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Forenzično određivanje dentalne dobi kod odraslih

Forensic Determination of Dental Age of Adults

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Sažetak

Svrha rada: Određivanje dentalne dobi kod odraslih ljudskih ostataka vrlo je važno u identifikaciji forenzičnih slučajeva, a provodi se i u paleostomatološkim analizama. Svrha studije bila je usporediti kronološku dob s dentalnom dobi postignutom metodom prema Johansonu (1971.). **Materijal i načini**: Ukupno se u studiji koristilo 140 trajnih zdravih zuba pripadnika bijele rase. Svi su bili bez dentalnih ispuna i karijesnih lezija. Kronološka dob ispitanika bila je između 18 i 80 godina, a srednja vrijednost iznosila je 45 godina. Za određivanje dentalne dobi koristio se postupak prema Johansonu iz godine 1971. Svaki je zub bio podvrgnut uzdužnoj sekciji do središta pulpnog prostora u vestibulo-lingvalnom smjeru. Na svakom je rezu promatrano šest parametara: količina sekundarnog dentina, atricija, nakupljenost zubnog cementa, resorpcija korijena, recesija parodontnog pričvrstka i translucencija korijenskog dentina. Postignuti rezultati dentalne dobi uspoređeni su s kronološkom, koristeći se Pearsonovim koeficijentom korelacije te regresijskom analizom. **Rezultati**: Dobiveni rezultati pokazali su veliku korelaciju između kronološke i određene dentalne dobi s koeficijentom korelacije koji je iznosio r=0,85, p<0,001. Korelacija među spolovima također je bila vrlo velika - r=0,99 za zube muških ispitanika i r=98 za zube ženskih ispitanika. **Zaključak**: Metoda korištena u ovom istraživanju pokazala se kao metoda izbora za određivanje dentalne dobi na ekshumiranim truplima i ljudskim ostacima u forenzičnim analizama u Hrvatskoj.

Uvod

Zubna tkiva su među najpostojanijim dijelovima ljudskoga tijela - otporna su na različite vanjske utjecaje, kao što su mehanički, termički i kemijski čimbenici. Njihov specifičan položaj i izgled uvjetovani su mnogim različitim prirođenim i stečenim čimbenicima (1).

Određivanje dentalne dobi neidentificiranih ljudskih trupala i ljudskih ostataka radi identifikacije, uvijek se koristi kao tradicionalni postupak u forenzičnim istraživanjima. Osim u forenzičnim analiza-

Introduction

Dental tissues are among the most durable substances produced by the human body resistant to different external influences, as well as to mechanical, thermal and chemical iritiations. Their specific position and shape are source of many different hereditary and acquired characteristics (1).

Forensic age estimation of unidentified human bodies and human remains for the purpose of identification has been a traditional feature of forensic science. They are useful in anthropologic, pa-

ma, zbog postojanosti i očuvanosti zuba nakon smrti, korisno je i u antropološkim, paleostomatološkim i paleoantropološkim istraživanjima (2,3).

Rijetko kad može se na taj način određivati i dob živih ljudi, osobito ako pojedinci nastoje prikriti svoju kronološku dob i identitet (4).

Premda danas postoje različite metode za određivanje dentalne dobi u forenzičnim slučajevima, one se mogu podijeliti u dvije glavne skupine - procjena dentalne dobi kod djece i kod odraslih (5-12).

Svrha ove studije bila je usporediti kronološku dob s procijenjenom dobi dobivenoj na temelju šest antropoloških parametara na ljudskom zubu starijih osoba.

Materijal i postupci

U radu je korišteno 140 trajnih intaktnih zuba bez ispuna i karijesnih lezija. Osamdeset je pripadalo muškim ispitanicima, a 60 ženskim. Razlozi za ekstrakciju zuba bile su indikacije specijalista ortodoncije, parodontologije i oralne kirurgije. Kronološka dob bila je između 18 i 80 godina, sa srednjom dobi od 45,5 godina. Opis uzorka i razvrstanost prema spolu prikazani su u Tablici 1. Ukupno je tijekom dvije godine bilo skupljeno 200 zuba, a za ovo istraživanje izdvojeno je 140 jednokorijenskih i dvokorijenskih iz obiju čeljusti. Nakon ekstrakcije svaki je zub bio očišćen pod mlazom hladne vode, dezinficiran u tri postotnom H_2O_2, i na kraju osušen na sobnoj temperaturi. Zatim su uloženi u svjetlosno polimerizirajući materijal (Varidur, Buhler®). Slijedilo je rezanje preciznom pilom Isomet 1000, Buhler®. Zubi su rezani longitudinalno u aksijalnoj osi, od vrška korijena do krune u tri tanka reza debljine 70-100μm.

