DENTAL AGE ASSESSMENT USING DEMIRJIAN'S METHOD – A RADIOGRAPHIC STUDY

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Abstract

Dental age estimation on panoramic X-rays is very useful for pediatric dentists and orthodontists in choosing a treatment plan, without the need for any additional radiographic investigation. The aim of this study was to compare chronological and dental age using Demirjian's method on children from Central Romania. The study was conducted on X-rays of 285 children aged between 6-13 years. Dental age was determined based on the degree of mineralisation of the seven left mandibular teeth, and t-tests were used to assess the difference between dental age and chronological age within each age category. Dental age was more advanced in girls in almost all age groups, whereas in boys just the 6-7 and 8-9 age groups presented a more advanced dental age. The results of our study show that Demirjian's method has some limitations for a Romanian population, and that these standards are applicable only in certain age groups. Further research is required on a larger sample.

Keywords: Dental age, Demirjian's method, radiographic assessment, chronological age, children

Introduction

Correct age estimation based on dental records is very important and useful in a broad range of different fields, including pediatric dentistry,

orthodontics, forensic medicine, pediatric endocrinology, orthopedics, and anthropological studies (Schmeling, Geserick, 2007; Rizig, 2013; Esenlik et al., 2014).

The concept of physiological age is based on the degree of maturation of different tissue systems. Different categories of biological age have been established: skeletal age, morphological age, secondary sexual character age and dental age (Demirjian, Goldstein, 1973). However, significant individual variability makes chronological age a poor indicator of skeletal maturity (Bhanat, Patel, 2013).

Dental age assessment (DAA) is important for pediatric dentists and orthodontists in planning and timing treatment, and selecting the appropriate orthodontic appliance (Bhanat, Patel, 2013). It is essential to start treatment in the optimal growth stage (pubertal growth spurt) in order to achieve ideal correction of skeletal discrepancies, use extraoral tractions and functional appliances, and correctly schedule orthognathic surgery (Bhanat, Patel, 2013; Saranya, Junaid, 2013).

Dental age can be assessed by observing the timing of eruption and the degree of mineralisation of the developing teeth from radiographs (Nakas et al., 2013). Tooth calcification is a more reliable indicator of dental maturity than eruption (gingival emergence) because it is not affected by local factors such as loss of primary teeth, lack of space, malnutrition, dental decays, ankylosis, or orthodontic anomalies, and is instead much more genetically determined (Demirjian, Goldstein, 1973; Shakuntala et al., 2011; Ogodescu et al., 2011). Many authors have developed scoring methods in order to asses dental age using dental calcification stages of permanent teeth, including Demirjian, Nolla, Goldstein, and Van der Linden (Demirjian, Goldstein, 1973; Ogodescu et al., 2011; Nolla et al., 1960; Prahl-Andersen et al., 1972). The most widely used dental maturity scaling system is the method developed by Demirjian in 1973 on a sample of French-Canadian children (Demirjian, Goldstein, 1973). Due to its accuracy and feasibility in a developmental sample we chose this method for our study.

Material and methods

We conducted a cross-sectional retrospective study on a sample of 285 panoramic X-rays (Figure 1). The study protocol was approved by the ethics committee of the University of Medicine and Pharmacy of Târgu Mureş (UMF). The study sample was composed of records of patients referred to the Orthodontics Department from UMF and from five local private practices.

The main objective of the study was to compare the chronological age and the dental age as assessed from X-rays using the Demirjian method, in children aged between six and thirteen years. Our study also aimed to test

the applicability of Demirjian's method on children from Central Romania, to create a database for Romanian children, to compare results with other European countries and to determine differences between boys and girls regarding dental development.

Patient selection

Inclusion criteria

- Availability of complete patient records (date of birth, date of X-ray)
- Age between 6-13 years
- No systemic disease affecting growth
- No history of orthodontic treatment
- Good quality of the radiographs
- No abnormal dental conditions (e.g. impactation, congenitally missing teeth, etc.)

Exclusion criteria

- Patients with orthodontic appliances
- Incomplete patient records
- History of extractions

All X-rays were rated by one examiner with no knowledge of the patients' age. To control for intra-observer reliability, a number of 50 radiographs were reexamined after one month. No significant differences were found between the two readings and the differences did not exceed one developmental stage.

