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Dental age assessment: The applicability of Demirjian method in southwestern of eastern Anatolia region Turkish children

Orhan H. Karataş, DDS,[a] Fırat Öztürk, DDS, PhD,[a] Numan Dedeoğlu, DDS,[b] Cemil Çolak, DDS, PhD,[c] Oğuzhan Altun, DDS, PhD[b]

[a]Department of Orthodontics, Inonu University, Faculty of Dentistry, Malatya, Turkey.
[b]Department of Oral and Maxillofacial Radiology, Inonu University, Faculty of Dentistry, Malatya, Turkey.
[c]Assistant Professor, Department of Biostatistics, Inonu University, Faculty of Medicine, Malatya, Turkey.

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ABSTRACT

Objectives: Age estimation plays an important role in forensic medicine and orthodontics. Many methods of age estimation have been suggested. Demirjian method is the most frequently used one of these. In the literature, there is a little known about applicability of this method in Turkish children. The aim of the present study was to evaluate the reliability of Demirjian method of dental age estimaiton and for description of mandibular permanent tooth formation in Turkish children from the southwest Eastern Anatolia region.

Materials and Methods: A retrospective study was performed on 1015 panoramic radiographs and 5-15 years of age South western of Eastern Anatolia Regionof Turkish children. The stages of dental maturity of the mandibular left seven permanent teeth for each subject using the eight radiographic dental maturity stages demonstrated by Demirjian's method were evaluated. A pired t-test was used for statistical analysis.

Results: The mean difference between the chronological and dental ages ranged 0,28 to 1,10 years in boys and from 0,18 to 0,68 years in girls. South western of Eastern Anatolia Region of/Turkish children were generally delayed in dental maturity compared with children in Demirjian sample. The differences between the chronological and dental ages were statistically significant in 6-6.9, 8-8.9, 9-9.9, 10-10.9, 11-11.9 years in boys and in 8-8.9, 9-9.9,11-11.9 years in girls.

Conclusions: Turkish children from the southwest Eastern Anatolia region are significantly more delayed in dental maturity compared to Demirjian's French-Canadian sample. The applicability of Demirjian data is not suitable for Southwestern of Eastern Anatolia Region of Turkish children.

Keywords: forensic science, dental age, age estimation, Demirjian method, radiographs, dental maturity.

INTRODUCTION

In forensic medicine, pediatric endocrinology, clinic dentistry and physical anthropology, age estimation plays an important role. It helps us to know the variations in degree of maturation. Dental maturity, expressed as a dental age, and hand-wrist radiographs are the most commonly used age estimation methods.[1,2]

Orhan H. KARATAS
Inonu University, Faculty of Dentistry,
Department of Orthodontics,
44280, Malatya, Turkey.
e-mail: drorhanhakkikaratas@gmail.com

Especially pedodontists and orthodontists would like to know a child's growth, developmental status and dental age, which are particularly significant in diagnosis and treatment planning.[3,4] The estimate of dental development is one of the most trusted indicators of chorological age, and it is most widely used in forensic and legal dentistry, since teeth are less affected than other body tissues by endocrine diseases and environmental damage.[1,5]

Dental age and developing teeth of children can be measured in two ways: dental eruption and calcification as observed in radiographs. The second

method is considered better than the first, because tooth eruption occurs over a shorter period. It is a discontinuous and variable measurement affected by local factors such as lack of space and systemic factors such as malnutrition, causing premature loss of primary teeth, crowding and dental decay. On the other hand, dental calcification is seen as a better measurement, because it has a low coefficient of variation and environmental resistance factors.[4,6-8] Several methods of determining the dental age according to the degree of calcification of the permanent teeth as seen in radiographs have been described.[8-11]

Currently, one of the most well-known and widely used methods for estimating dental age is the Demirjian method, first described in 1973 and based on a large sample of French-Canadian children.[9,12] This method is based on eight calcification stages spanning from crown and root formation to apex closure of the seven left permanent mandibular teeth as shown in panoramic radiographs. The score of each stage is apportioned and the sum of the scores gives an estimation of the subject's dental maturity. The dental maturity score can be converted to dental age using the conversion tables and percentile curves for girls and boys that were provided by Demirjian et al. in their original study.[9] Various investigators have demonstrated differences between several ethnic groups[3,4,13], as well as between geographical areas or cities the same country.[13,14]

In the literature, little is known about the applicability of this method in Turkish children. To date, it was tested in a group of 900 northern[13], 419 northwestern[15], and 807 eastern[14] Turkish children.

