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Correlations between dental age and chronological age in children and adolescents

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Abstract. Objective: The aim of this study was to evaluate the dental age of a sample of children and adolescents in Crișana region from Romania using the Demirjian's method and to perform some comparisons between dental age and chronological age. Material and methods: The study was conducted on 215 children and adolescents, aged 8-14 years. To analyze the dental age, the authors used the patient's orthopantomography and Demirjian's analysis method. For the assessment of the chronological age, the authors considered the age of the patients at the time the X-ray was performed. All the data from the study was analyzed using IBM SPSS Statistics 20. Results: The patients who have higher values of dental age also have higher values of chronological age ($p<0.001$). The girls tend to have a higher rate of premature dental age while the boys tend to have a higher rate of late dental age. The difference between dental age and chronological age using Demirjian's method was 0.67 years in girls and 0.74 in boys. Conclusions: Our research demonstrates that most patients undergoing the study had an advance in dental age compared to the chronological age, both in girls and boys, the percentage of girls being significantly higher. The average value of the difference between dental age and chronological age was higher for boys than for girls. We consider that Demirjian's method of assessment of dental age is only indicative for children in Romania and that this method requires adaptations for this population.

Key Words: dental age, chronological age, Demirjian's method

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Introduction

The evaluation of dental age in children and adolescents is a particularly important aspect for many fields such as: planning of orthodontic and pedodontic patients (Sinha et al 2014), researches on dental occlusion (Iacob et al 2019), establishment of individual correlations with chronological age, individual bone-age correlations as well as in forensic medicine to determine the age of abandoned, orphaned or lost children when the date of birth is not available or in the case of juvenile corpses that do not have other parts of the body that allow the criminal investigators to establish the chronological age of the deceased child. (Mani et al 2008, Lewis & Senn 2015, Bagiæ et al 2008). Several methods of assessing dental age have been described over time. There are clinical methods of direct endooral examination of patients, depending on the number of teeth erupted in the oral cavity or undergoing the eruption process. These methods are extremely relative, given that some teeth may remain retented under a dense fibro mucosa, others may remain intramaxillary due to obstructions in the way of eruption or due to a vicious intramaxillary position of buds, infections, crowding or ankylosis. (Sinha et al 2014, Aissaoui et al 2008).
A useful method of assessing dental age is that proposed by Demirjian et al in 1973 on an extended group of children and adolescents in Canada (Demirjian et al 1973). Demirjian's method allows the accurate assessment of the dental age according to the calcification stages of eruption or noneruption teeth using orthopantomography. Demirjian's method has been used by many researchers and allows dental age assessment, separately for girls and for boys (Demirjian & Golstein 1976, Vanshika Jain et al 2016).
The aim of this study was to evaluate the dental age of a sample of children and adolescents in the NW of Romania using Demirjian's method and to perform some comparisons between the dental age and the chronological age.

Material and method

The study was conducted on patients aged between 8-14 years in Crișana region, Romania, in accordance with the World Medical Association (WMA) Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects approved by the Ethics Committee of the University of Oradea, Romania. The patients included in this study requested orthodontic and/or pedodontic treatment during January-December, 2018. All patients in the study had their parents' consent.
The sample consisted of 300 children and adolescents, aged 8-14 years, who required orthodontic treatment. After applying the inclusion/exclusion criteria, 215 patients remained, of whom 69 were males and 146 were females. To analyze the dental age, the authors used the patient's orthopantomography and Demirjian's analysis method. The inclusion criteria were

the following: non syndromic patients, absence of endocrine, developmental or nutritional disorders, good quality of the radiograph, complete mandibular permanent dentition (erupt or not). Exclusion criteria included: local causes (such as obstacles on the eruptive tract of the tooth, severe crowding etc.), congenital anomalies (such as cleft lip or/and cleft palate), dental abnormalities (hypodontia, supernumerary teeth, impaction, missing, transposition of teeth etc.), sever dental pathology (history of trauma, malformations of dental buds/teeth), dentoalveolar ankylosis (evidenced by orthopantomography), suspicion of primary failure of eruption (taking into account the patient's medical and family history). For the assessment of the chronological age, the authors considered the age of the patients at the time the X-ray was performed.