Dental age was judged based on the degree of maturation of the seven left mandibular teeth, excluding the third molar. Every tooth was assigned a rating from "A" to "H" (Figure 2). The eight developmental stages are described in Figure 3. Stages were subsequently converted to scores by using conversion tables specific to gender. The scores for each tooth were then added, resulting in a total maturity score, which was then transformed into dental age using standard tables given for each gender separately.

Dental formation stages according to Demirjian are as follows (Demirjian, Goldstein, 1973):

Stage A: In both uniradicular and multiradicular teeth, a beginning of calcification is seen at the superior level of the crypt in the form of an inverted cone or cones. No fusion of these calcification points is observed.

Stage B: Fusion of calcified points forms one or several cusps which unite to give a regularly outlined occlusal surface.

Stage C: Enamel formation is complete at the occlusal surface, dentine deposition has started and the pulp chamber has a curved shape at the occlusal border.

Stage D: Crown formation is complete, extending down to the cemento-enamel junction. Beginning of root formation is seen in the form of a spicule.

Stage E: The walls of the pulp chamber form straight lines. The root length is less than the crown height. In molars the formation of the radicular bifurcation is seen like a calcified point or a semi-lunar shape.

Stage F: The walls of the pulp chamber form an isosceles triangle. The apex ends in a funnel shape. The root length is equal to or greater than the crown height.

Stage G: The walls of the root canal are parallel and the apical end is still partially open.

Stage H: The apical end of the root is completely closed and the periodontal membrane has a uniform width around the tooth apex.

Chronological age for each patient was calculated by subtracting the date of birth from the date when the radiograph was taken.

Figure 1: Sample distribition by gender

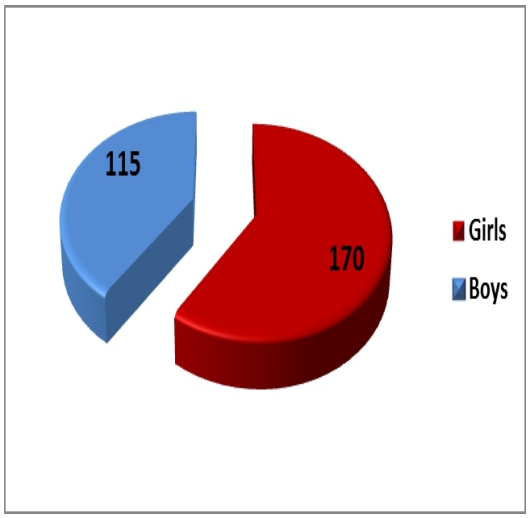


Figure 3: Dental stages according to Demirjian

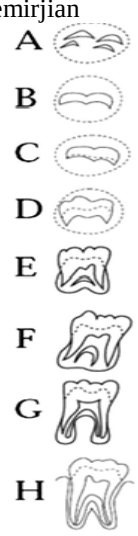
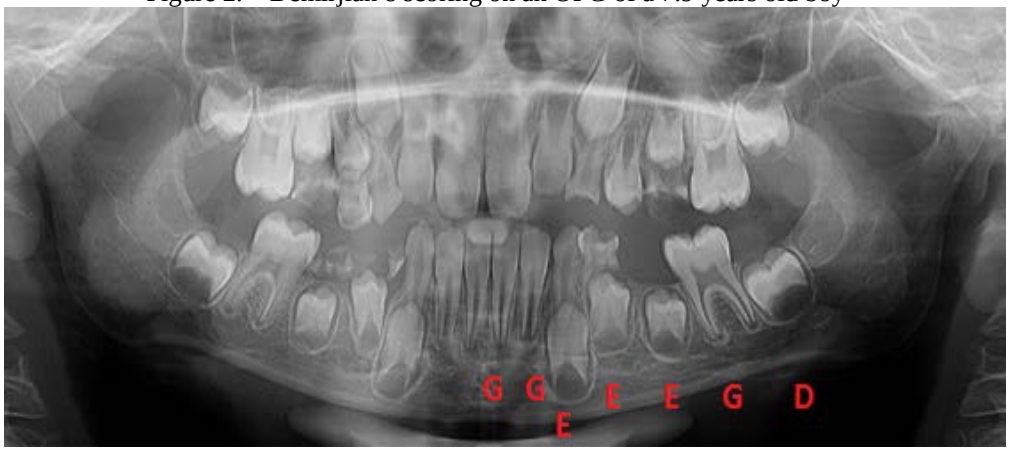