The aim of this present study was:

1. To determine dental age from digital panoramic radiographs using the Demirjian method;

2. To test the accuracy of the Demirjian method for estimation of chronological age when applied to a group of Turkish boys and girls from the southwest Eastern Anatolia region.

MATERIALS AND METHODS

Subjects

In this retrospective study, digital panoramic radiographs and clinical records of 1015 Turkish children from the southwest Eastern Anatolia region of known chronological ages and gender were selected. In total, 516 males and 499 girls were included and their ages ranged from 5–15 years. The radiographs of healthy children were randomly selected from patients receiving dental care at the Inonu University Faculty of Dentistry and Department of Orthodontics in Malatya, Turkey. All subjects were divided into eleven groups, each corresponding to an age range. All digital radiographs were performed by using an orthopantomography device (Planmeca Proline XC 2009, 62 kVp, 5 mA, 17 sec exposure time; Helsinki, Finland). The distribution by age and gender of digital dental panoramic radiographs is given in Table 1. Children were excluded from the study if they exhibited agenesis of teeth, history of systemic or surgical disease that affected the presence and development of mandibular permanent teeth, poor quality of digital dental panoramic radiographs, or gross pathology. The chronological age was calculated for each subject by subtracting the date of the digital panoramic radiograph from date of birth after having converted both to a decimal age.

Dental age estimation

Dental age assessment was performed according to the Demirjian method. The method was based on the development of

Table 1. Distribution of age and gender in the study population.

Age (years)	Male	Female	Total(%)
5-5,9	16	22	38(3,7)
6-6,9	34	32	66(6,5)
7-7,9	56	62	118(11,6)
8-8,9	56	77	133(13,1)
9-9,9	79	65	144(14,2)
10-10,9	83	63	146(14,4)
11-11,9	49	61	110(10,8)
12-12,9	55	57	112(11)
13-13,9	36	50	86(8,5)
14-14,9	23	19	42(4,1)
15-15,9	12	8	20(2)
Total	499(49,1)	516(50,9)	1015(100)

the seven left permanent mandibular teeth. Tooth formation was rated on an eight-stage scale from A to H; criteria for stages were given for each tooth separately, in detailed written descriptions and supplementary illustrations. Each stage of seven teeth was allocated a score, and the sum of the scores provides an estimate of the patient's dental maturity, measured on a scale from 0–100. The overall maturity score of each patient was then converted to a dental age by using standard tables and/or percentile curves. Standards were given for each gender separately.

Assessment of the study sample

All digital radiographs were viewed on the same LCD monitor (ASUS VH192D, 300 cd/m2). The stages of the seven left mandibular permanent teeth were assessed at the same time from digital panoramic radiographs by two trained observers without knowledge of the patient's age and gender. . In case of discrepancies between two observers while assessing stages of teeth from digital panoramic radiographs, the lower developmental stage was always chosen. For each gender and age group in the present study sample,

Statistical analysis

The assumption of normal distribution was confirmed using the Shapiro Wilk test. A paired t-test was used for comparing the dental ages and chronological ages of the children.

In describing the formation of the mandibular permanent teeth, the same data were used. The mean and standard deviation was calculated separately for each stage of individual teeth for boys and for girls.

Reproducibility

To assess intra-observer reproducibility, 50 randomly selected digital radiographs were reassessed 1 month after the initial assessment by the second observer (DN). The percentage agreement between two readings was calculated by examining 50 radiographs of 350 teeth. The agreement of the two duplicate scores of the mineralization of 350 teeth was 98%. There was no significant difference between two readings ($p>0.05$). The difference between the two scores did not exceed one stage for any tooth.

Table 2. Differences between dental age determined by using the standards by Demirjian et al. and chronologic age.

Age Group(years)	Male							Female					
	n	Mean Difference (DA-CA)	SD	Min.	Max.	P		n	Mean Difference (DA-CA)	SD	Min.	Max.	P
5-5.9	16	-0.28	0.92	-0.78	0.20	0.73		22	0.18	1.46	-0.46	0.83	0.55
6-6.9	34	0.41	0.69	0.17	0.66	0.001		32	0.20	0.71	-0.05	0.46	0.11
7-7.9	56	-0.05	0.58	-0.21	0.10	0.48		62	0.68	0.66	-0.10	0.23	0.41
8-8.9	56	-0.30	0.58	-0.45	-0.14	<0.001		77	-0.36	0.72	-0.53	-0.20	<0.001
9-9.9	79	-0.47	0.92	-0.68	-0.27	<0.001		65	-0.45	0.98	-0.69	-0.20	<0.001
10-10.9	83	-1.10	1.07	-1.33	-0.86	<0.001		63	-0.51	1.35	-0.85	-0.17	0.004
11-11.9	49	-0.61	1.25	-0.97	-0.25	0.001		61	-0.53	1.12	-0.82	-0.24	<0.001
12-12.9	55	-0.45	1.58	-0.87	-0.02	0.4		57	-0.16	1.06	-0.44	0.12	0.25
13-13.9	36	-0.47	1.57	-0.99	0.02	0.64		50	-0.33	1.39	-0.73	0.06	0.96
14-14.9	23	-0.47	1.44	-1.10	0.14	0.12		19	-0.34	1.20	-0.92	0.23	0.22
15-15.9	12	-0.71	1.46	-1.64	0.21	0.11		8	-0.22	0.88	-0.96	0.51	0.49
DA: dental age; CA: chronologic age													

