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Studija dvaju različitih postupaka za određivanje dentalne dobi kod djece u Hrvatskoj

Studies of Two Different Methods for Dental Age Estimation in Croatian Children

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Sažetak

Određivanje dentalne dobi djece i odraslih, jedan je od vrlo zahtjevnih postupaka u kliničkim, forenzičnim i arheološkim istraživanjima. Svrha ovoga rada bila je usporediti pouzdanost Demirjianove i Haavikkove metode u određivanju točne kronološke dobi djece hrvatske populacije. Dentalna zrelost proučavala se na 115 ortopantomograma djece u dobi od 4 do 17 godina, različita spola bijele rase, a pohranjeni su u arhivima Stomatološkog fakulteta i Klinike za stomatologiju KBC-a u Zagrebu. Srednja vrijednost godina za obje skupine iznosila je 12 godina. Koeficijent korelacije za ukupni uzorak prema Demirijanu iznosio je 0,96 ($p < 0,001$), a za ukupni uzorak prema Haavikku iznosio je 0,97 ($p < 0,001$). Koeficijenti korelacije za dječake i djevojčice, prema promatranim metodama, također su bili vrlo visoki i statistički znatni. Rezultati ovoga istraživanja upozoravaju na moguću praktičnu primjenu objiju metoda u kliničkim i forenzičnim postupcima na uzorku dječje dobi hrvatske populacije.

Zaprimljen: 4. svibnja 2006.

Prihvaćen: 1. lipnja 2006.

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Ključne riječi

određivanje dentalne dobi;
forenzična stomatologija

Uvod

Tijekom povijesti sudske medicine, kao posebna znanstvena grana, razvila se forenzična stomatologija. Jedan od njezinih glavnih zadataka jest identifikacija ljudskih ostataka posebnim metodama i tehnikama rada, među kojima su i postupci određivanja dentalne dobi (1).

Određivanje dobi sastavni je dio svakog identifikacijskog postupka i vrlo je važan ako su nedostupne ostale informacije o unesrećenome. Osim u forenzičnim postupcima, procjena dentalne dobi vrlo je važna i u kliničkim stomatološkim analizama te u arheološkim istraživanjima (2, 3). U nekim društvima kronološka dob živih osoba ima veliko značenje za socijalne olakšice, zapošljavanje i brak (3).

Introduction

In the course of the evolution of the forensic medicine, forensic dentistry has developed as a separate scientific discipline. One of the main tasks of forensic dentistry is the identification of human remains using dental methods and techniques, one among many being the procedure for determination of dental age (1).

Apart from significance in forensic procedures, dental age determination is also important in clinical dental analysis, especially orthodontics and paedodontics, and in archaeological research (2, 3). In some societies dental estimation of the real age of the living persons may be a determining factor for the eligibility for social benefits, employment, school attendance and marriage (3).

Poznajući biološke promjene u razvoju zuba, možemo odrediti dentalnu zrelost. Određivanje kronološke dobi kod djece obuhvaća promatranje razvoja kosti i razvoja zuba (4). Mineralizacija kosti pokazuje visoku varijabilnost, jer je pod utjecajem egzogenih i endogenih čimbenika. Stupnjevi mineralizacije zuba ključni su u određivanju kronološke dobi, zato što su u razvoju neovisni o ostalim čimbenicima. U prvih šest mjeseci života dob se određuje na osnovi stupnja mineralizacije mliječnih zuba, a od šestog mjeseca prema kronologiji nicanja te stupnju razvoja korijena (5-7). Danas postoje razne metode za određivanje dobi kod djece, a sve se temelje na morfološkim i razvojnim promjenama krunskih i korijenskih dijelova zuba mliječne i trajne denticije, a jedna od najčešće korištenih metoda jest ona prema Demirijanu (8-11).

Svrha istraživanja bila je usporediti dvije poznate metode za procjenu dentalne dobi kod djece prema Demirijanu i Haavikku, s mogućom primjenom u kliničkim i forenzičnim postupcima u Hrvatskoj.

