

Dental Age Assessment: Validity of the Nolla Method in a Group of Western Turkish Children

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Abstract

The aim of this study was to evaluate the validity of the Nolla method for dental age estimation in western Turkish children. This study consisted of 688 orthopantomograms of patients of western Turkish children aged between 7 and 17 years. Dental maturity was evaluated according to the stages proposed by Nolla. A paired *t*-test was used for statistical analysis. The mean difference between the chronological and dental ages ranged from -1 to 0.13 years for males and from -1.15 to 0.25 years for females. The differences between the CA and DA were statistically significant in 10-10.9, 11-11.9, and 12-12.9 year age groups for males ($p < 0.05$). The differences between the CA and DA were statistically significant in 7-7.9, 8-8.9, 9-9.9, 10-10.9, and 11-11.9 year age groups for females ($p < 0.05$). The applicability of Nolla method is suitable for western Turkish children except ages 10, 11 and 12 in males and 7, 8, 9, 10 and 11 in females. Therefore, in this study, it is suggested that there is a need for standardization in the Turkish population in age estimation.

Key words: Age determination by teeth, chronological age, dental age, nolla method

Introduction

Age determination is carried out for various reasons such as criminal cases, as well as for identification of mutilated victims of mass disasters, rape, kidnapping, employment, marriage, premature births, adoption, illegal immigration, pediatric endocrinopathy, and orthodontic malocclusion, circumstances in

which the birth certificate is not available or the records are suspectfull (1, 2).

Skeletal indicators such as hand-wrist examination, diaphysis-epiphysis fusion, cervical vertebrae assessment, changes in secondary sex characteristics, and fusion of cranial sutures were used for forensic age estimation (3-6). In addition to these methods teeth can be helpful for age estimation. Tooth mineralization is used most reliably in age estimation; teeth are the most indestructible part of the body and exhibit the least amount of turnover of their natural structure. Therefore, they not only survive death, but also remain relatively unchanged thereafter for many thousands of years (1).

Radiology has an important role in human age determination. Dental radiography used routinely in dental practice, has been utilized in methods of age estimation for many years (1). The dental age (DA) of children can be determined by evaluating the stages of mineralization of teeth on radiographic images. Several methods have been used to determine DA according to the degree of calcification observed while performing radiographic examinations of permanent teeth (7-11). The dental age estimation method devised by Nolla (12) is the most commonly used one in teaching and clinical practice. This method evaluates the mineralization of permanent dentition in ten stages, and can be used to assess the development of each tooth of the maxillary and mandibular arch (13). The Nolla method has been tested in Spanish and Bangladeshi-British children for DA estimation. These studies showed that dental development varies among different populations and applicability of this method was found to be limited in these populations (13, 14). Miloglu et al. (7) reported that the Nolla method was suitable for eastern Turkish males.

Environmental, climatic, genetic, hormonal and nutritional factors can influence the development of each human's organs (15). This situation necessitates population-specific studies, as well as among geographical areas or cities within the same country (16). A literature review revealed that there are only two researches regarding the applicability of the Nolla method for age estimation in a Turkish population. These studies were carried out on eastern (7) and northeastern (8) Turkish children. Therefore, the aim of this study was to evaluate the validity of the Nolla method for DA estimation in western Turkish children.

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Materials and methods

This retrospective study was performed on a sample of digital panoramic radiographs taken from 688 western Turkish children (357 males; 331 females) who ranged in age from 7 to 17 years. Table 1 shows the distribution of patients by gender and age. Panoramic radiographs from the subjects attending to the Izmir Educational Dental Hospital (Izmir, Turkey) were included. Selection criteria included the following:

- (i) Western Turkish children who were between 7 and 17 years of age.
- (ii) Born after a normal gestation period, and showed normal growth, development, and dental conditions.
- (iii) High-quality orthopantomograms, particularly in the region of the mandibular left side.

Chronological age

The chronological age (CA) of each child was calculated by subtracting the date of birth from the date the radiograph was taken.

