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Comparison of Dental and Skeletal Age Estimating Methods in Children

Usporedba metoda za procjenu dentalne i skeletne dobi djece

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Abstract

Objectives: Estimating age is a crucial determinant of forensic science. Various methods have been used to estimate dental age (DA) and skeletal age (SA).The aim of the current study was to compare the Cameriere's DA method with the Cameriere's SA method in estimating CA in children. **Materials and methods:** A total of 216 radiographs of 130 females and 86 males (between 9 to 14.99 years of age) were evaluated in northwestern Turkey. DA was calculated on the panoramic images using Cameriere's open-apex method. SA was determined on the lateral cephalograms using the fourth cervical vertebrae method by Cameriere. The DA, SA, and CA data were compared using a paired t-test and Wilcoxon test. **Results:** The mean CA of all groups was calculated as 12.96±0.30, the mean DA of 12.74±0.68 and the mean SA of 12.89±0.89. In males, the DA method presented an underestimation between ages of 14.00 and 14.99 ($p<0.05$) and an overestimation between ages 9.00 and 11.99 ($p<0.05$). In females, the DA method showed an underestimation in the 13.00- and 14.99-year-old age groups ($p<0.05$) and an overestimation in the 10.00- and 11.99-year-old age groups ($p<0.05$). The SA method revealed a significant underestimation in females between the ages of 13.00 and 14.99 and in males between the ages of 14.00 and 14.99 ($p<0.05$). **Conclusions:** The SA estimation method may provide more accurate results compared to the DA method with children of both sexes aged between 9.00 to 12.99 in the determination of CA.

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Introduction

Age estimation covers a wide range of disciplines, including, forensic medicine, orthodontics, and pediatric endocrinology (1). In children and adolescents, various forensic and legal issues, including the age of criminal responsibility or the age of adulthood can be resolved through age estimation methods (2). The chronological age (CA) refers to the date of birth of a child. However, it is not an accurate indicator of the stage of development of the child, since the stage of growth-development varies from one individual to another (3,4). Therefore a variety of methods, including dental and skeletal age estimation which can be calculated from panoramic, cephalometric, and hand-wrist plain radiographs as well as cone-beam computed tomography (CBCT) images have been described in the literature (5,6).

Dental age (DA) is one of the most reliable age estimation parameters as it is less affected by endocrine diseases or dietary variations than other morphological structures (7). DA is estimated by grading the eruption of the teeth or the de-

Uvod

Procjena dobi obuhvaća širok raspon disciplina, uključujući sudsku medicinu, ortodonciju i pedijatrijsku endokrinologiju (1). Kod djece i adolescenata mogu se metodama procjene dobi riješiti razna forenzička i pravna pitanja, uključujući dob kaznene odgovornosti ili dob punoljetnosti (2). Kronološka dob (CA) odnosi se na datum rođenja djeteta. No to nije točan pokazatelj stupnja djetetova razvoja s obzirom na to da stupanj rasta i razvoja varira od osobe do osobe (3, 4). Zato su u literaturi opisane različite metode, uključujući procjenu dentalne i skeletne dobi koja se može izračunati iz panoramskih, kefalometrijskih i običnih rendgenskih snimaka šake kao i slika kompjutorizirane tomografije s konusnom zrakom (CBCT) (5, 6).

Dentalna dob (DA) jedan je od najpouzdanijih parametara za procjenu dobi s obzirom na to da na nju manje utječu endokrine bolesti ili varijacije u prehrani od drugih morfoloških struktura (7). DA se procjenjuje na temelju rendgenske snimke stupnjevanjem nicanja zuba ili prema razvijeno-

velopment of the crown and roots from radiographs (8). Several radiological methods have been used to determine DA in immature individuals (9). Cameriere et al. (9) introduced the Open Apex-based estimation method based on the relationship between the age and the measurement of open apices of the teeth to improve the precision and reliability of the age estimations which was validated in Turkish children (8).

The skeletal age (SA) method has been reported to be used to determine developmental age (10–14). In the literature, most reported studies (10–14) have used lateral cephalograms to estimate SA. Lateral cephalograms are standard treatment records when planning an orthodontic treatment. They provide significant data for a cephalometric analysis of the bones, teeth, soft tissue, and the airway of the head as well as the projections of the cervical vertebrae (15). Several methods, including the cervical vertebral maturation (CVM) method (10) and evaluation of second, third, and fourth cervical vertebrae (C2-4) (11,12) have been used to determine SA. Cameriere et al. (13) have also examined the relationship between the ages of children and adolescents by examining the ratio between the radiological projections of the posterior and anterior sides of the fourth cervical vertebra (C4) on lateral cephalograms to determine SA. This method has been reformulated and validated in Turkish children and adolescents (14).

To our knowledge, to date, no study has compared Cameriere's C4 SA method (13) and Cameriere's open-apex DA method (9) in determining CA in children. Thus, the purpose of this study was to evaluate these two estimation methods in order to improve knowledge of the methods of estimating age and their possible advantages in the determination of CA in the age group of 9.00-14.99 Turkish children from Marmara Region of Turkey. The null hypothesis of the current study was that there would be no difference between the DA and SA estimation methods when compared to CA.