Demirjian's method considers the analysis of seven teeth in the left side of the mandibular dental arch, describing eight stages of calcification (from A to H) of the tip of the cusp to the closure of the apex of these seven teeth. The evaluation of the developmental stage of the level of each tooth can be obtained by precisely following the written and pictorial criteria set out by Demirjian (Figure 1). The calcification stage of each tooth (from A to H) was converted into a score using the conversion table given by Demirjian for boys and girls. The scores of all the seven teeth were added together to give an evaluation of the subject's dental maturity. After the maturity score was calculated, it was converted to the dental age by referring to the table and percentile curves given by Demirjian, to obtain the dental age. (7) The difference between the dental and chronological age indicates premature or delay in dental development. Figure 2a-b shows an example of the evaluation of the calcification stages of the seven mandibular teeth (boy and girl) using Demirjian's method.
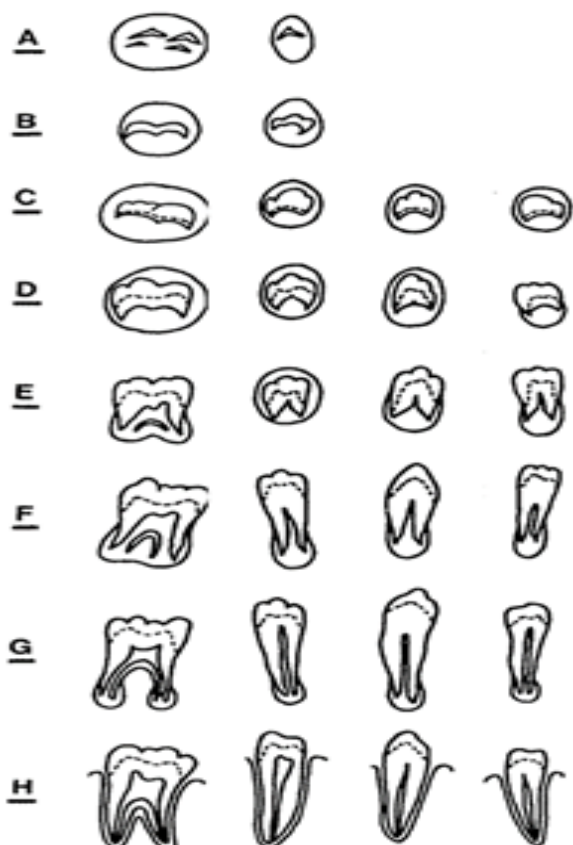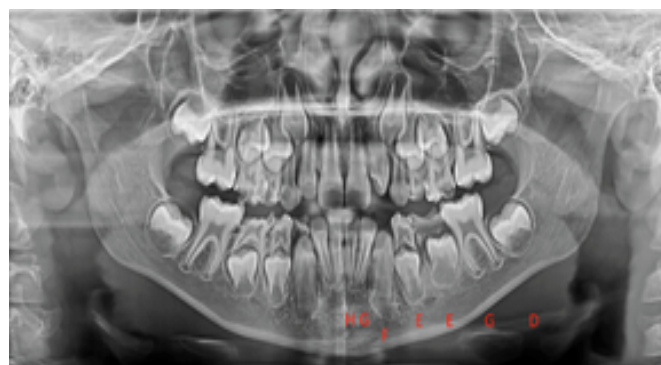

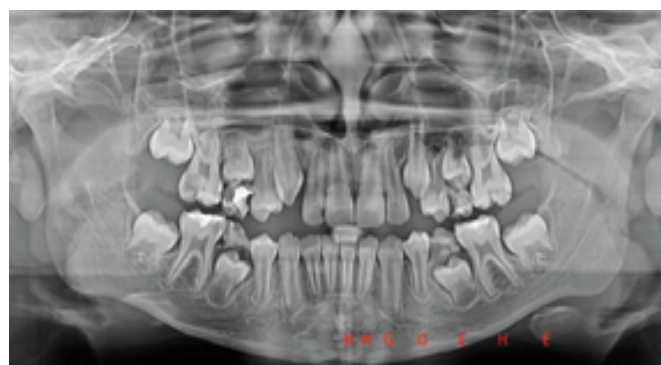Fig.2a. Demirjian's scoring on an OPG of a 8.1 years old boy

