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Dental age assessment in orthodontic patients with and without skeletal malocclusions

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Structured Abstract

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Background – The aim of this report was to investigate the dental development in an orthodontic patient population with and without different sagittal skeletal malocclusions.

Setting and Sample Population – Department of Orthodontics, Faculty of Dentistry, Ataturk University, Turkey.

Material and Methods – A retrospective study was performed on a sample of panoramic radiographs taken from 525 orthodontic patients (Class II: 186, Class III: 177, Class I: 162) aged between 9.00 and 15.00 years. Dental age (DA) from panoramic radiographs was assessed. Statistical analyses showing the differences between chronological age (CA) and DA were compared by using the one-way ANOVA, paired, and Student's t-tests.

Results – Both genders were advanced in dental maturity when compared with the reference samples ($p = 0.000$). The mean difference between CA and DA in orthodontic patients with different skeletal malocclusions was approximately twice the difference in the Class I group. However, the difference between CA and DA was statistically significant for girls in Class III group ($p = 0.021$).

Conclusion – The results of this study showed that DA of patients with sagittal skeletal malocclusions was approximately twice more advanced when compared with patients without sagittal skeletal anomaly patterns.

Key words: Demirjian's method; dental age; malocclusions; orthodontics

Introduction

In archeology and forensic odontology, age estimation methods can aid to the age identification of a deceased child. They have also been proven valuable when birth data are lacking or doubted in the management of immigration to help to determine physiologic age (1, 2). Additionally, it is of particular interest to the pedodontist and orthodontist as information aids in diagnosis and treatment planning (2, 3).

The dental age (DA) of the children can be determined by dental eruption and calcification as observed on radiographs. Dental calcification is considered to be more reliable for DA estimation than dental eruption, because dental eruption is discontinuous and influenced by

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various factors such as malnutrition, crowding, extractions, ankylosis, ectopic eruption, and persistence of the primary tooth (4, 5). Several methods for the determination of DA have been described and one widely used method is that of Demirjian et al. (6), first described in 1973 and based on a large number of French-Canadian children. Hägg and Mattson (7) have found a high precision and accuracy with Demirjian's method when applied to younger age groups rather than older age groups.

Although reports suggesting accurate techniques for age estimation have been widely published over the past two decades, most of these studies have been performed exclusively in the general population, not considering the effects of different skeletal malocclusions on dental maturity. Thus, little is known about the applicability of this method in subjects with different skeletal malocclusions of the jaws. Only Janson et al. (8) and Jamroz et al. (9) evaluated the DA in subjects with short and long faces. The background of the present study was that different skeletal development of the jaws might affect the dental development. The aim of this report was therefore to investigate the dental development in orthodontic patients with and without different sagittal skeletal malocclusions of the jaws.

Material and methods

A retrospective study was performed on a sample of 525 orthodontic patients aged between 9.00 and 15.00 years (Fig. 1). The Local Ethical Board agreed on the study because it had a retrospective investigation. For all patients, panoramic X-rays and lateral cephalograms were available. The lateral cephalograms were traced, and the anterior–posterior skeletal relationship of the maxilla and mandible was classified as skeletal Class I, II, and III using the value for the ANB angle (Class I: ANB angle between 0° and 4°; Class II: ANB > 4°; Class III: ANB < 0°). Of them, 186 patients were skeletal Class II, while 177 patients were skeletal Class III; 162 patients with skeletal Class I were also used as control group. Skeletal Class II subjects were characterized with maxillary protrusion and/or mandibular retrusion and Class III subjects with mandibular prognathism and/or maxillary retrusion. The subjects in the Class I group were not characterized with any of the sagittal skeletal anomalies (with minor crowding or spacing).

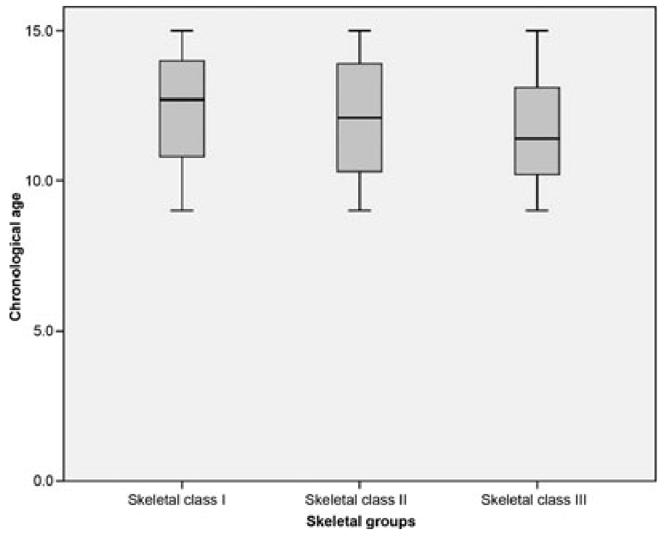

Fig. 1. The distribution of the chronological ages among the skeletal groups.