Dental age

The stage of tooth mineralization was evaluated for left permanent mandibular teeth (except third molar) according to the method proposed by Nolla. (12) The development and mineralization of the teeth were classified into ten stages that is between 1 and 10. If the tooth was between two stages an appropriate fraction (0.2, 0.5 or 0.7) was added as recommended by Nolla. The sum of scores was compared to the average sum for boys or girls and dental age was calculated.

Reproducibility

Two examiners assessed all the images separately, and any disagreement between them was discussed until a consensus was reached. To test the reproducibility of the assessment of the dental development stage, the two observers reexamined 70 randomly selected panoramic radiographs 5 weeks after the first evaluation.

Statistical Analyses

All the data were analyzed by using the SPSS software package (Statistical Package for Social Sciences, version 11.5, SPSS Inc., Chicago, IL, USA). 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. Pearson's correlation was performed to determine the coefficient of determination (*r*) for each gender. All statistical analyses were performed at a significance level of $p < 0.05$.

Results

There were no statistically significant differences between the two readings, indicating diagnostic reproducibility according to the paired *t*-test. Differences between the mean CAs and estimated mean DAs according to the Nolla method are presented in Table 2. The mean difference between the CAs and DAs ranged from -1 to

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

Chronological age	Male	Female	Total (%)
7-7.9	18	16	34 (5.0)
8-8.9	50	19	69 (10)
9-9.9	30	34	64 (9.3)
10-10.9	35	31	66 (9.5)
11-11.9	41	36	77 (11.1)
12-12.9	38	30	68 (9.9)
13-13.9	26	34	60 (8.7)
14-14.9	29	32	61 (8.8)
15-15.9	53	83	136 (19.8)
16-16.9	37	16	53 (7.7)
Total (%)	357 (51.9)	331 (48.1)	688 (100)

Table 2. Differences between chronological ages and dental ages determined by Nolla method

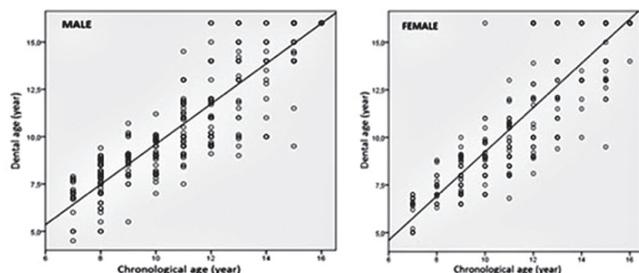
Age	Mean CA	Mean DA	DA-CA	P
Males				
7-7.9	7.01±0.34	6.75±1.00	-0.26±1.01	0.307
8-8.9	8.03±0.43	7.72±1.02	-0.31±0.95	0.059
9-9.9	9.23±0.25	8.73±0.95	-0.50±0.92	0.139
10-10.9	10.08±0.04	9.08±0.92	-1.00±1.40	0.000*
11-11.9	11.10±0.13	10.51±1.42	-0.59±1.80	0.033*
12-12.9	12.09±0.03	11.24±0.86	-0.85±2.21	0.017*
13-13.9	13.34±0.40	12.98±2.21	-0.36±2.02	0.972
14-14.9	14.11±0.33	13.46±2.02	-0.65±1.28	0.262
15-15.9	15.23±0.62	15.36±1.28	0.13±1.14	0.061
16-16.9	16.82±0.17	16.0±0.38	-0.62±0.39	0.543
Females				
7-7.9	7.08±0.14	6.16±0.81	-0.92±0.73	0.001*
8-8.9	8.21±0.23	7.33±0.68	-0.88±0.94	0.000*
9-9.9	9.18±0.02	8.06±0.94	-1.12±1.06	0.000*
10-10.9	10.20±0.11	9.05±1.64	-1.15±1.32	0.003*
11-11.9	11.13±0.24	9.59±1.32	-0.54±1.08	0.000*
12-12.9	12.37±0.64	11.96±2.81	-0.41±2.30	0.933
13-13.9	13.41±0.36	12.42±2.32	-0.99±1.91	0.234
14-14.9	14.30±0.32	14.55±1.91	0.25±1.41	0.196
15-15.9	15.02±0.11	15.25±1.41	0.23±0.32	0.150
16-16.9	16.39±0.29	15.95±0.329	-0.44±0.32	0.324