Fig.2b. Demirjian's scoring on an OPG of a 10.2 years old girl

All the data from the study were analyzed using IBM SPSS Statistics 20. Quantitative variables were tested for normal distribution using the Shapiro-Wilk Test and were expressed as medians and interquartile ranges, while categorical variables were written as counts or percentages. Quantitative variables were tested using Mann-Whitney U tests or Kruskal-Wallis H tests because of their non-parametric distribution and all existent correlations were demonstrated using Spearman's rho Correlations, while categorical variables were tested using Pearson Chi-Square tests and all existent correlations were demonstrated using a Pearson Contingency Coefficient.

Results

After the evaluation of the dental age, we divided the initial sample in three groups according to patients' dental age: premature – 108 patients, concordant (normal) – 60 patients, late – 47 patients. Figure 3 presents the distribution of the patients according to gender and dental age. The Pearson Chi-Square test was used to analyze the differences between the groups, results show that the differences observed were statistically significant (p=0.046).

Figure 4 illustrates the correlation between the chronological age and the dental age of the patients. The Shapiro-Wilk test was used to determine the normality of the chronological age, results show that the distribution was non-parametric (p<0.001). Furthermore, a significant and positive high-grade correlation (p<0.001, R=0.861) was detected using the Spearman's rho correlation coefficient between the dental age and the chronological age of the patients, which shows that patients who have higher values of dental age also have higher values of chronological age. Figure 5 illustrates the comparison of the chronological age between the dental age. The Kruskal-Wallis H test was used, results show that the differences observed were statistically significant

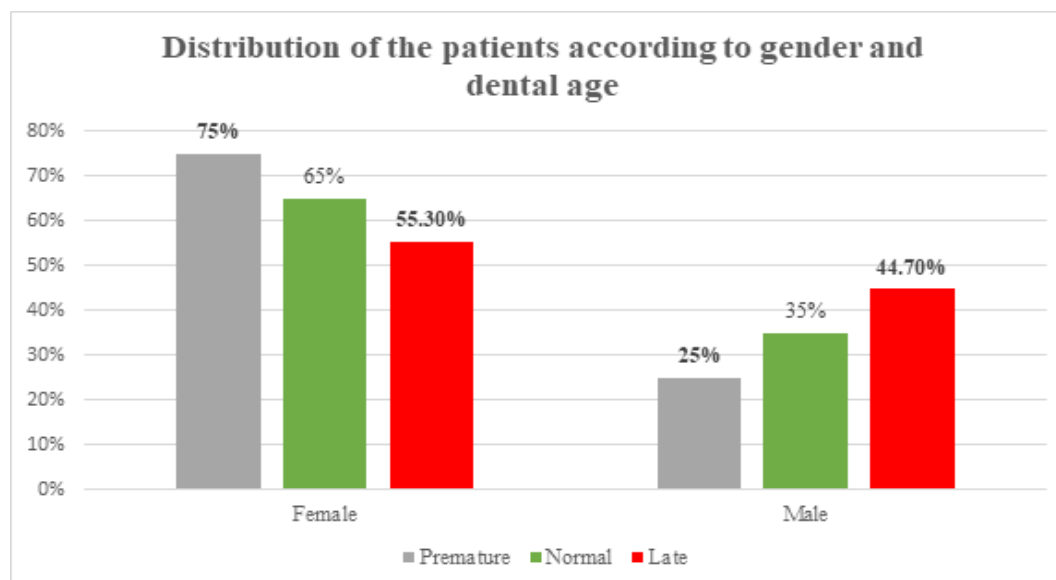Fig. 1. Dental formation stages according to Demirjian

