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Use of the Demirjian method to estimate dental age in panoramic radiographs of patients treated at the Buenos Aires University School of Dentistry

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ABSTRACT

The aim of this study was to determine the difference between real age (RA) and dental age (DA) in boys and girls from the Autonomous City of Buenos Aires (C.A.B.A.) by analyzing digital panoramic radiographs from the database of the Imaging Department at the Buenos Aires University School of Dentistry, using the Demirjian Method (DM). The sample consisted of 508 panoramic radiographs of 6- to 14-year old Argentines (268 female and 240 male). The Demirjian method was used to estimate dental age from each panoramic radiograph, and the Wilcoxon test was applied to perform a comparative analysis with the real age recorded in the image database. Average RA was 9.36 years (SD 2.11), and average DA according to the Demirjian method was 10.45 years (SD 2.31). For females, RA was 9.25 (SD 2.12), and DA according to the DM was 10.40 years (SD 2.41). For males, RA was 9.46 (SD 2.10), and DA according to the DM was 10.50 years (SD 2.22). An inter-class correlation coefficient (ICC) calculated as a correlation measure between dental age and real age was ICC = 1.09%. The ICC was 1.04% for the males and 1.15% for females. Significant differences were found between DA and RA (p <0.01) in general and according to sex. Real age was found to be lower than dental age in the study population from Buenos Aires City.

Keywords: *age determination by teeth - panoramic radiography.*

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Utilización del Método de Demirjian para estimación de la edad dental en radiografías panorámicas de pacientes atendidos en la Facultad de Odontología de la Universidad de Buenos Aires

RESUMEN

El objetivo del presente trabajo fue determinar la diferencia entre la edad real (ER) y la edad dental (ED) en niños y niñas de la Ciudad de Buenos Aires analizando radiografías panorámicas digitales de la base de datos de la Cátedra de Diagnóstico por imágenes FOUBA, utilizando el Método Demirjian (MD). La muestra consistió en 508 radiografías panorámicas (268 del sexo femenino y 240 del sexo masculino) en una población argentina de 6 a 14 años de edad. Se realizó el cálculo de la edad dental en cada una de ellas, conforme el método de Demirjian. Se efectuó un análisis comparativo con la ER proveniente de la base de datos, utilizando la prueba de Wilcoxon. En las 508 panorámicas se estimó la ED. Se pudo establecer que la ER en promedio es 9.36 años con un desviación estándar (DS) de 2,11 y que la edad según el método de Demirjian es 10,45 años con una DS de 2,31. Para el sexo femenino se obtuvo una ER de 9,25 y una DS de 2,12 y según MD es de 10,40 años con una DS de 2,41. Para el sexo masculino se obtuvo una ER de 9,46 y una DS de 2,10 y según MD es de 10,50 años con una DS de 2,22. Se obtuvo un coeficiente de correlación inter-clase (CCI), como medida de correlación entre edad dental y real, de (CCI 1,09%). El CCI para el sexo masculino fue de (CCI 1,04 %) y en el caso del sexo femenino fue de (CCI 1,15%). Se hallaron diferencias significativas entre ED y ER (p<0,01) en general y también para ambos sexos. Se pudo evidenciar que la edad real es menor que la edad dental en la población de la Ciudad de Buenos Aires.

Palabras clave: *determinación de la edad por los dientes - radiografía panorámica.*

INTRODUCTION

The ability to estimate age is important in medical studies such as pediatric endocrinology, archeology, anthropology and odontology, and has social, legal and religious connotations. In forensic science, age estimation is used in the identification of human remains. Age estimation is also relevant to living subjects, especially considering the current international context of constantly increasing migratory flows, which leads to an increase in the activity of legal medicine institutes. A person's real age (RA) is linked to their date of birth which, if adequately registered, is accredited legally on the identification document (ID). However, in some countries, birth registries have been reported to have serious difficulties and discrepancies.

As a person grows, their skeletal, dental, anthropological and psychological features enable their age to be estimated. Different study groups recommend using three systems for age analysis of individual development to increase diagnostic precision during forensic procedures and to optimize identification of age development disorders. These systems consider bone age, dental age and development of secondary sexual characteristics[1-3].

In line with the above, in Argentina it has been reported that the Supreme Court's Forensic Medical Center estimates age through a protocol that includes physical examination, periapical scans of the third molars and a scan of the left hand carpus. It is important to consider that dental development is one of the most usual and precise methodologies used to estimate age in teenagers and young adults, while when all teeth are completely formed, associated regressive changes are used[4].