Na svakom je rezu promatrano šest obilježja: atricija (A), sekundarni dentin (S), taloženje cementa (C), razina periodontnog pričvrstka (P), resorpcija korijena (R) i translucencija korijenskog dentina (T). Taj je postupak obavljen prema Johansonovu postupku - Slika 1. (13).

Rezultati kronološke i postignute dobi statistički su uspoređeni Pearsonovim koeficijentom korelacije i regresijskom analizom. Statistička analiza provedena je MedCalc Softwarom (Verzija 8, Mariakerke, Belgija).

Postignuta dob na uzorku zuba gornje i donje čeljusti u signifikantnoj je korelaciji s kronološkom dobi. Koeficijent korelacije iznosio je 0,99 za maksilarne zube i 0,98 za mandibularne (p<0,001, Tablica 2., Slika 2.)

laeodontologic, palaeoanthropologic and forensic investigation as biomarkers of aging because they may be preserved for a long time after death (2,3).

In rare cases it may be necessary to determine the age of living persons particularly in cases when the individual is either unwilling or unable to reveal his identity (4).

Although there are many different techniques used for the establishment of the dental age for forensic purposes, they all can be divided into two main groups: Dental age estimation in children and in adults (5-12).

The purpose of this study was to compare chronological age with estimated dental age using anthropological parameters on human teeth in adults.

Material and methods

A total of 140 Caucasian permanent intact teeth without fillings and dental caries from 80 males and 60 females were taken. The known age ranging from 18 to 80 years old with average age 45.5 years. The sample size and gender distribution of the material is shown in Table 1. The reasons for teeth extractions were orthodontic and periodontal provided the patient's consent upon strict indications of the orthodontic and periodontal specialists and oral surgeons. A total of 200 teeth were collected within the time frame of two years out of which 140 one- and two- rooted teeth from maxilla and mandible were isolated for this research. After the extraction, the teeth were cleaned under the running water, disinfected in the 3% H_2O_2 and dried at the room temperature. Every tooth was embedded in light curing resin (Varidur, Buhler®). Further processing was carried out with the precise cutter Isomet 1000, Buhler®. Every tooth was cut perpendicular to the root axis at the tooth crown and three subsequent thin-slices sections of 70-100μm were prepared.

Six variables were measured: attrition (A), secondary dentin (S), cementum apoposition (C), periodontal recession (P), root resorption (R), and root translucency (T) according to Johanson method, Figure 1, (13).

The results of the chronological and the estimated age have been statistically compared using Person's correlation coefficient and regression analysis. Statistical analysis was performed using MedCalc Software (Version 8, Mariakerke, Belgium).

Age determination on a sample of maxillary and mandibular teeth is in significant correlation with known age. Correlation coefficient was 0.99 for maxillary, and 0.98 for mandibular teeth (p<0.001, Table 2, Figure 2).

Postignuta dob na uzorku zuba među spolovima u signifikantnoj je korelaciji s kronološkom dobi. Koeficijent korelacije bio je 0,99 za muške uzorke i 0,98 za ženske (p<0,001, Tablica 3., Slika 3.).

Age determination on a sample of teeth between genders is in significant correlation with known age. Correlation coefficient was 0.99 for male, and 0.98 for female samples (p<0.001, Table 3, Figure 3).