Ispitanici i postupci

Istraživanje je provedeno na 115 ortopantomogramskih snimki iz arhiva Stomatološkog fakulteta Sveučilišta u Zagrebu. Od toga je 53 učinjeno kod dječaka, a 62 kod djevojčica u dobi između 4 i 17 godina. Djeca su pripadala zagrebačkoj populaciji, to jest kontinentalnom dijelu Hrvatske. Rendgenske su snimke snimljene prema strogim kliničkim indikacijama specijalista pedodontije i ortodontije.

Koristile su se samo ortopantomogramske snimke koje su sadržavale svih sedam zuba u donjem lijevom kvadrantu i na kojima nije bilo kongenitalnih anomalija. Demirijanova metoda (10, 11) temelji se na korištenju razvojnih stadija zuba pomoću ljestvice od osam stupnjeva koja pokriva razvoj jednokorijenskih i višekorijenskih zuba. Očitavanja su obavljena na zubima u donjem lijevom kvadrantu. Donji lijevi treći kutnjak /38/ nije bio uključen u određivanje dentalne dobi zbog njegove podložnosti varijacijama oblika, položaja, veličine i pojavnosti. Demirijan i suradnici 1973. opisali su osam stupnjeva mineralizacije (A-H) za svaki zub i svakom dodali bod. Zbroj bodova za svaku osobu dao je procjenu dentalne zrelosti.

Haavikkova metoda (12) temelji se na podjeli razvoja zuba na dvanaest radiografskih stadija za jednokorijenske i dvokorijenske zube.

Realna dob uspoređena je s procjenjenom dobi koristeći Pearsonov koeficijent korelacije samo s $p < 0,05$ značajnosti.

Recognition of biological changes marking the teeth development enables the determination of dental maturity. Determination of the chronological age in children encompasses determination of the degree of the development of bones and teeth (4). Mineralization of the bones show some variability because they are subjected to the influence of environmental and nutritional factors. The mineralization of the teeth is largely independent of these factors. During the first six months of human life age is usually determined by the degree of mineralization of the primary teeth. From the sixth month on, age is determined according to the chronology of eruption and the level of crown and root development as seen in radiographs (5 to 7). There are several methods for age determination in children based on dental maturation. They may be divided into those using the atlas approach and those using scoring systems. One of the most frequently used scoring system method is the Demirjian's method (8 to 11).

The aim of the research was to compare two widely used methods for the estimation of dental age in children, according to Demirjian and according to Haavikko with the possibility of their application in the clinical and forensic procedures in the Croatian population.

Material and Methods

The study was conducted on 115 panoramic radiographs from the archives of the School of Dental Medicine, University of Zagreb. Out of the total, 53 were from boys and 62 from girls aged between 4 and 17 yrs. The children (Caucasian) were citizens of Zagreb i.e. of the continental part of Croatia. The radiographs had been taken on strict clinical indications by paedodontic and orthodontic specialists.

Only panoramic radiographs containing all the seven teeth in the lower left quadrant / i.e. teeth 31–37/ and with no congenital anomalies were used. The lower left molar /38/ was not included in the dental age determination due to its variability in development. The Demirjian method (10, 11) is based on the use of the developmental stages of the seven teeth by applying an eight degree scale that covers the development of both single and multirrooted teeth. Demirjian et al. (1973) described eight developmental stages of the mineralization (A-H) for each tooth. These stages are then transformed into "dental maturity score" which estimate the dental maturity.

The Haavikko's method (12) is based on the recognition of twelve radiographic stages for each

Rezultati su analizirani statističkim programom MedCalcu (MedCalc, Version 7.5, Mariakerke, Belgium) izračunom korelacije i regresije između realne i procijenjene dentalne dobi.

Rezultati

Uzorak je činilo 115 ispitanika (53 djevojčice i 62 dječaka) prosječne dobi 12 godina (medijan; raspon 4 do 17 godina). Metodom prema Demirijanu prosječna (medijan) dob iznosila je 12,3 godina (4,4 do 16), a metodom prema Haavikku 11,5 godina (5,4 do 17). U odnosu prema poznatoj dobi, procijenjena dob prema Demirijanu kod djevojčica je bila precijenjena za sedam mjeseci. U odnosu prema poznatoj dobi, procijenjena dob prema Haavikku bila je podcijenjena za šest mjeseci i kod dječaka i kod djevojčica. Podaci su prikazani na Tablici 1., zajedno s podacima o dobi ispitanika unutar skupina prema spolu.

