve

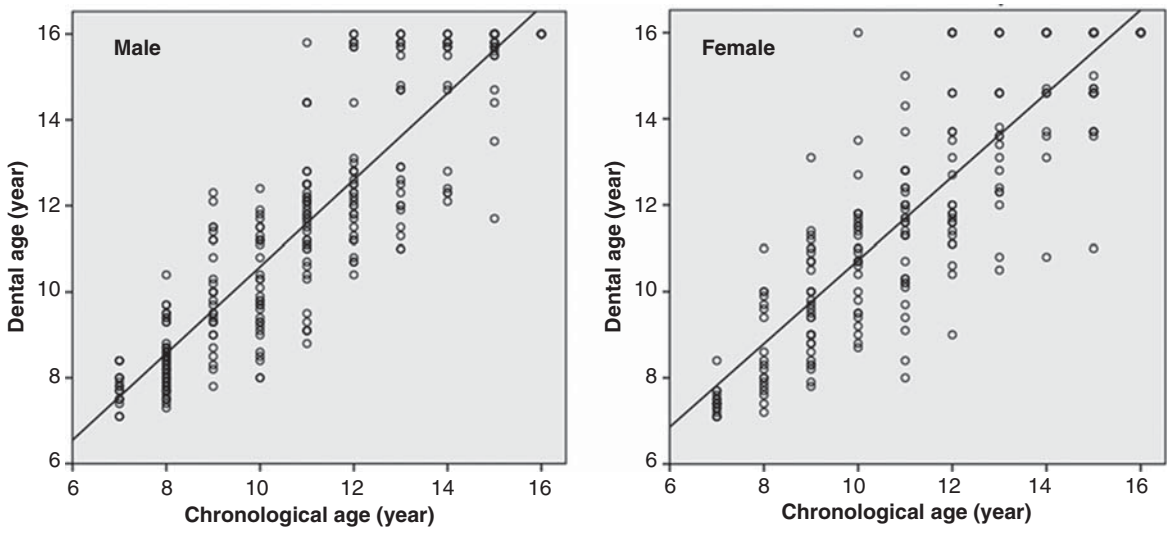

Figure 2. The scatter plot dental age according to the Demirjian method vs chronological age for males and females.

the same level of dental development. As the regional variations from this study demonstrate, it is necessary to adapt this method for use with local population [1,23]. For these reasons, we tested the suitability of applying the Demirjian method for DA estimation in western Turkish children.

Many studies were conducted in order to determine the applicability of the Demirjian method in particular populations [7,13,17,24–27]. In the current study, both genders had advanced DAs as compared with their CAs. The mean difference between the CAs and the DAs ranged from 0.10–0.87 years. Results from other studies that used the Demirjian method in various populations demonstrated an over-estimation of the DA; these studies showed the following results: 0.14–2.79 in a Serbian population [28]; 0.07–0.80 in a South Australian population [10]; 0.65 in a Brazilian population [11]; 0.3 for males and 0.4 for females in a Saudi Arabian population [12]; and 0.42–2.54 in a Malaysian population [29]; and −1 (in two age groups) to 1.3 in a Chinese population [30]. The reasons for these wide ranging results might be because of ethnic diversity, climate, nutrition, socio-economic level, sample size and statistical methods [8,31].

In our study, the mean difference between the DA and the CA ranged from 0.10–0.76 years for males and from 0.28–0.87 years for females. Previous studies conducted in Turkish populations found that the patients had advanced DAs and that the mean difference between the DA and the CA ranged as follows: from 0.36–1.43 years for males and from 0.50–1.44 years for females in northern Turkey [7], from 0.27–1.60 years for males and from 0.15–1.24 years for females in northeastern Turkey [17]; and from 0.4–1.3 years for males and from 0.2–1.9 for females for eastern Turkey [13]. These reports showed a more advanced dental maturity than our findings. These differences have been attributed to regional differences within the same country. The subjects involved in prior studies were of an eastern, a northeastern or a northern Turkish population; however, the subjects in the present study were of a western Turkish population. These regions have profound environmental and climatic differences.

It was also previously stated that sex differences do exist and need to be taken into consideration. Previous studies found that females show faster dental maturation than males [7,32,33]. In the present study, there were no differences between dental maturity in females and males, as the mean differences between the DA and the CA were 0.52 years for males and 0.56 years for females.

Conclusion

Western Turkish children have a more advanced dental maturity as compared with that of Demirjian's French-Canadian sample. Therefore, the Demirjian method is not suitable for western Turkish children. In addition, western Turkish children have a lower degree of dental maturity than that observed in eastern, northeastern and northern Turkish subjects.

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