Tablica 1. Veličina uzorka prema spolu
Table 1 Sample size and sex distribution

|	**Muško • Male**	**Žensko • Female**	**Ukupno • Total**
Ukupno • Total	80 (57%)	60 (43%)	140 (100%)
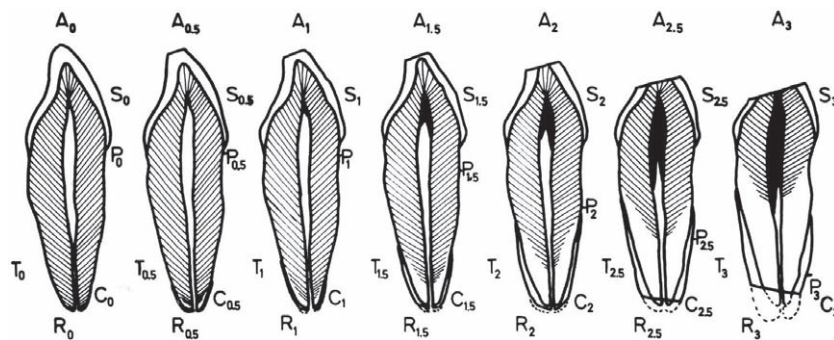
Slika 1. Šest stadija promjena na zubima prema Johansonu: (A- atricija, S- sekundarni dentin, P- parodontni pričvrstak, T- translucencija, C- zubni cement, R- resorpcija korijena), (13)

Figure 1 Six stages of changes in teeth according to Johanson: attrition (A), secondary dentin (S), cementum apoposition (C), periodontal recession (P), root resorption (R), and root translucency (T), (13)

Tablica 2. Koeficijent korelacije između kronološke i postignute dobi – koristili su se zubi gornje i donje čeljusti
Table 2 Correlation coefficients between chronological and estimated age using maxillary and mandibulary teeth

Zubi • Teeth	**N**	**CA**	**EA**	**r**	**p**
Maksilarni zubi • Maxillary teeth	40	39 (14-69)	39 (11-67)	0.99	<0.001
Mandibularni zubi • Mandibulary teeth	100	46 (14-79)	46 (14-75)	0.98	<0.001

N – broj uzoraka • number of samples
CA – kronološka dob • chronological age
EA – postignuta dob • estimated age
r – koeficijent korelacije • correlation coefficient
p - znatnost • significance
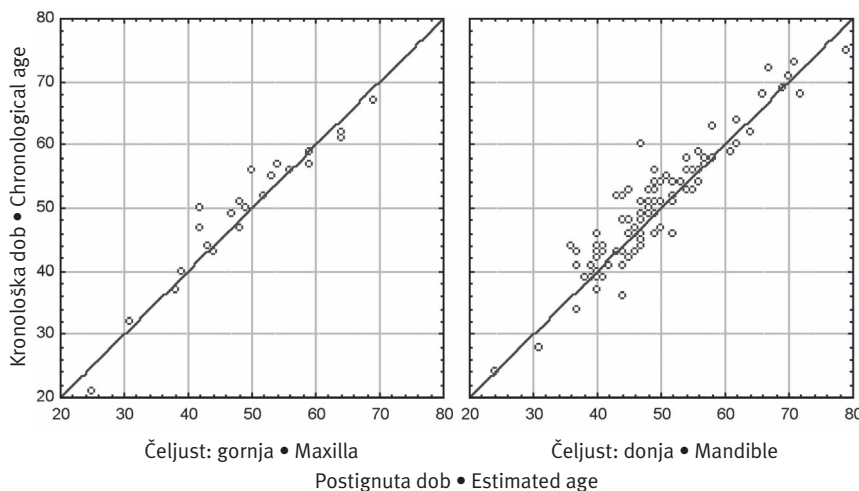
Slika 2. Regresijski pravci između čeljusti i postupka prema Johansonu

Figure 2 Plots of regression lines between jaws and method by Johanson and estimated age with 95% confidence

Tablica 3. Koeficijent korelacije između kronološke i postignute dobi prema spolu
Table 3 Correlation coefficients between chronological and estimated age by gender

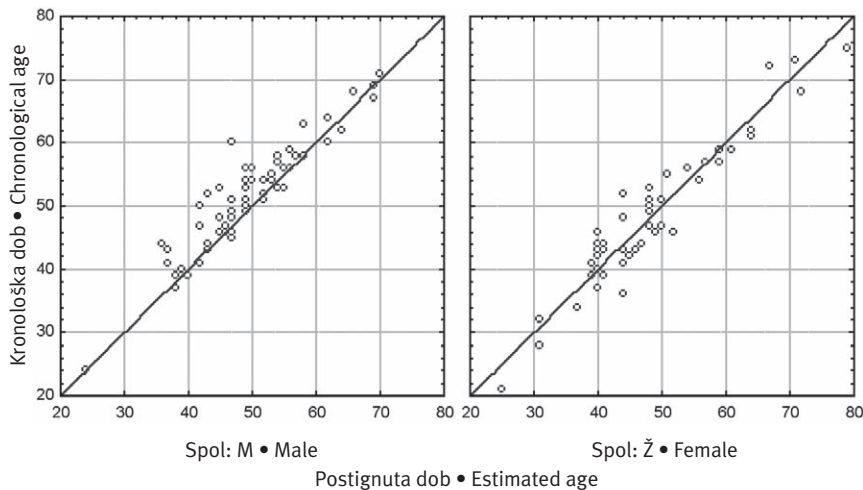| Spol • Gender	N	CA	EA	r	p
Muški • Males	78	47 (14-70)	49 (14-71)	0.99	<0.001
Ženski • Females	65	41 (14-79)	43 (14-75)	0.98	<0.001