Na Tablici 2. su koeficijenti korelacije realne dobi u promatranom uzorku prema spolu, a koristile su se metode Demirijana i Haavikka. Korištenjem obiju metoda dobivena je statistički vrlo znatna korelacija (za sve: $p < 0,001$) usporedbom realne dobi i dobi procijenjene dvjema metodama u svih ispitanika i unutar skupina prema spolu.

tooth and the transformation of these stages into a dental age. The chronological age is then estimated as the mean of all the estimates.

Data were presented with median and range. Real age was compared to estimated age using Pearson correlation coefficient and only $p < 0.05$ was considered significant. Association of real age with estimated age was presented with scatterplots where linear regression was used to calculate regression line with 95% confidence intervals. Data were analyzed by the statistical program MedCalc (MedCalc, Version 7.5, Mariakerke, Belgium).

Results

Using Demirjian's method the average estimated age was 12.3 years (range 4.4 to 16 yrs), and using Haavikko's method it was 11.5 years (range 5.4 to 17 yrs). In relation to the real age, the estimated age of girls according to Demirjian was overestimated by seven months. According to Haavikko estimated age of both girls and boys was underestimated by six months. The detailed data is presented in Table 1.

Table 2 shows the correlation coefficients between the estimated and the real age of the samples using the Demirjian's and Haavikko's methods. For

Tablica 1. Prikaz dentalne dobi u promatranom uzorku prema spolu.

Table 1 Dental age at monitored sample by gender

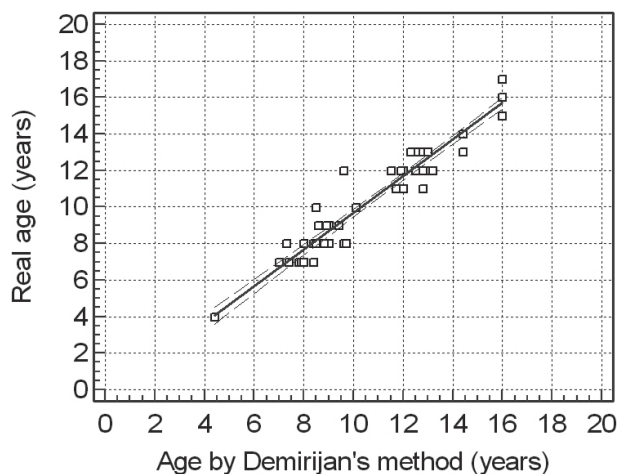
	Ukupno • Total (djevojčice i dječaci) • (girls and boys)		Djevojčice • Girls		Dječaci • Boys	
	Raspon godina • Age interval	Medijan • Median	Raspon godina • Age interval	Medijan • Median	Raspon godina • Age interval	Medijan • Median
Godine • Chronological years	4-17	12	5-17	12	4-17	12
Metoda prema Demirijanu • Estimated age with Demirjian's Method	4,4-16,0	12,3	6,0-16,0	12,7	4,4-16	12
Metoda prema Haavikku • Estimated age with Haavikko's Method	5,4-17	11,5	6,4-17	11,5	5,4-17	11,5
N	115		53		62	

Tablica 2. Prikaz korelacije realne dobi prema spolu:

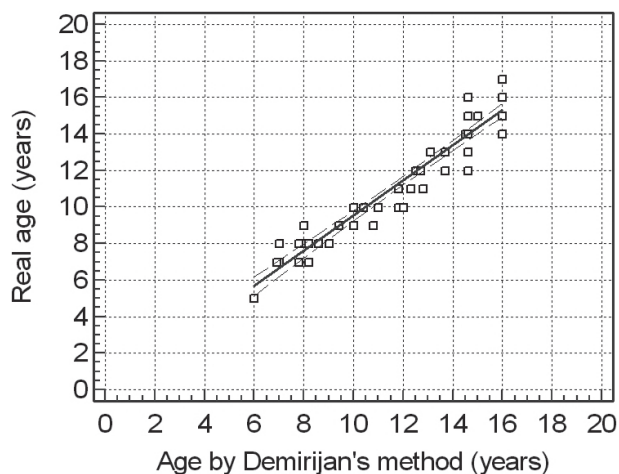
Table 2 Correlation with the real age by gender

	Ukupno • Total (djevojčice i dječaci) • (girls and boys)		Djevojčice • Girls		Dječaci • Boys	
	r	p	r	p	r	p
Estimated age with Demirjian's Method	0,96	$p < 0,001$	0,96	$p < 0,001$	0,96	$p < 0,001$
Estimated age with Haavikko's Method	0,97	$p < 0,001$	0,98	$p < 0,001$	0,96	$p < 0,001$
N	115		53		62	

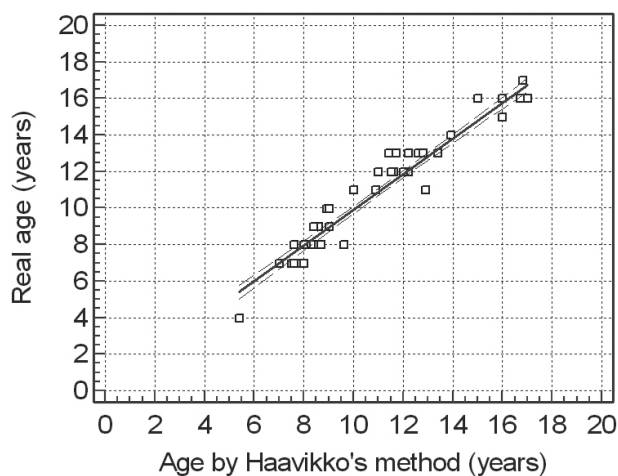
r = Koeficijent korelacije • Correlation coefficient; p = Statistička znatnost • Statistical significance



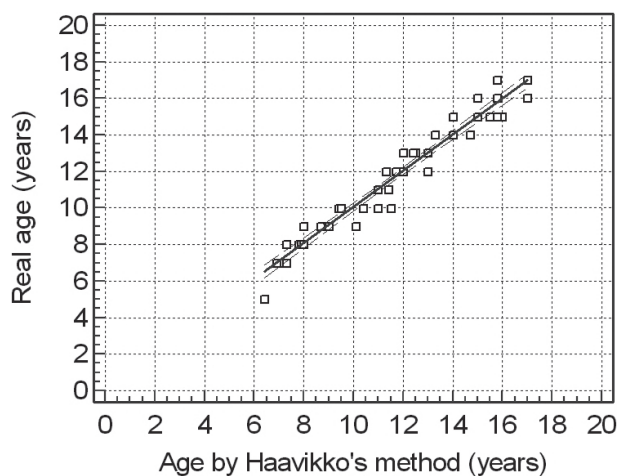
Slika 1. Realna dob dječaka u korelaciji sa procijenjenom dobi prema Demirijanu
 Figure 1 Real age of boys correlated with age estimated by Demirjian's method



Slika 2. Realna dob djevojčica u korelaciji sa procijenjenom dobi prema Demirijanu
 Figure 2 Real age of girls correlated with age estimated by Demirjian's method



Slika 3. Realna dob dječaka u korelaciji sa procijenjenom dobi prema Haavikko
 Figure 3 Real age of boys correlated with age estimated by Haavikko's method



Slika 4. Realna dob djevojčica u korelaciji sa procijenjenom dobi prema Haavikko
 Figure 4 Real age of girls correlated with age estimated by Haavikko's method

Podaci iz tablice 2 prikazani su grafički uz pomoć regresijskog pravca, slike 1-4.