Figure 2. Demirjian's scoring on an OPG of a 7.9 years old boy



Results

The study sample was divided into four age groups (6-7 years, 8-9 years, 10-11 years and 12-13 years) and two gender groups (boys, girls). T-tests were used to assess the difference between dental and chronological age in each group, as shown in tables 1 and 2. There were no significant differences between the two age categories when the whole sample was analysed (p=0.583). Statistically significant differences were found in the following groups: girls in the age group 6-7 years (p<0.0001), and boys in the age groups 6-7 years (p<0.0001) and 12-13 years (p=0.0071).

The dental age in girls was more advanced in all age groups except in the 12-13 years group. In boys, the age groups 6-7 years and 8-9 years presented a more advanced dental age, whereas in the older age groups 10-11 and 12-13 years, chronological age was ahead of dental age.

Table 1: Comparison between chronological and dental age in boys

Boys	**Nr. of Patients**	**Mean Chronological Age**	**Mean Dental Age**	**Mean Difference**	**Dispersion of Chronological Age**	**Dispersion ofDental Agep**	
6 -7 years	29	7.424	**7.986**	0.562	0.418	0.4962	**<0.0001**
8 - 9 years	40	9.085	**9.145**	0.06	0.594	0.8009	0.6018
10 - 11 years	30	**10.915**	10.76	-0.155	0.488	1.2221	0.5151
12 - 13 years	16	**12.613**	11.375	-1.238	0.420	1.6262	**0.0071**
Total	**115**						

Table 2: Comparison between chronological and dental age in girls

Girls	Nr. of Patients	Mean Chronological Age	Mean Dental Age	Mean Difference	Dispersion of Chronological Age	Dispersion ofDental Age	p
6 -7 years	28	7.051	**7.736**	0.685	0.512	0.5546	**<0.0001**
8 - 9 years	62	8.836	**8.881**	0.045	0.609	0.7752	0.6009
10 - 11 years	50	10.901	**10.972**	0.071	0.619	1.5117	0.6877
12 - 13 years	30	13.02	12.687	-0.333	0.709	1.0686	0.1045
Total	**170**						

Pearson's correlations revealed strong positive associations between dental and chronological age in the 8-9 years and 10-11 years groups in girls ($p<0.0001$) and in the 6-7 years group ($p=0.0361$) and 8-9 years group ($p=0.0011$) in boys (Figure 4; Table 3, Table 4).

Figure 4: Scatter Plot between Chronological Age and Dental Age

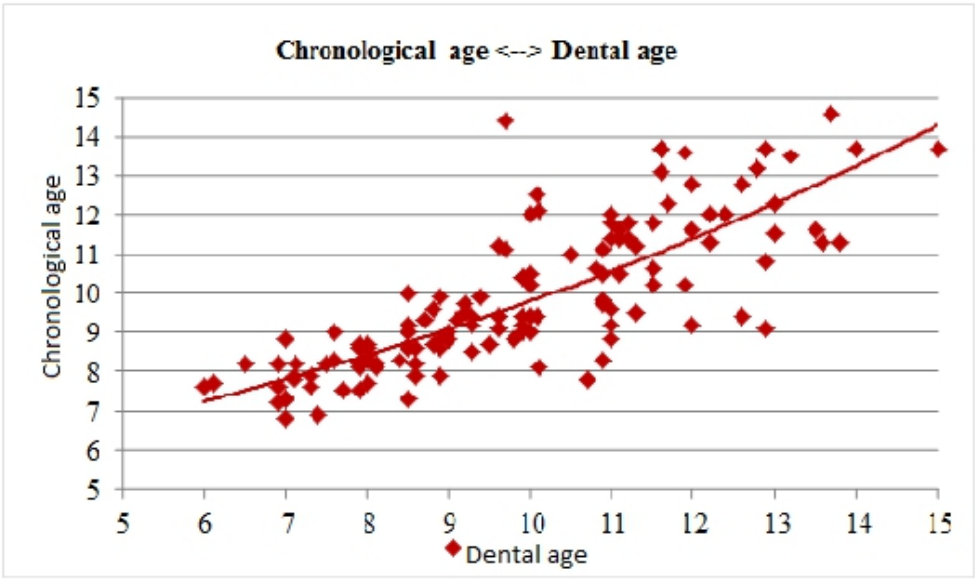


Table 3: Pearson's correlations between chronological age and dental an girls

Girls	rp
6-7 years	0.10430.5974
8-9 years	0.5516<**0.0001**
10-11 years	0.5974<**0.0001**
12-13 years	0.30220.1045