N – broj uzoraka • number of samples
CA – kronološka dob • chronological age
EA – postignuta dob • estimated age
r – koeficijent korelacije • correlation coefficient
p - znatnost • significance

Spol: M • Male   Spol: Ž • Female
Postignuta dob • Estimated age

Slika 3. Regresijski pravci među spolovima i postupkom prema Johansonu
Figure 3 Plots of regression lines between gender and method by Johanson and estimated age with 95% confidence

Rasprava

Određivanje dentalne dobi podijeljeno je u dvije velike skupine: određivanje dobi kod djece i adolescenata te određivanje kod odraslih. Glavna razlika između tih dviju skupina jest u tome što se u prvoj skupini koriste faze razvoja i mineralizacije trajnih zuba. Obično su to neinvazivni postupci s dobrim poznavanjem rasta i razvoja zuba koje očitavamo na ortopantomogramima (14).

Za razliku od određivanja dentalne dobi kod djece, što je brz, precizan i jednostavan zadatak za forenzičnog stomatologa, određivanje dentalne dobi u srednjoj i starijoj životnoj dobi zahtjevan je postupak s manjom točnošću. Zato je znanje o životnim promjenama na tvrdim zubnim tkivima iznimno važno za svakog forenzičnog stomatologa koji se bavi određivanjem dentalne dobi.

Dentalna se dob može određivati na temelju mikrostrukture zubnih tkiva, analizom kemijskog sastava (racemizacija) i analizom zaživotnih morfoloških promjena na zubima (15).

Određivanje dentalne dobi kod odraslih istraživali su mnogobrojni stručnjaci, a prema podacima iz literature prvi put se koristilo godine 1800. (16). Metoda prema Gustafsonu iz 1950. obavljena na

Discussion

Dental age determination can be divided in two major groups: age determination in children and adolescents, and age determination in adults. Main difference between these two groups is in the fact that the first group uses phases of development and mineralization of permanent teeth; it is usually non-invasive and requires good knowledge of dental growth and development as seen on orthopantomograms (14).

Contrary to the estimation and calculation of dental age in children, which is a quick, precise and simple task for a forensic dentist, dental age estimation in mid and old age is a time-consuming, difficult and rarely completely accurate procedure. Therefore, knowledge of lifetime changes on hard dental tissues is the most important task for every forensic dentist who is focusing on dental age estimation.

Dental age can be assessed by means of dental microstructure analysis, by analyzing chemical composition of the tooth (racemization), and by analyzing morphological and lifetime changes on teeth (15).

Dental age estimation in adults has been performed by many investigators, and based on the

uzorku od 40 zuba, bila je zapravo glavna smjernica i okosnica svim ostalim znanstvenicima u dotjeravanju i oplemenjivanju postupaka kojima se određuje dentalna dob odraslih (11).

Meinl i suradnici (17) analizirali su 67 trajnih zuba i na njima određivali dentalnu dob koristeći se trima različitim postupcima, a njihovi rezultati bili su bolji od onih koji su promatrali više parametara na svakom zubu.

U studiji Wagnera i njegovih kolega (18) koeficijent korelacije između translucencije dentina i kronološke dobi iznosio je 0,67. Solheim (19) je istaknuo da su koeficijenti korelacije između translucencije korijenskog dentina i kronološke dobi iznosili od 0,68 do 0,86, a koristili su se raličitim postucima i mjerenjima od 0,57 do 0,83 rabeći različite zube, a pozitivna korelacija zabilježena je u dugoj translucentnoj zoni kod muškaraca.

Istraživanje Banga i Ramma pokazalo je da je translucentna zona veća na zubima desne strane čeljusti u odnosu prema lijevoj strani, a u ovom istraživanju nije bila zabilježena razlika u translucenciji prema stranama čeljusti. Rezultati dobiveni prema Johansonovoj metodi bili su isti kao u ovom istraživanju (13,20).