The radiographs of the children, taken as part of their routine orthodontic treatment, were randomly selected from the data of the subjects attending the Department of Orthodontics, Faculty of Dentistry of the Ataturk University from January 2003 to January 2009. Data of 23 children (9: Class III, 8: Class II, and 6: Class I) were excluded from this report because of the following reasons: agenesis of teeth, systemic diseases affecting the growth and development of the teeth, poor quality of panoramic radiographs, or image deformity affecting mandibular permanent teeth. Finally, this investigation was performed in 525 orthodontic patients with different skeletal malocclusions described earlier. All radiographs were performed by an X-ray technician using a panoramic device (Planmeca Proline CC 2002, 60–80 kVp, 8–10 mA, 12.8 s exposure time, Helsinki, Finland) with a magnification factor of 1.2.

All assessments were performed by one investigator in a darkened room with a radiographic illuminator to ensure contrast enhancement of tooth images. To avoid observer bias, each panoramic radiograph was coded with a number and thus the observer was blinded for the gender and skeletal pattern of the child. The chronological age of the patient was calculated by subtracting his or her birth date from the date on which panoramic radiographs were obtained after having converted both to a decimal age. The stages of dental maturity of the mandibular left seven permanent teeth for each subject were evaluated by using the eight radiographic dental maturity stages demonstrated by Demirjian et al. (6). Each stage of the seven mandibular teeth was allocated a biologically weighted score, and the sum of the scores provided an estimate of the dental maturity, measured on a scale from 0 to 100. The overall maturity score was then converted to a DA.

Statistical analysis

To assess the intra-observer reliability, 53 randomly selected panoramic radiographs were re-evaluated 4 weeks after the first examination by the same investigator. The difference between the two readings was tested for significance with paired *t*-test. To determine the errors associated with digitizing and measurements, 15 radiographs were selected randomly. All procedures such as landmark identification, tracing, and measurement were repeated 2 weeks later by the same author. Intraclass correlation coefficients were performed to assess the reliability of the measurements as described by Houston (10). Besides, the mean differences between the DA and chronological age (CA) of the subjects in each group were tested by means of paired *t*-test. On the other hand, the mean differences between the DA and CA of the subject in different skeletal malocclusions were calculated. The comparisons between the groups were made by means of the Student's *t*-test and one-way ANOVA test. All statistical analyses were performed using the SPSS software package program (SPSS for Windows 98, version 10.0, SPSS Inc, Chicago, Ill).

Results

Repeated evaluating of a subsample of 53 randomly selected panoramic radiographs indicated no significant intra-observer difference ($p > 0.05$). The percentage agreement at the second reading of stage assessments in a total 371 teeth was 89%. Additionally, the coefficients of reliability of the measurements (ANB angle) were above 0.90 for all parameters. Table 1 shows the distribution of the girls and the boys into different skeletal malocclusion groups: 269 (51.2%) were girls and 256 (48.8%) were boys. Comparison of the mean chronological ages in patients with different skeletal malocclusion patterns showed that there were no statistically significant differences in the distribution of the chronological ages among three skeletal classes ($p > 0.05$) (by means of one-way ANOVA).

***Table 1.* The distribution of the subjects with different skeletal malocclusions**

Malocclusion pattern	Girls (%)	Boys (%)	Total (%)
Class I	85 (52.5)	77 (47.5)	162 (30.9)
Class II	91 (48.9)	95 (51.1)	186 (35.4)
Class III	93 (52.5)	84 (47.5)	177 (33.7)
Total (%)	269 (51.2)	256 (48.8)	525 (100)

Both genders were advanced in dental maturity as compared with the reference samples of French-Canadian children. The differences between the CA and DA were statistically significant for both genders ($p = 0.000$). The mean difference between the CA and DA for orthodontic patients without skeletal malocclusion, the Class I group, was 0.63 years for girls and 0.58 years for boys. The mean difference between CA and DA in orthodontic patients with different skeletal malocclusions was approximately twice more than the mean difference in the Class I group. For girls, the difference in the Class II and Class III malocclusion groups was 1.08 and 1.38 years, respectively; for boys, it was 1.10 and 1.15 years, respectively (Table 2). On the other hand, when the data of girls and boys with all skeletal classes were pooled, the difference between CA and DA for girls was very close to the data found for boys with no statistical difference ($p > 0.05$).

Table 3 shows the statistical comparison of the mean differences in patients with different skeletal malocclusion patterns for both girls and boys. The mean difference for girls in the Class III group was statistically significant when compared with the Class I group ($p = 0.021$).