Materials and methods

This retrospective cross-sectional study was approved by the Ethics Committee of the (Bolu Abant İzzet Baysal) University Institutional Review Board (#2020-242) and conducted under the Declaration of Helsinki (16). The study examined the panoramic radiographs and lateral cephalograms of 400 Turkish orthodontic patients who were treated between January 2016 and April 2020. They were randomly chosen from the digital archive of Bolu Abant İzzet Baysal University, Faculty of Dentistry, Department of Orthodontics. Both estimation methods of DA and SA by Cameriere used in the current study had been previously tested and validated in Turkish children (8,14).

The inclusion criteria were as follows: patients aged between 9.0 and 14.99 years at the beginning of treatment, with panoramic radiographs and lateral cephalograms of sufficiently good quality, normal tooth eruption, and no pathological conditions in the jawbone. The exclusion criteria included missing accurate data on sex/CA, patients with previous orthodontic treatment history, extracted lower teeth (except for the third molar), dental and congenital anomalies, systemic diseases, and dental trauma.

sti krune i korijena (8). Za određivanje DA-e, kada je riječ o nezrelim osobama, korišteno je nekoliko radioloških metoda (9). Cameriere i suradnici (9) uveli su metodu procjene koja se temelji na otvorenom apeksu (Open Apex), tj. na odnosu između dobi i mjerenja otvora apeksa zuba kako bi se poboljšala preciznost i pouzdanost procjene dobi koja je potvrđena kod turske djece (8).

Zabilježeno je da se metoda skeletne dobi (SA) koristi za određivanje razvojne dobi (10 – 14). U literaturi, u većini objavljenih istraživanja (10 – 14), upotrebljavali su se lateralni kefalogrami za procjenu SA-e. Lateralni kefalogrami standardni su zapisi pri planiranju ortodontske terapije. Oni daju važne podatke za kefalometrijsku analizu kostiju, zuba, mekog tkiva i dišnih putova te projekcije vratnih kralješaka (15). Za određivanje SA-e korišteno je nekoliko metoda, uključujući metodu sazrijevanja vratnog kralješka (CVM) (10) i procjenu drugoga, trećega i četvrtoga vratnog kralješka (C2-4) (11, 12). Cameriere i suradnici (13) također su ispitivali odnos između dobi djece i adolescenata ispitujući omjer između radioloških projekcija stražnje i prednje strane četvrtoga vratnog kralješka (C4) na lateralnim kefalogramima kako bi odredili SA-u. Ta je metoda preformulirana i potvrđena kod turske djece i adolescenata (14).

Koliko znamo, do danas se ni u jednom istraživanju nije uspoređivalo Camerierеovu metodu C4 SA (13) i Camerierеovu metodu otvorenog apeksa DA (9) u određivanju CA-e kod djece. Stoga je svrha ovog istraživanja bila evaluirati te dvije metode za procjenu kako bi se unaprijedilo znanje o metodama procjene dobi i njihovim mogućim prednostima u određivanju CA-e u dobnoj skupini od 9,00 do 14,99 godina kod turske djece iz regije Marmara. Nulta hipoteza glasila je da neće biti razlike između metoda za procjenu DA-e i SA-e u usporedbi s CA-om.

Materijal i metode

Ovo retrospektivno presječno istraživanje odobrio je Etički odbor Sveučilišnog institucionalnog odbora za reviziju (#2020-242) i provedena je prema Helsinškoj deklaraciji (16). U istraživanju su analizirani ortopantomogrami i lateralni kefalogrami 400 turskih ortodontskih pacijenata liječenih između siječnja 2016. i travnja 2020. Oni su nasumično odabrani iz digitalnog arhiva Zavoda za ortodonciju Stomatološkog fakulteta. Obje Camerierеove metode za procjenu DA-e i SA-e koje su korištene u ovom istraživanju prije toga su testirane i potvrđene na turskoj djeci (8, 14).

Kriteriji za uključivanje bili su sljedeći: pacijenti u dobi između 9,0 i 14,99 godina na početku liječenja, s dovoljno kvalitetnim ortopantomogramom i lateralnim kefalogramom, normalnim izbijanjem zuba i bez patoloških stanja u čeljusnoj kosti. Kriteriji za isključivanje bili su nedostatak točnih podataka o spolu/CA-i, ortodontski liječeni pacijenti, izvađeni donji zubi (osim trećeg kutnjaka), dentalne i kongenitalne anomalije, sistemske bolesti i dentalne traume.

Datum rođenja, spol i rendgenske snimke svakog pacijenta zabilježio je istraživač koji nije vidio slike. Nakon evaluacije rendgenskih snimaka uključene su slike 130 djevojčica i

The birthdate, sex, and radiographs of each patient were recorded by a researcher who was blind to the images. After the evaluation of the radiographs, the images of 130 females and 86 males were included (Table 1). The CA of the patients was calculated by subtracting the image date from the birthdate, and the results were converted to decimal ages by Excel (Excel *15*.0, Microsoft, Redmond, WA, USA). The panoramic radiographs and lateral cephalograms were obtained using the same device (Vatech, PaX-Uni3D, Yongin, Republic of Korea) (50–90 kV, 4–10 mA, and 10.1 s exposure time).

