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A comparison of dental maturation in twins

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Abstract
Aim: The aim of the study was to assess the correlation between dental age among monozygotic (MZ) and dizygotic (DZ) twins.
Materials and methods: Panoramic radiographs of 156 twins, aged between 6-16 years (mean age 10.44 ± 2.72 years), divided into a group of 48 MZ and 108 DZ. Dental age was assessed by Willems method. BMI was determined for each patient. Wilcoxon signed rank test and Mann-Whitney U test were used for statistical analysis. The significance level was set to be <0.05.
Results: The dental age of MZ and DZ twins were found to be similar (p>0.05). The dental age of MZ twins was more similar than DZ twins in the 6-9 year age group (p<0.05).
Conclusion: There is a correlation between dental age in MZ and DZ twin pairs. Dental maturation is more similar in MZ twins in the prepubertal period.

Keywords: Dental maturity, twins, Willems method, x-ray diagnosis

1. Introduction

Different biological indicators including the sexual maturation characteristics, body height and weight [1], skeletal maturation of the hand and wrist [2], skeletal maturation of the cervical vertebrae [3], and dental development and tooth eruption have been proposed to evaluate physiologic maturity [4]. Chronological age is not a reliable source for assessing the maturation of an individual because of the variations in the development of individuals of the same chronological age [5]. Among these methods, evaluation of dental development from radiographs have become popular [6].

Dental maturity is important in terms of being one of the best physical indicators of external and internal factors [7]. Because twins share all and/or part of their genome, environmental or genetic contributions can easily be identified. Twin studies can show important aspects of how genetic factors might affect human dentition [8].

There are many methods to assess dental age, and the majority of the methods are based on the evalution of the stage of mineralization of the tooth root [9]. The Demirjian method is the most commonly known dental age estimation procedure, in which the mineralization of seven left mandibular permanent teeth are evaluated using panoramic radiographs [10]. However, there have been reports in the literature indicating that the chronological age calculated using the Demirjian method is overestimated because ethnic and/or geographic factors are not taken into consideration [9, 11–13]. In 2001, Willems *et al*. modified the Demirjian scoring system for each gender and age [14]. Numerous studies showed that Willems method was found to be more accurate in various populations [15–18], including Turkey [19–22].

Since the studies showed that underweight or obese individuals may have altered dental development compared to controls [23], dentists should also consider the BMI percentiles in the context of assessment of growth and development in children [22].

The purpose of this study was to assess the dental age and its concordance between monozygotic (MZ) and dizygotic (DZ) twins. We also investigated whether the difference in BMI may affect dental maturation in twin pairs.

2. Materials and methods

This cross sectional study was conducted in the Clinics of Istanbul University, Faculty of Dentistry, and Department of Pedodontics.

Ethical approval was provided by the Ethical Committee of the Istanbul University under reference no.2014/278 according to the Declaration of Helsinki. The inclusion criteria comprised of adequate diagnostic quality of panoramic radiographs, presence of all permanent mandibular teeth except the third molars, ages between 6-16 years old, and parental permission (written informed consent).

Children having dentofacial deformities or any syndromes, medically and physically compromised children, children undergoing orthodontic treatment, and children with tooth agenesis were excluded from the study.

Initially, out study sample consisted of 404 twin children, who were referred for their dental examination from 2017-2017. Since some of the radiographs were not clear (we did not take a new radiograph), 92 children were exluded from the study. The remaining 312 twin children (154 girls and 158 boys) enrolled in the study. Zygosity verification was performed using 16 STR markers.

The age of the children was calculated from the their birth date and the date of the panoramic radiographs were taken. In order to achieve a more accurate evaluation, each digital panoramic radiograph was analyzed under magnification. All panoramic radiographs were scored by two examiners. The development of the seven left mandibular permanent teeth (31 to 37) were assessed. These seven teeth were rated on the eight-stage scale from A to H (Figure 1), then the Willems method was used to obtain the dental age [14]. Cohen's Kappa was used to assess inter-examiner reliability for the Willems method. For this purpose, 20 radiographs was assessed by each examiner. The inter-examiner correlation of dental age assessment for the Willems method was found to be acceptable at a value of 0.90.

BMI was calculated as weight divided by height squared: BMI = weight (kg) / height^2 (m)^2. Children whose BMI is below 5th percentile is considered underweight, 5th percentile to less than 85th percentile considered normal, 85th percentile to less than 95th percentile considered overweight and 95th percentile and above is considered as obese. The gender, age and the BMI percentile were used to investigate each patients status (normal, underweight or obese) using growth charts from the reference values for Turkish children [24].

The obtained results were analyzed using the IBM SPSS software package, version 25.0. Nonparametric tests were preferred due to low sample size. In order to compare the dental age of the twin siblings, the mean age of the groups were examined by the Wilcoxon signed rank test. The comparison of sibling similarities according to their zygosity were performed using the Mann-Whitney U test. Statistical differences between children's age and the BMI were evaluated by using the Mann-Whitney U test. The significance level was set to be <0.05.