Rasprava

Demirjianova metoda za određivanje dentalne dobi djece bila je velik napredak kada se pojavila prije više od 25 godina (10, 11). Od tada je u široj primjeni, a od posebnog je interesa za ortodontu u planiranju terapijskih postupaka različitih oblika malokluzije. Korisna je i forenzičarima tijekom određivanja dentalne dobi živih osoba i pronađenih ljudskih ostataka (13).

Kako je stupanj simetrije između lijeve i desne strane donje čeljusti visok, dovoljno je promatrati

both methods, a statistically significant correlation was found ($p < 0.001$) for both gender groups.

Figures 1 to 4 present scatterplots with regression lines comparing data from Table 2.

Discussion

Demirjian's method for the dental age determination in children was a great step forward more than 25 years ago (10, 11). The method has been widely used ever since, and it is of special interest both for the orthodontists when planning therapeutical procedures of different kinds of malocclusions as well as in forensic examinations for the dental age determination of living persons as well as of human remains (13).

7 zuba jedne strane. Za svako dijete proučavali su dentalnu dob koristeći se s 14 i 7 zuba donje čeljusti. Standardna devijacija tih dviju metoda bila je mala. Zato je postala temeljna metoda koja proučava 7 zuba na lijevoj strani donje čeljusti. Donji trajni zubi na lijevoj strani rangirani su na ljestvici A-H. Zbroj stadija svih 7 zuba daje bodovnu zrelost, koja se očitava iz tablica kako bi se dobila djetetova kronološka dob (14, 15).

Skupina autora dokazuje da je dob testirane populacije, koristeći se tablicama za francusko-kanadsku djecu, obično precijenjena. To bi značilo da je njihova dobivena dentalna dob ranija od dobi francusko-kanadske djece (16).

Willems i suradnici (16) ponovili su Demirjjanovu studiju na belgijskoj populaciji. Statistička analiza rezultata dovela je do kreiranja novih tablica za oba spola.

Teivens i Mörnstad pripremili su i objavili modifikaciju Demirjjanove metode (17). Svrha je bila pronaći model s najboljim mogućim faktorom korelacije između bodova dentalne zrelosti i kronološke dobi. Svaka populacija tada treba vlastitu tablicu pretvorbe, kako bi došli do kronološke dobi, jer postoje razlike u stadijima sazrijevanja denticije kod različitih populacija. Jasno je da povezanost bodovne zrelosti i kronološke dobi ne slijedi jednostavne matematičke funkcije. Naprednijim regresijskim analizama, uz tri različite regresijske funkcije (linearna, kvadratna, hiperbolna), moguće je doći do povezanosti bodova zrelosti i kronološke dobi, ali se ne koriste zbog kompleksnosti. Uporaba modificirane originalne Demirjjanove metode s objektivnom kubičnom funkcijom ima tri prednosti. Moguće je opisati pouzdani interval oko procjene godina, uspoređivati različite populacije i konstruirati specifične tablice (17, 18).

Uspoređujući modificiranim postupkom švedsku i korejsku populaciju, autori zaključuju da švedski dječaci i djevojčice pokazuju raniju dob u dentalnom sazrijevanju, nego korejska skupina. Razlika je 2 do 3 mjeseca za dječake i pola godine za djevojčice, što posebice dolazi do izražaja u rasponu od 6 do 12 godina (19). Ipak, švedska skupina pokazala je valjanost originalne tehnike u određivanju dentalne zrelosti, bez obzira na biološke različitosti pojedina.

Chaillet i suradnici (20, 21) proučavali su dentalnu dob finske djece te na temelju postignutih rezultata savjetuju Demirjjanovu metodu sa specifičnim finskim bodovima samo za određivanje dobi tamošnje djece, a polinomsku funkciju kada je cilj odre-

Dental age for each child has been examined by monitoring 7 and 14 teeth of the lower jaw. Standard deviation between the two methods was not significant (10, 11). Given that the degree of symmetry between the left and the right sides of the lower jaw is high, it is sufficient to monitor the seven teeth on one side.

Some authors have shown that the age of tested populations – using the tables for the French-Canadian children – was usually overestimated (14, 15). It has been shown that the Norwegian, Swedish and Finnish children the up to one year ahead of their French-Canadian counterparts.