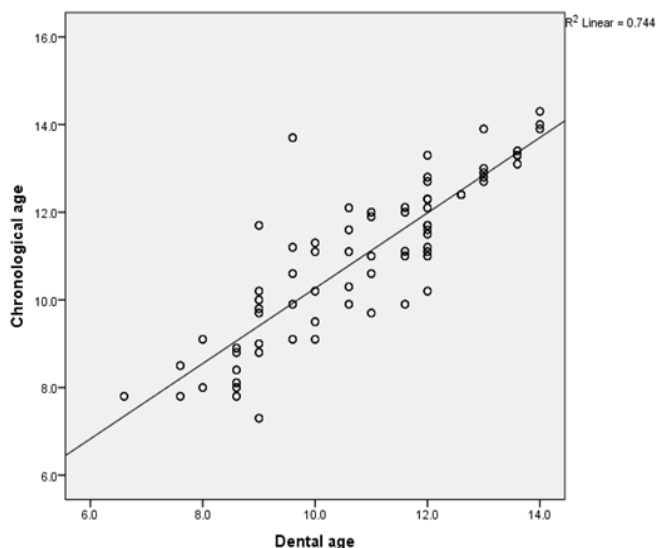Figure 3. Distribution of the patients according to gender and dental age

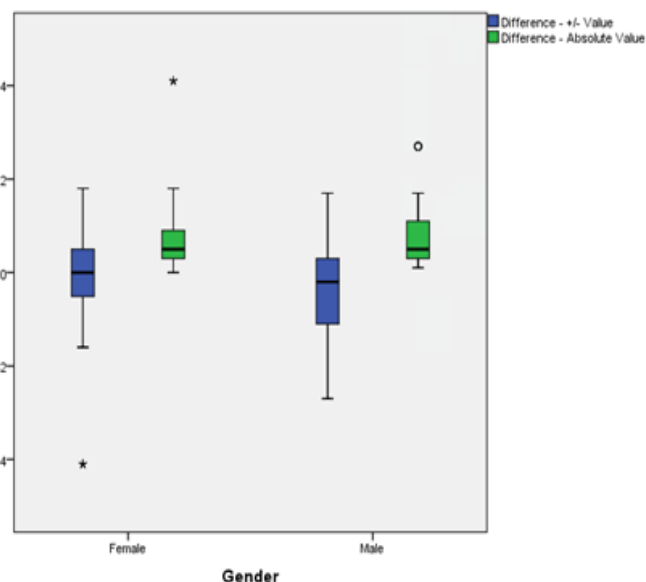Figure 4. Correlation between the chronological age and the dental age of the patients

Figure 6. Box plot for the difference between dental age and chronological age between genders
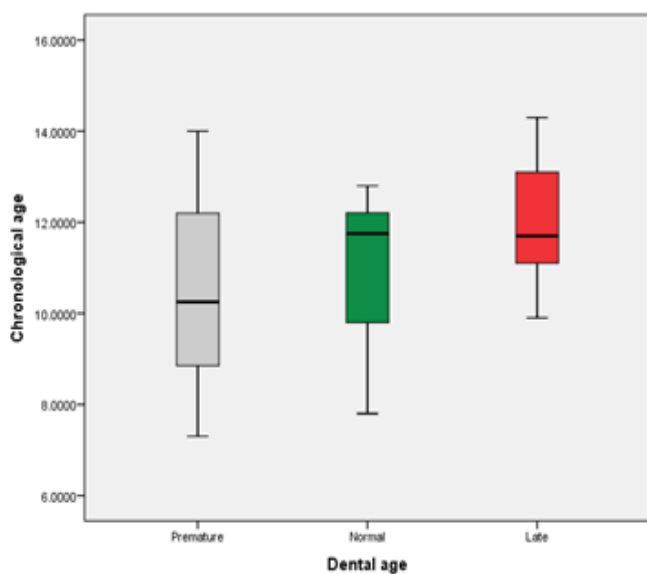
Table 1. Average value of the difference between dental age and chronological age

Difference / Gender	Positive/Negative value (p<0.001)**	Absolute value (p<0.001**)
	Average ± SD	Average ± SD
Female	-0.069 ± 0.955	0.675 ± 0.677
Male	-0.321 ± 0.919	0.747 ± 0.619
p*	0.022	0.304

(p<0.001). Post-hoc analysis shows that median chronological age was significantly lower only in patients with premature dental age (10.25) in comparison with patients with late dental age (11.7) (p<0.001).