RESULTS

Table 1 shows the distribution of the girls and boys into different age groups: 499 (49.1%) were boys and 516 (50.9%) girls. Differences between the mean chronological ages and estimated dental ages according to the Demirjian method are presented in Table 2. Both genders were found to be delayed in dental maturity when compared with the reference samples except 5–5.9, 6–6.9 and 7–7.9 years in girls and 6–6.9 years in boys. The mean difference between the chronological and dental ages ranged from 0.28–1.10 years in boys and from 0.18–0.68 years in girls. The differences between the chronological and dental ages were statistically significant at 6–6.9, 8–8.9, 9– 9.9, 10–10.9, 11–11.9 years in boys and in 8–8.9, 9–9.9, and11–11.9 years in girls. The least differences between the chronological and estimated dental ages were observed in the 7–7.9 year age group in boys and the 5–5.9 year age group in girls. Descriptive statistics (mean and standard deviation) for individual stages of each tooth are shown in Tables 3 and 4. Nearly all the mean ages of attainment of tooth developmental stages were earlier in girls as compared to boys.

DISCUSSION

It is of great value to assess the growth and development of children from medical,

dental and odontologic points of view.[9,16] Tooth formation is widely used to evaluate and calibrate growth and maturity.[6] Several methods exist that allow either the prediction of age or an assessment of maturation.[1,10,15,17] The Demirjian method is one of the simplest, most practical, and widely used methods to predict age and maturation.[17,18] Also, Demirjian's standard charts are an attempt to provide an international means of evaluating the dental maturity for children.[15] Various studies have modified this method to apply it to other populations, showing a huge variability in the dental maturation process.[1,13,17] The investigations using the Demirjian method on s everal ethnic and geographical groups showed some changes in dental formation.[3,4,15,19-21]

Table 3. Mean and standard deviation for the mineralization stages of mandibular permanent teeth for boys.

Tooth	A	B	C	D	E	F	G	H
I1			5	5.78 (0.80)	6.62 (0.76)	7.47 (1.06)	9.21 (1.41)	11.68 (1.82)
I2			5	6.02 (0.82)	7.21 (0.97)	8.31 (1.36)	9.89 (1.36)	12.34 (1.58)
C			6.24 (1.78)	7.35 (1.14)	8.71 (1.33)	10.49 (1.21)	12.58 (1.39)	13.35 (1.69)
P1	5.1	6.50 (1.75)	7.68 (1.28)	9.21 (1.16)	11.00 (1.31)	11.87 (1.24)	13.58 (1.07)	10.08 (2.40)
P2	5.03 (0.57)	5.60 (0.68)	7.24 (1.51)	8.42 (1.39)	9.91 (1.43)	11.4 (1.25)	12.97 (1.11)	13.92 (1.54)
M1	5.60	5.73	5.82 (1.65)	6.08 (0.74)	7.45 (1.01)	9.50 (1.48)	12.13 (1.66)	12.1 (1.66)
M2	5.96 (1.58)	6.22 (1.14)	7.36 (1.08)	8.87 (1.23)	10.27 (1.33)	11.83 (1.32)	13.34 (1.32)	14.12 (1.05)

Table 4. Mean and standard deviation for the mineralization stages of mandibular permanent teeth for girls.