3. Results & Discussion

Three hundred and twelve twin children (154 girls, 158 boys) aged 6-16 years old (mean ± SD; 10.44 ± 2.72 years) participated in this study. We calculated dental age to compare correlations between MZ and DZ children.

The chronological age of children is a poor maturity indicator, but when it is compared with a reliable dental maturity indicator, it may help us to predict the time of growth of an individual [23].

Dental age estimation is a widely used indicator to evaluate a child's development. The Demirjian method has been popular for almost half a century [25]. However, this method is mostly suitable for French-Canadian children, and overestimations have been reported in the literature [26–31]. As the estimations using the Demirjian's method began to give overestimations, Willems *et al.* [14] revised this method. Since the Willems method give more accurate results in dental age estimation [19–21], we chose this method to assess dental age in our study.

The dental age and chronological age of MZ and DZ twins were found to be similar (p>0.05) (Table 1), which are in confirmation with previously published twin studies [32–34]. Garn *et al.* [33], Green and Aszkler [34] found that the difference in dental maturation of MZ twin pairs were significantly less than in DZ twin pairs. A good correlation between the same zygosity of twin pairs was found by Gupta *et al.* [32]. However, no relation was found between mixed sex pairs and different zygosity in twins [32, 35].

In our study, the dental age and chronological age were found to be similar in both MZ and DZ twins. The chronological age and dental age of MZ twins were more similar than DZ twins in 6-9 year-old children (p<0.05) (Table 2). As for the reason of the similarity in chronological age and dental age between MZ twins who were younger than 9 years of age, it is thought that puberty related hormonal effects are less seen in this age group. During 6 to 8 years of age, the skeletal growth of both sexes is similar before puberty according to the growth atlases [36].

The distribution of BMI showed that 250 (80.12%) children were of normal weight, 31 (9.93%) were underweight, 13 (4.16%) were overweight, and 18 (5.76%) were obese. There are no statistically significant differences in mean values between males and females regarding their BMI percentile (p>0.05). There is also no statistically significant difference between chronological and dental age in underweight, overweight and obese children (p>0.05) (Table 3). This result is obviously to have been related due to the higher number of normal percentile of children than underweight, overweight and obese children, taking part in the study.

Statistical analysis was performed in order to obtain multiple regression formulae, with chronological age as an independent variable as shown below:

Dental Age = - 0.848 + 1.078 * Chronological Age

This model explained a 86.2% of variation in estimated chronological age. According to the regression, gender and BMI did not significantly influence regression models.

3.1 Tables and Figures

Table 1: Comparison of mean dental age between MZ and DZ twin pairs. MZ: monozygotic twins, DZ: dizygotic twins, N: number, SD: standard deviation.

Age (years)		Variable	N	Mean	SD	Z value	p
6-7	MZ	1st child	7	5.88	0.72	-0.730	0.465
		2nd child	7	5.75	0.75		
	DZ	1st child	11	6.36	1.14	0.000	1.000
		2nd child	11	6.39	1.05		
7-8	MZ	1st child	7	7.27	0.88	0.000	1.000
		2nd child	7	7.22	0.82		

	DZ	1st child	9	7.41	1.27	-0.280	0.779
		2nd child	9	7.61	0.99		
8-9	MZ	1st child	8	7.96	0.99	0.000	1.000
		2nd child	8	7.99	0.92		
	DZ	1st child	18	8.49	0.70	-0.828	0.407
		2nd child	18	8.45	1.10		
9-10	MZ	1st child	5	9.54	1.38	-1.069	0.285
		2nd child	5	9.19	1.05		
	DZ	1st child	13	9.18	0.87	0.000	1.000
		2nd child	13	9.08	1,07		
10-11	MZ	1st child	2	10.18	0.08	-1.000	0.317
		2nd child	2	9.93	0.45		
	DZ	1st child	10	10.57	1.82	-1.172	0.241
		2nd child	10	10.27	1.24		
11-12	MZ	1st child	4	13.00	0.72	-1.342	0.180
		2nd child	4	13.25	0.39		
	DZ	1st child	10	11.48	1.61	-0.816	0.415
		2nd child	10	11.36	1.13		
12-13	MZ	1st child	5	12.07	1.08	-1.214	0.225
		2nd child	5	11.57	1.47		
	DZ	1st child	10	12.75	1.47	-0.770	0.441
		2nd child	10	12.28	1.76		
13-14	MZ	1st child	5	14.42	1.27	0.000	1.000
		2nd child	5	14.43	0.80		
	DZ	1st child	13	13.78	1.85	-0.706	0.480
		2nd child	13	14.05	1.72		
14-15	MZ	1st child	4	15.55	0.81	-1.000	0.317
		2nd child	4	15.06	1.14		
	DZ	1st child	8	14.48	1.30	-0.314	0.753
		2nd child	8	14.64	1.18		
15-16	MZ	1st child	1	15.79	.	.	.
		2nd child	1	14.23	.		
	DZ	1st child	6	15.26	1.10	-0.365	0.715
		2nd child	6	15.35	0.79		

Wilcoxon signed rank test $p<0.05$

Table 2: The effect of zygosity on the diffrence between dental age and chronological age. MZ: monozygotic twins, DZ: dizygotic twins, N: number, SD: standard deviation.