Discussion

Dental development is an important indicator of disturbances during odontogenesis and factors such as trauma, systemic diseases, malnutrition, chemotherapy, and radiation therapy can affect the teeth at any phase prior to their complete formation and calcification (4, 11, 12). Additionally, Garn et al. (11) stated that genes, hormones, and calories play a role in dental development.

Janson et al. (8) indicated that subjects with a long face have in principle a dental maturation advanced by 6 months when compared with the short-face subject.

***Table 2.* Descriptive data and statistical analyses showing the differences among skeletal groups for girls and boys**

Gender	Group	Chronological age	Dental age	Mean difference	P1	P2
Girls	Class I	13.01	13.64	0.63	0.000	0.285
	Class II	12.39	13.47	1.08	0.000	
	Class III	11.39	12.77	1.38	0.000	
	Total	12.30	13.32	1.02	0.000	
Boys	Class I	12.59	13.17	0.58	0.000	0.887
	Class II	12.75	13.85	1.10	0.000	
	Class III	12.45	13.60	1.15	0.000	
	Total	12.59	13.57	0.98	0.000	
Total		12.51	13.51	1.00	0.000	

P1: Results of the paired *t*-test comparing the difference between chronological and dental ages.
P2: Results of the one-way ANOVA test comparing the chronological age among the skeletal groups for girls and boys.

***Table 3.* Statistical comparison of the mean differences in patients with different skeletal malocclusion patterns**

	p value for Student's *t*-test		
Mean differences between groups	Girls	Boys	Total
Class I and Class II Groups	0.154	0.215	0.056
Class I and Class III Groups	0.021	0.155	0.008

However, the sample included in his study was rather small, and the two extreme groups were overlapping each other, which might have obscured the results. Jamroz et al. (9) found this difference between long and short-face subjects not to be statistically significant. The reports evaluating the effects of skeletal anomalies of the jaws are limited in the literature.

Although several methods (2, 13–17) for the determination of DA have been described in the literature, some of these methods identify a large number of stages that are difficult to delimit from one another. The method of Demirjian (6) distinguishes only four stages of crown development and four stages of root development and uses no numeric identification so as not to imply that the different stages represent processes of the same duration. All the stages are defined by changes of shape. Tunc and Koyuturk (18) also concluded that this method shows a strong linear correlation between dental and chronologic ages for males (r^2 = 0.78) and for females (r^2 = 0.77). Additionally, Orhan et al. (19) stated that this method is one of the simplest, practical, and widely used methods. Therefore, this method of DA estimation was selected for the present study.

This study revealed that an orthodontic population showed a more advanced DA compared to the general populations as presented by many authors who also obtained overestimation of DA in their populations when using this method (2, 18, 20, 21). Maber et al. (2) and Liversidge et al. (20) believed that the overestimation in DA in recent reports using Demirjian method might be explained by a positive secular trend in growth and development during the last 25 years.

The results of the present study showed that orthodontic patients with skeletal anomalies of the jaws were dentally advanced compared to the orthodontic patients without skeletal anomaly. This difference was the highest for the subjects characterized with mandibular prognathism for both girls and boys. However, this difference was statistically significant only for the girls (p = 0.021). It was also previously stated that sex differences do exist and need to be taken into account. With most maturational events, the tempo of maturation is faster in girls (13). Additionally, a recent study (21) investigating the applicability of Demirjian method in eastern Turkish children showed that eastern Turkish children were dentally advanced when compared to French-Canadian standards by 1.0 year. The mean difference found in females was 1.1 year and in males 0.9 year. In this study, the mean difference between the CA and DA for orthodontic patients without sagittal skeletal malocclusion, the Class I group, was 0.63 and 0.58 years for girls and boys, respectively. This difference might be because of the sample differences used in both studies. The authors performed their study on a sample of 807 healthy eastern Turkish children aged between 7.00 and 15.00 years. However, we investigated the dental development in 525 orthodontic patients with and without different sagittal skeletal malocclusions of the jaws aged between 9.00 and 15.00 years. Additionally, this report showed that orthodontic patients with sagittal skeletal anomalies were more advanced in dental maturity when compared with the reference samples than for both French-Canadian samples and orthodontic patients without sagittal skeletal malocclusions in eastern Turkish population. Because this report was the first in the literature investigating the relationship of sagittal skeletal anomalies of the jaws and the dental development, future reports are necessary to elucidate precisely the reason for this variation.

Conclusions

- This sample of orthodontic patients was more advanced in dental maturity compared to Demirjian's French-Canadian sample.
- When differences between CA and DA were compared, the results of this study showed that orthodontic patients with sagittal skeletal malocclusions were approximately 0.6 years more advanced when compared to patients without sagittal skeletal anomaly patterns.

Clinical relevance

Reports evaluating the effects of skeletal anomalies of the jaws on dental maturity are limited in the literature. How dental maturity is influenced by skeletal anomalies of the jaws still remains unclear, and this report will help clinicians to determine the optimal timing for treatment planning.

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