Tooth	A	B	C	D	E	F	G	H
I1				5.76(0.99)	6.64(1.18)	7.48(1.34)	8.81(1.59)	11.49(1.80)
I2			5	5.75(0.81)	6.91(0.87)	8.02(1.27)	9.59(1.60)	12.01(1.60)
C		6.58	5.55(0.81)	6.78(1.13)	7.98(1.13)	9.58(1.34)	11.93(1.33)	1305(1.36)
P1			6.45(2.07)	7.37(1.42)	8.70(1.22)	10.35(1.16)	11.58(1.30)	13.23(1.07)
P2		5.93(1.07)	6.86(2.15)	7.85(1.01)	9.46(1.45)	11.22(1.30)	12.63(1.11)	13.75(1.21)
M1			6.20	6.35(1.20)	6.76(0.99)	7.15(1.19)	8.91(1.43)	11.8(1.65)
M2		5.76(0.74)	7.22(1.14)	8.48(1.40)	10.16(1.37)	11.4(1.20)	12.85(1.24)	14.09(1.20)

For that reason, the aim of this study was to appraise the suitability of the Demirjian method for assessing dental maturation in Turkish children from the southwest Eastern Anatolia region. This information helps us in comparing the status of dental maturity of our population with those of other populations, which were previously tested. This information shows the necessity of creating representative databases for each population to reach a better comprehension of human dental maturation.[13] Tunc and Koyuturk[13] and Celikoglu et al.[14] noted differences between geographical areas or cities within the same country. However, such research had not yet been conducted in the southwest Eastern Anatolia Region.
For this reason, the aim of this study was to assess the applicability of the Demirjian method for the Turkish population in the southwest Eastern Anatolia region and thus compare the dental maturity of the study population with that of that of other populations.

Tunc and Koyuturk[13] showed that the mean differences between the chronological and dental ages in the northern Turkish population ranged from 0.5–1.4 years in girls and from 0.4–1.4 years in boys. The mean difference between the dental age and the chronologic age ranged from 0.28–1.10 years in the boys and from 0.18–0.68 years in the girls in the present study.

The greatest mean difference was 1.10 years, compared with 0.73 years[13], 1.9 years[14] and 1.4 years[15] reported in different parts of Turkey. This difference has been attributed to both regional differences within the same country and the sample size.[4]

Comparison of results for Turkish children from the southwest Eastern Anatolia region and the French-Canadian reference sample in the present study showed that the Turkish children from the southwest Eastern Anatolia region revealed a more delayed dental age. In contrast to other reports[13-15] published on Turkish populations, our study showed significantly delayed dental maturity. This controversy may be due to difference in genetic, environmental, nutritional and geographical factors.

A common finding in reports published on different populations is that the Demirjian method for dental age estimation does not accurately estimate the dental age of the examined subjects. Although some reports[22,23] showed an underestimation of the dental age, others [3,4,11,13,19,22] reported overestimation of dental age. In the present study, the use of the Demirjian method for dental age estimation led to an underestimation of the dental development of Turkish children from the southwest Eastern Anatolia region. As a group, this study population is dentally delayed by 0.38 years, compared to French-Canadian standards. The mean delay in girls was 0.33 years and in boys 0.48 years. The mean difference was greater in the Swedish sample[11] The Swedish girls differed by 0.5–1.8 years and the boys by 0.4–1.8 years. But then, the mean difference for Dutch boys was 0.4 years and for girls 0.6 years.[24] In the sample of Norwegian children, the mean difference was smaller; it was 0.2 years for boys and 0.3 years for girls.[25] The differences between the chronological and dental ages were statistically significant at 6–6.9, 8–8.9, 9–9.9, 10–10.9, and 11–11.9 years in boys and at 8–8.9, 9–9.9, and 11–11.9 years in girls.

Girls and boys both indicated delayed dental development except at 5–5.9, 6–6.9 and 7–7.9 years in girls and 6–6.9 years in boys. In addition, girls indicated more advanced dental development in all groups and reached dental age maturation earlier than did boys. This finding was in accordance with earlier maturation of girls measured by other parameters of

development such as height, sexual maturation and skeletal age.[26,27]

One must remember that any difference found between the standard population and the sample population can be attributed to many variables, including precision of the method, age structure of the sample, sample size, statistical approach and biological variation of individual children.[4] The interpretation of results from differing dental growth standards is hindered by these factors. This is overcome by direct comparison[21] or by calculating age-of-attainment data for each group.[28] For this reason, the other aim of this study was to describe the chronology of mandibular permanent teeth mineralization in Turkish children from the southwest Eastern Anatolia region. Tooth development is a continuous process, but determining the end point of tooth development is very difficult. Thus, the calculation of a mean age for each stage is difficult. On this note, further research is needed to determine the apex closure stage of teeth.

CONCLUSION

Turkish children from the southwest Eastern Anatolia region are significantly more delayed in dental maturity compared to Demirjian's French-Canadian sample. In contrast to other studies, the results obtained in this study, the dental age was smaller than the chronological age. The Demirjian data thus is not suitable for Turkish children from the southwest Eastern Anatolia region. This evidence supports the need for population-specific standards. Each population of children needs its own specific standard for accurate estimation of chronological age. In all age groups, further study involving more cases is required.

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