Table 4: Pearson's correlations between chronological age and dental age in boys

Boys	**rp**
6-7 years	**0.39070.0361**
8-9 years	**0.49810.0011**
10-11 years	0.06670.7262
12-13 years	0.21280.4288

Discussion

Many studies have investigated the accuracy of Demirjian's method and their results vary. Some authors found that Demirjian's method was accurate on the studied population (Bagherpour et al., 2010; Hedge et al., 2002; Baghdadi et al., 2012) while others highlighted various limitations of the method (Nik-Hussein et al., 2011; Cruz-Landeira et al., 2010).

When compared to Demirjan's French-Canadian standards, the girls in our study were more advanced in all age groups except the girls between the ages of 12 and 13 years, while boys' dental ages were ahead only in the age groups 6-7 years and 8-9 years.

Our results are somewhat similar to those of other authors from Romania, who found that Demirjian's standards are suitable for almost all age groups (Ogodescu et al., 2011). In Ogodescu's study, girls presented a significantly more advanced dental age in the groups 5.5 - 6.4 years and 11.5 - 14.4 years, whereas in our study a significantly increased dental age was found in the 6-7 years group. In boys, Ogodescu found an advanced chronological age in most age groups except the groups of lowest (5.5-6.4 years, 6.6-7.4 years) and highest (13.5-14.4 years) ages, while our study showed an increased chronological age only in the higher age groups (10- 11 years, 12-13 years).

We compared our results with the results of studies conducted in other countries on Caucasian samples, as well as studies with Indian and Black samples. There are several studies in which the dental age was less advanced than the chronological age. When compared to Dermijian's standard values, a study on Turkish children from the Anatolia Region showed a delayed dental age by -0.38 years in the whole group, 0.33 years in girls and -0.48 years in boys (Karatas et al., 2012). In a sample of Dutch children, Leurs revealed that the dental age was lower than the chronological age by -0.6 years in girls and 0.4 years in boys (Leurs et al., 2005). Similar results of a delayed dental age were reported in India by Hedge (-0.04 years in girls and -0.14 years in boys) and Serene Koshy (-2.82 years in girls and -3.04 years in boys) (Hedge et al., 2002; Serene Koshy et al., 1998). In a study conducted on Sudanese children, Rizig found an underestimation of age (1.42 years in girls and 0.70 years in boys) (Rizig, 2013).

Studies in which dental age was more advanced than the chronological age were mostly from Nordic countries. In Sweden, Mornstad

found differences between randing between 0.4 and 1.8 years in boys and between 0.5 and 1.8 years in girls (Mornstad et al., 1995). Nykanen revealed that in a sample from Norway, dental age was ahead by 0.2 years in boys and 0.3 years in girls, while in Finland Nystrom found a difference of 0.7 years in boys and 0.9 years in girls (Niknen et al., 1998; Nystrom et al., 1986). Comparable results were obtained by Rozylo-Kalinowska in Poland where both girls and boys were more advanced than French-Canadian children (Rozylo-Kalinowska et al., 2008).

The differences observed in the various studies between dental maturity and chronologic age as measured by the Dermijan method can be due to the variability of the sample structure regarding its size, the age, sex, ethnicity, nationality, socio-economic status and/or nutrition of patients, the statistical analysis method used and/or the examiner's subjectivity (Rizig, 2013; Hedge et al., 2002).

Conclusion

The results of our study show that Demirjian's method has some limitations for a Romanian population. Demirjian's standards appear to be applicable for Romanian children only in certain age groups. Girls showed a more advanced dental maturity in all age groups except the age group 12-13 years. In contrast, dental age of boys was ahead only in lower age groups (6-7 years, 8-9 years). The results suggest the necessity for new population-specific standards. Further research is required on a larger sample for all age groups.

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