Human dentition follows a reliable, predictable sequence of development, starting at approximately the fourth week after conception and continuing until the beginning of the third decade of life, when the development of all permanent teeth is complete. Dental eruption and mineralization are the main odontological indicators that are studied for the estimation of forensic age in children and young adults. Dental development is a pragmatic measure of maturity and can provide substantial data for any individual. Historically, different authors have proposed methodological strategies to measure the course of the formation and growth of tooth germs to estimate age, considering the degree of mineralization, with an acceptable degree of error in the calculation. In this context, the method advocated by Demirjian, described for first time in 1973 and based on a study conducted on French-Canadian children, uses panoramic scans to analyze development of tooth germs on the seven mandibular left teeth, without considering the third molars. They classified 8 distinctive stages, called AH, defined by morphological changes, without speculative estimations of longitude. The study was based on a scale of maturation outlined by Tanner et al. to estimate real age, which provides a score for each stage of tooth development, for girls and boys. The sum of the scores of the seven teeth provides a value of dental maturity on a scale of 0 to 100, which can be directly converted into dental age by using the percentage tables and curves designed by the authors. Different studies have found that the results obtained for different populations using Demirjian's standards are uneven and contradictory, suggesting the need to create a database for each population in order to gain a clearer picture of human dental maturation. There is a considerable degree of association between dental age and real age, compared to any other biological marker of maturity, because dental age is believed to be less affected by malnutrition. Moreover, evaluation of real age is important to all dental disciplines, for designing treatments for all types of malocclusion, and for pediatric dentists to know how age, sex, weight and height are associated with tooth eruption as events of somatic growth[5-8].

Due to all of the above, members of the Buenos Aires University School of Dentistry from the departments of Image Diagnosis and Legal Odontology decided to analyze digital panoramic radiographs from the database of the Imaging Department using the Demirjian's Method (DM) to determine the difference between real age (RA) and dental age (DA) in boys and girls from Buenos Aires City.

MATERIALS AND METHODS

This was a study with a descriptive, retrospective, analytic design. The sample consisted of 508 panoramic X-ray scans obtained at the Image Diagnosis Department of the Buenos Aires University School of Dentistry between September 2016 and June 2018. Images from patients aged 6 to 14 years (268 females and 240 males) were selected and saved in JPEG format (2440 x 1292 pixels).

Parents or legal guardians signed informed consent before the use of the images for research purposes under anonymity. Fig. 1 shows an example of the cases under study.

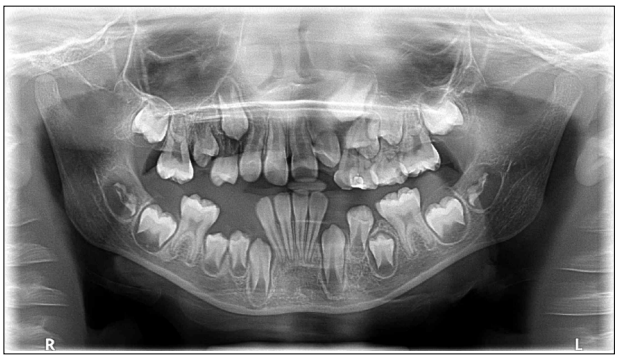

Fig. 1: Example of the images under study. Panoramic x-ray showing the different stages of development of the central incisor, lateral incisor, canine, first and second premolar, first and second molar.

Before the evaluation of the final sample, 43 panoramic scans were selected randomly to calculate intra-evaluator variability. They were analyzed by one observer (IC) twice with a 3-week interval between the first and second evaluation, obtaining a kappa index of 0.8. Exclusion criteria were images with significant distortion, which hinder visualization of the teeth in the area of examination, images with pathologies such as tumors or cysts, scans of patients in orthodontic treatment, and images showing absence of tooth due agenesis or exodontia. Dental age was calculated in each image by the Demirjian method, and compared to real age recorded in the image database, using the Wilcoxon test. The stages of development of the seven mandibular teeth were analyzed in the following order: central incisor, lateral incisor, canine, first and second premolar, first and second molar, called IC, IL, C, 1PM, 2PM, 1M and 2M. A spreadsheet was prepared in Microsoft Office Excel 2007 to record patients, assigning to each case a number (1, 2, 3, 4) and to calculate the scores and dental age. At the time of evaluation, the observer did not know the birth date of each subject. The cases were subsequently separated into two different spreadsheets, one for boys and one for girls. The stages were transformed from letters into numbers (from A, B, C, D, E, F, G, H to 1, 2, 3, 4, 5, 6, 7, 8, respectively) to facilitate the allocation of the maturation score according to the described criteria for each dental stage, and comparing the tooth with diagrams and scans created by Demirjian et al. In case of doubt between two stages, the tooth was assigned the stage of lesser development. Then, the percentage of maturation and dental age were calculated to one decimal place. Real age was calculated to one decimal place by subtracting the birth date from the date of the panoramic scan. The margin of acceptable error generally ranged from 4% to 8% with a confidence interval of 95%. The collected data were remodeled with the program SPSS Version 21 for statistical analysis. To observe the normal distribution of data, the Kolmogorov-Smirnov test was applied, which provided a significant result ($p < 0.05$). The importance of the difference between RA and DA was evaluated.