Tabel 1 and Figure 6 illustrates the comparison of the difference between dental age and chronological age between genders. Mann-Whitney U tests shows that there are significant differences only in comparison of the positive/negative value

Figure 5. Box-plots for the chronological age of the patients according to their dental age

of the difference between the dental age and the chronological age (p=0.022), boys have a more negative median value (-0.2) in comparison with girls (0).

Discussion
The present study shows that female patients tend to have a higher rate of premature dental age while male patients tend to have a higher rate of late dental age (p<0.05). It is noteworthy that the percentage of girls is much higher (75%) than the percentage of boys (25%) in the group of patients with premature dentition, unlike the group of patients with late dentition where the girls represent a slightly higher perentage (55.3%) compared to the boys (44.7%). On the other hand, our study illustrates that the difference between dental age and chronological age using Demirjian's method is 0.67 years for girls and 0.74 for boys (Table 1). Even though the percentage of girls with premature dentition was much higher compared to boys, the mean difference between dental age and chronological age of girls was lower than in boys. These results can be used in future studies on the validation of Demirjian's method on the Romanian population making the necessary adaptations.

Demirjian's method presents many advantages such as: the use of orthopantomography, which is a routine investigation in orthodontics and pedodontics. Not only it is easy to comprehend, but it also save time.

There are several methods of estimating dental age. For example, Nolla's method defines the teeth development in 10 stages. Some authors prefer the Nolla method because this method has additional staging of mineralization that make it to be more accurate, reliable than Demirjian's method and it is widely used around the world (Bolanos et al 2000, Rai et al 2006). Gupta R. et al. concluded that Demirjian's method is the mostly used method because of lesser complex formulas and least exhaustive staging of development as compared to Nolla's method. (Gupta et al 2015).

Many authors have concluded that Demirjian's method is the most accurate method for estimating age in the given sample when compared to Nolla's method (Sinha et al 2006). The Demirjian method has been used by researchers from different parts of the planet, trying to validate this method on the respective populations or to establish various correlations between dental age and chronological age. Thus, in the literature there are studies on the Canadian population, carried out by Demirjian et al 1973, the promoter of the method, on the northeastern Turkish children, (Nur et al 2012), on the southern French children (Chaillet et al 2004), on the western Chinese children, (Chen et al 2010), on the Tunisian children [6], on the Belgaum population, (Hedge et al 2002), on the Malay population, (Mani et al 2008), on the North Indian population (Vanshika Jain et al 2016), on the Malaysian children (Nik-Hussein et al 2011).

In a study performed on a group of children aged 6-13 years in the centre of Romania using the Demirjian method, the authors concluded that, in general, girls registered a dental age advance versus the chronological age, and only in the categories of children aged 6-7 years and 8-9 years boys registered a slight advance (Jurca et al 2014).

In another study conducted on a population from Malaysia using two methods of dental age evaluation, the authors concluded that Demirjian's method overestimated the age by 0.75 and 0.61 years, while the Willems method overestimated the age by 0.55 and 0.41 years among boys and girls, respectively (Mani et al 2008). In our study the overestimated dental age using Demirjian's method was higher in boys (0.74 years) compared to girls (0.67 years).

Conclusions
The analysis of the comparisons between dental age and chronological age depends on the method used for dental age assessment. Our research demonstrates that most patients undergoing the study had an advance in dental age compared to the chronological age, both in girls and boys, the percentage of girls being significantly higher. Despite the fact that the number of girls with differences between dental age and chronological age was higher than for boys, the average value of the difference between dental age and chronological age was higher for boys than for girls. We consider that Demirjian's method of assessment of dental age is only indicative for children in Romania and that this method requires adaptations for this population.

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