Age (years)		Variable	N	Mean	SD	Z value	p
6-7	MZ	1st child	7	0.38	0.43	8.000	0.004**
		2nd child	11	1.26	0.68		
	DZ	1st child	7	0.16	0.26	8.000	0.012*
		2nd child	9	0.94	0.72		
7-8	MZ	1st child	8	0.26	0.23	32.000	0.026*
		2nd child	18	0.79	0.72		
	DZ	1st child	5	0.39	0.54	19.500	0.208
		2nd child	13	0.75	0.79		
8-9	MZ	1st child	2	0.26	0.36	2.000	0.121
		2nd child	10	1.43	1.37		
	DZ	1st child	4	0.26	0.47	7.500	0.076
		2nd child	10	0.94	0.81		
9-10	MZ	1st child	5	0.81	0.51	23.000	0.859
		2nd child	10	1.28	1.28		
	DZ	1st child	5	0.79	0.84	24.000	0.443
		2nd child	13	1.11	0.85		
10-11	MZ	1st child	4	0.49	0.98	9.000	0.283
		2nd child	8	1.31	0.91		
	DZ	1st child	1	1.56	.	2.000	0.857
		2nd child	7	0.38	0.43	8.000	0.004**
11-12	MZ	1st child	11	1.26	0.68		
		2nd child	7	0.16	0.26	8.000	0.012*
	DZ	1st child	9	0.94	0.72		
		2nd child	8	0.26	0.23	32.000	0.026*
12-13	MZ	1st child	18	0.79	0.72		
		2nd child	5	0.39	0.54	19.500	0.208
	DZ	1st child	13	0.75	0.79		
		2nd child	2	0.26	0.36	2.000	0.121
13-14	MZ	1st child	10	1.43	1.37		

		2nd child	4	0.26	0.47	7.500	0.076
	DZ	1st child	10	0.94	0.81	23.000	0.859
		2nd child	5	0.81	0.51		
14-15	MZ	1st child	10	1.28	1.28	24.000	0.443
		2nd child	5	0.79	0.84		
	DZ	1st child	13	1.11	0.85	9.000	0.283
		2nd child	4	0.49	0.98		
15-16	MZ	1st child	8	1.31	0.91	2.000	0.857
		2nd child	1	1.56	.		
	DZ	1st child	7	0.38	0.43	8.000	0.004**
		2nd child	6	0.73	0.87		

Mann-Whitney U Test $*p<0.05$, $**p<0.01$

Table 3: Differences between chronological age and dental age among BMI groups. BMI: body mass index, N: number, SD: standard deviation.

BMI	N	Variable	Mean ± SD	p
Underweight	31	Chronological age	11.47 ± 2.56	0.773
		Dental age	11.60 ± 3.05	
Overweight	13	Chronological age	9.84 ± 2.88	0.448
		Dental age	9.26 ± 2.53	
Obese	18	Chronological age	10.49 ± 2.76	0.628
		Dental age	11.00 ± 3.38	

Mann Whitney U test $*p<0.05$

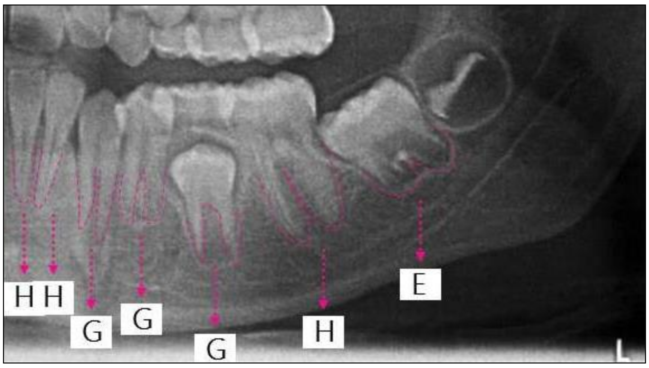

Fig 1: Dental age assessment using seven left mandibular teeth according to Willems method [25]. E: initial formation of radicular bifurcation is seen in the form of either a calcified point or a semi-lunar shape, the root length is less than the crown height; G: tha walls of the root canal are parallel and its apical end is partially open; H: the apical end of the root canal is completely closed.

4. Conclusions

Dental age assessment will guide pediatric dentists to plan their treatments. Dental maturation is more similar in MZ children in the pre-pubertal period. Pediatric dentists should be aware of that twin pairs may have different dental development since mid-puberty.

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