Willems et al. (16) repeated Demirjjan's study on Belgian Caucasian population. Statistical analysis of the results led to the creation of new tables for girls and boys with maturity scores expressed in years.

Teivens and Mörnstad (17) published a modification of the Demirjjan's method. The aim was to find a mathematical model with the best possible correlation factor between the dental maturity scores and chronological age. With the help of the advanced regression analysis with different regression functions, it was possible to obtain better correlation between the maturity score and chronological age, but due to their complexity, they are not in common use. Given that there may be differences in dental maturation in different populations, each population may need its own table of transformation. The use of the modified Demirjjan's method allows this and it is possible to describe the reliability interval around the age estimation, to compare different populations and to construct the tables for each population (17, 18).

Comparing Swedish and Korean populations by the modified method, the authors concluded that Swedish boys and girls are maturing earlier than the Koreans. The difference is up to 2 to 3 months for boys and 6 months for girls, which is especially the case in the age group between 6 to 12 years (19). However, the Swedish group showed the validity of the original technique in the determination of dental maturity regardless of the individual biological differences.

Chaillet and al. (20, 21) studied the dental age in Finnish children. Based on the obtained results, they suggested the use of the Demirjjan's method with the specific Finnish scores only for the determination of the dental age in Finnish children. The specific results of the various populations need to be adjusted in order to obtain reliable age estimation.

diti godine za forenzične potrebe. Potrebno je prilagoditi specifične rezultate promatranih populacija za učinkovitiju procjenu godina.

Dva najčešća postupka za određivanje dentalne dobi u djece korištene u ovom radu potvrdile su prethodne rezultate i dosadašnje studije. Rezultati ovog istraživanja na uzorku dječaka i djevojčica u dobi između 4 i 17 godina, pokazuju visoku korelaciju između stvarne kronološke dobi i dobi procijenjene postupcima prema Demirijanu i Haavikko, $p < 0,001$.

Temeljem postignutih rezultata u ovom istraživanju može se zaključiti da je korelacija između postignute i realne dobi, koristeći se dvjema različitim metodama, vrlo visoka i statistički značajna te se zato obje mogu preporučiti za praktičnu primjenu, kako u kliničkim tako i u forenzičnim postupcima u Republici Hrvatskoj.

Zahvala

Istraživanje je obavljeno u sklopu projekta koji je financiralo Ministarstvo znanosti, obrazovanja i športa Republike Hrvatske – projekt 0065004.

Two of the most common methods for age estimation in children using dental development were used in this study and they have confirmed previous results and previous studies. The results obtained in our study on both boys and girls aged between 4 and 17 years showed a high correlation between the real chronological age and the age estimated by both Demirjian's and Haavikko's methods, $p < 0,001$.

Based on the results of this research, it can be concluded that – using any of the two methods – the correlation between the estimated and real age is high and statistically significant. Therefore, both methods can be recommended for practical application in clinical and forensic procedures on the Croatian population.

Acknowledgments

The research was supported by the Ministry of Science, Education and Sports of the Republic of Croatia – grant No. 0065004.

Abstract

Dental age determination in children and adults is an important task in the clinical, forensic and archaeological examinations. The objective of this paper was to compare the reliability of the Demirjian's and Haavikko's methods in the determination of chronological age of Croatian children. Dental maturity was studied by the use of 115 panoramic radiographs of Caucasian children of both sexes aged between 4 and 17, from the archives of the School of Dental Medicine and the Dental Clinic of the Clinical Hospital Centre in Zagreb. The median age for both groups was 12 years. Correlation coefficient between estimated and real age for the total sample according to Demirjian's method was 0.96 ($p < 0,001$), while for Haavikko's method it was 0.97 ($p < 0,001$). According to the monitored methods, the correlation coefficients for both sexes were high and statistically significant. Results of this research show the possibility for use of both methods in clinical and forensic cases in Croatia.

Received: May 4, 2006

Accepted: June 1, 2006

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Key words

aging; age determination by teeth;
forensic dentistry

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