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

0.13 in males. The differences between the CA and DA were statistically significant in 10-10.9, 11-11.9, and 12-12.9 year age groups for males ($p < 0.05$). The mean difference between the CAs and DAs ranged from -1.15 to 0.25 in females. The differences between the CA and DA were statistically significant in 7-7.9, 8-8.9, 9-9.9, 10-10.9, and 11-11.9 year age groups for females ($p < 0.05$).

Pearson correlation coefficients were used to assess the correlation between DA and CA. There was a strong correlation between CA

Figure 1. The scatter plot dental age according to the Nolla method versus chronological age for males and females



and DA for both females ($r=0.897$) and males ($r=0.896$). The scatter plots of DA versus CA for males and females according to the Nolla method are presented in Fig. 1

Discussion

Determination of dental age is one of the most reliable indicators of CA and one of the most widely used in forensic and legal dentistry (13). Dental maturity also provides useful information for diagnosis and treatment planning, especially for pedodontists and orthodontists in dentistry (5, 9).

Up to now, several methods have been used for the determination of dental development in different populations (7, 14, 16, 17). Nolla ten-stage method is one of the most commonly used technique in teaching and clinical practice (7, 13). This method has two more degrees of mineralization of the crown than the dental age estimation method conducted by Demirjian et al. (18) and intra-observer agreement in its application is well over 90%. (19, 20). Caro and Contreas (21) reported that Nolla method offered more accurate results for age determination than other methods they tested. For the reasons mentioned above, Nolla's age estimation method was preferred in the present study.

There are variations in dental development among individuals and among different populations as well as geographical areas or cities within the same country (16). Eastern and western regions of Turkey shows very different geographical and climatic features. As the regional variations demonstrate, it is necessary to adapt this method for use within local populations (1, 22). There are only two researches regarding the applicability of the Nolla method for age estimation in a Turkish population. These studies were carried out on eastern (7) and northeastern (8) Turkish children. To resolve this shortcoming in the literature, we evaluated the applicability of the Nolla method for DA estimation in western Turkish children.

Maber et al. (14) reported that the Nolla method under-estimated age by -0.87 years for males and -1.18 years for females in Bangladeshi and British children. Bolanos et al. (13) reported that the estimation of DA by using Nolla method can be carried by teeth 21, 46 and 43 for boys and 21, 47, and 46 for girls under 10 years of age in Spanish children. Miloglu et al. (7) reported that the Nolla method was suitable for eastern Turkish males. They found that the eastern Turkish children had underestimated DAs and that the mean difference between the DA and the CA ranged from -0.5 to 0.0 years for males and from -0.1 to -1.0 years for females. Nur

et al. (8) reported that the northeastern Turkish children had underestimated DAs and that the mean difference between the DA and the CA ranged from -0.01 to -0.94 years for males and from -0.01 to -0.93 years for females. In our study, the mean difference between the DA and the CA ranged from -1.0 to 0.13 years for males and from -1.15 to 0.25 years for females. The differences between the CA and DA were statistically significant in 10 to 12.9 year age groups for males and in 7 to 11.9 year age groups for females. Previous reports that were conducted in Turkey (7, 8) showed underestimated DA, however in the present study, some of the age groups showed underestimated DAs and the others showed overestimated DAs. These differences have been attributed to regional differences within the same country. The subjects involved in prior studies were of an eastern and a northeastern 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, 9, 23). 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 -0.5 years for males and -0.49 years for females.

Conclusion

The applicability of Nolla method is suitable for western Turkish children except the ages of 10, 11 and 12 in males and 7, 8, 9, 10 and 11 in females. Therefore, in this study it is suggested that there is a need for standardization in the Turkish population in age estimation.

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