Brkić i suradnici (21) analizirali su zube starije životne dobi, koristeći se trima različitim postucima. Rezultati su pokazali da su zubi s obiju strana čeljusti pouzdani za procjenu dentalne dobi. Koeficijent korelacije bio je jak za sve zube u gornjoj čeljusti, a kretao se od 0,92 do 0,99. Koeficijent korelacije za zube donje čeljusti bio je između 0,72 i 0,98. Multipla regresijska analiza pokazala je da maksilarni pretkutnjaci s dva korijena imaju jaču korelaciju s kronološkom dobi u odnosu prema jednokorijenskim zubima. Koeficijent korelacije u istraživanju Banga i Ramma iznosio je 0,98, a za istraživanja u kojima je promatrano više parametara na zubu bio je 0,99.

Rezultati postignuti u tim istraživanjima slažu se s rezultatima Soomerove i njezinih suradnika (22). Oni su istraživanje u određivanju dentalne dobi obavili koristeći osam različitih postupaka s vrlo malom standardnom pogreškom (0,4) za postupak prema Johansonu.

Zaključak

Na kraju se može zaključiti da je postupak prema Johansonu metoda izbora u određivanju dentalne dobi na ekshumiranim tijelima i ljudskim ostacima u forenzičnim i antropološkim analizama u Hrvatskoj.

literature it was first used, as an age indicator, in 1800s (16). Gustafson's method from 1950, performed on a sample of 40 teeth was the main guideline and basis for all other investigators who used and upgraded procedures for dental age estimation in adults (11).

Meinl et al. (17) analyzed 67 permanent teeth by using three procedures and showed that the results in dental age estimation were superior to those observing several parameters on each tooth.

In the study of Wegner et al. (18), the correlation coefficient between root dentin translucency and known age was 0.67. Solheim (19) showed that correlation coefficients between translucency factor and known age were 0.68 to 0.86 in different methods of measurements and 0.57 to 0.83 in different teeth, and positive correlation demonstrated a longer zone of translucent dentin in males.

Bang and Ramm have showed that the translucent dentine zone is greater on the right side of the jaw, while our research showed that there is no difference in the size of the translucent zone on either side of the jaw. Johanson has reported the same data (13,20).

Brkić et al. (21) determined the dental age in adults by using three methods and showed that both sides of the jaw are reliable for dental age estimation, although the correlation coefficient was stronger for all types of maxillary teeth, in a range from 0.92 to 0.99. The correlation coefficient for mandibular teeth was between 0.72 and 0.98. Multiple regression analysis has shown that maxillary premolars with two roots have stronger correlation with age when compared with single-rooted teeth. Correlation coefficient according to Bang and Ramm was 0.98, and 0.99 for the method where more dental characteristics were analyzed.

The results of our study are in accordance with data published by Soomer et al. (22) regarding the assessment of eight different methods for dental age estimation with a very small standard error (0.4) for Johanson method.

Conclusion

It can be concluded that Johanson method is the method of choice for dental age estimation on exhumed bodies and skeletal remains for forensic and anthropological analysis in Croatia.

Abstract

Objectives: Estimaiting the dental age of the adult human remains can often be of great importance in forensic identification cases, and also provides valuable data in paleodontology. The aim of the present study was to compare chronological age with estimated dental age by the method according to Johanson, published in 1971. **Material and Methods:** 140 permanent intact teeth without dental fillings and/or dental cavity were taken. The known age was ranging from 18 to 80 years. The average age was 45 years. For the dental age estimation the method according to Johanson was used. Every tooth was subject to longitudinal section of the midpulpal area in a vestibulo-lingual plane. Six variables were analyzed: secondary dentin, attrition, cementum apposition, root resorption, periodontal recession, and root translucency. The results of the chronological and the estimated age have been statistically compared using Person's correlation coefficient and regression analysis. **Results:** The results showed strong correlation coefficient $r=0.85$; $p<0.001$ between chronological and determinated dental age. Age determination on samples of teeth between genders is in significant correlation with known age. Correlation coefficient was 0.99 for male, and 0.98 for female samples ($p<0.001$) **Conclusion:** The method used in this research is the method of choice for dental age determination on exhumed bodies and skeletal remains for forensic and anthropological analysis in Croatia.

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