RESULTS

Dental age was estimated from 508 panoramic scans. Average real age was 9.36 years (SD 2.11) and age according to the Demirjian method was 10.45 years (SD 2.31).

For the females, average RA was 9.25 (SD 2.12) and average age according to DM was 10.40 years (SD 2,41). For males, average RA was 9.46 (SD 2.10) and average age according to DM was 10.50 years (SD 2.22). The inter-class correlation coefficient (ICC), as a measure of correlation between dental and chronological ages was ICC 1.09%. The ICC was 1.04% for males and 1.15% for females. Significant differences were found between DA and RA ($p<0.01$) in general and for both sexes, but mainly in females.

DISCUSSION

From the prenatal stage of dental development to adulthood, it is feasible to estimate age using a radiographic method for ages 2.5 to 18 years. Demirjian's principles promoted understanding of the divergence of dental maturity for individuals, however, it is not precise and not even among all populations. The modification of Demirjian's technique included the analysis of third molars, widening the spectrum of applicability to a group of older French children. Both methods, however, have provided variable results in other populations, with patterns of advance and/or regression in dental maturity with respect to the values found for the original sample. This led to unanimous consensus on the need to redesign the standards for each population sample, given the variability, even within a single geographic area[9-21].

For instance, the Demirjian Method overestimated age in most studies conducted in China, England, Spain, Iran, Tukey, Malaysia, France, Chile and Tunisia[22-26]. Conversely, it was found to underestimate age in Venezuela, Kuwait, Turkey and North China, while it was more precise in Norwegian children[27-31].

One study found coincidence of scores between the original investigations and a study on schoolchildren in some Indian states. The Demirjian method was considered to underestimate the real age for girls and boys in Indian populations[32, 33].

In Argentina, researchers from the University of Cuyo in Mendoza Province calculated dental ages in a population in the Cuyo region using Nolla and Demirjian methods, analyzing 374 panoramic scans of children and teenagers aged 5 to 17 years. They concluded that the Demirjian method overestimated age, in accordance with the present study conducted in Buenos Aires[34].

The effectiveness of the prediction of age is represented by the medium absolute error, which is calculated by subtracting the real age from the age based on dentition. An error of less than one year is considered acceptable, while an error greater than two years would be inaccurate. The methods proposed by Demirjian et al.[5] provided an absolute mean <2 years, therefore, it can be concluded that it estimates dental age precisely.

Many researchers have verified delayed growth in French children compared to other populations. Possible reasons explaining the great variability in the estimation of dental age may be attributed to factors such as ethnicity, dietary habits, environmental factors, and socio-economical standards, which all present notable differences among different populations. The consequence of malnutrition on dental development is still controversial, with inconsistent conclusions that suggest, on the one hand, a high impact factor and on the other hand, little or no impact. Supporting previous research, the present study has verified that dental development matures earlier in the female gender[35-39].

CONCLUSION

Digitized panoramic scans offer the advantage of estimating the different stages of dental development with great precision, and are sensitive to variables such as age distribution, sample size and statistical approach. The current study found that real age was lower than dental age determined by the Demirjian's method in children 6 to 14 years old from Buenos Aires City.

Due to the broad individual variation in dental maturity, the estimation of the real age in children must be complemented with other indicators of biological maturity. For this reason, we propose to promote further research on larger study samples, including younger children than in this research, incorporating children from other geographical areas in Argentina and using the Demirjian Method to compare and evaluate possible differences within the same country.

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DECLARATION OF CONFLICTING INTERESTS

The authors declare no potential conflicts of interest regarding the research, authorship, and/or publication of this article

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