86 dječaka (tablica 1.). CA pacijenata izračunat je oduzimanjem datuma slike od datuma rođenja, a rezultati su pretvoreni u decimalne dobi s pomoću programa Excel (Excel 15.0, Microsoft, Redmond, WA, SAD). Ortopantomogrami i lateralni kefalogrami dobiveni su s pomoću istog uređaja (Vatech, PaX-Uni3D, Yongin, Republika Koreja) (50 – 90 kV, 4 – 10 mA i 10,1 sekunda vrijeme ekspozicije).

Table 1 Distribution of sex and age groups.
Tablica 1. Distribucija spolnih i dobnih skupina

Sex • Spol	Female • Ženski	Male • Muški	Total • Ukupno
Age groups • Dobne skupine			
9-9.99	2	4	6
10-10.99	8	7	15
11-11.99	18	14	32
12-12.99	24	11	35
13-13.99	40	22	62
14-14.99	38	28	66
Total • Ukupno	130	86	216

Measurements of the Lateral Cephalograms for SA Estimation

All digital lateral cephalograms were analyzed using the open-access software ImageJ (National Institute of Health, Bethesda, MD, USA). After the lateral cephalograms had been calibrated, the projections of the (a) anterior and (b) posterior heights of each C4 body were measured by a researcher who was blind to the CA of the participants (13). The anterior height of the C4 vertebral body was measured before the anterior curvature. The ratio Vba = *a/b* was used for age estimation (Figure 1) (13,14). The data obtained from these measurements and calculations were adapted using the regression analysis developed by Gulsahi et al. (14):

$$Age_{female} = -11{,}15 + 28{,}02\ Vba;$$
$$Age_{male} = -9{,}63 + 25{,}84\ Vba;$$

(Vba)= anterior (a) / posterior (b) heights of each C4 vertebral body

Measurements of the Panoramic Radiographs for DA Estimation

All digital panoramic radiographs were first calibrated to minimize the magnification of the images and then analyzed using the open-access software ImageJ (National Institutes of Health, Bethesda, MD, USA). Cameriere's method (9) was applied to evaluate the seven left mandibular teeth. The width of the open apices of teeth with one root (A_i, i = 1,…, 5), the sum of the width of the two open apices (A_i, i = 6, 7), and the root lengths of the teeth with open apices (L_i, i = 1,…,7) were measured (Fig 2). The resulting data were adapted with the following formula using the regression analysis developed by Cameriere (9):

$$Age = 8{,}971+0{,}375g+1{,}631x_5+0{,}674N_0-1{,}034s-0{,}176sN_0$$

where g is 1 for males and 0 for females; x_5 is A5/L5; N_0 is

Mjerenja lateralnih kefalograma za procjenu SA-e

Svi digitalni lateralni kefalogrami analizirani su softverom otvorenog pristupa ImageJ (Nacionalni institut za zdravlje, Bethesda, MD, SAD). Nakon što su kalibrirani, istraživač koji je bio slijep za CA sudionike izmjerio je projekcije (a) prednje i (b) stražnje visine svakoga C4 tijela (13). Prednja visina tijela kralješka C4 izmjerena je prije prednje zakrivljenosti. Za procjenu dobi korišten je omjer Vba = a/b (slika 1.) (13, 14). Podatci dobiveni tim mjerenjima i izračunima prilagođeni su s pomoću regresijske analize koju su razvili Gulsahi i suradnici (14):

dob žene = −11,15 + 28,02 Vba;
dob muškarca = −9,63 + 25,84 Vba;

(Vba) = prednja (a) / stražnja (b) visina svakog tijela kralješka C4

Mjerenja ortopantomograma za procjenu DA-e

Svi digitalni ortopantomogrami najprije su kalibrirani da bi se smanjilo povećanje slike, a zatim su analizirani softverom s otvorenim pristupom ImageJ (Nacionalni institut za zdravlje, Bethesda, MD, SAD). Camerieereovom metodom (9) procijenjeno je sedam donjih lijevih zuba. Izmjereni su širina otvorenih apeksa zuba s jednim korijenom (Ai, i = 1,…, 5), zbroj širina dvaju otvorenih apeksa (Ai, i = 6, 7) i dužina korijena zuba s otvorenim apeksom (Li, i = 1,…,7) (slika 2). Dobiveni podatci prilagođeni su sljedećom formulom s pomoću regresijske analize koju je predložio Cameriere (9):

$$dob = 8{,}971+0{,}375g+1{,}631x_5+0{,}674N_0-1{,}034s-0{,}176sN_0$$

pri čemu je g 1 za muškarce i 0 za žene; x 5 je A5/L5; N_0 je broj zuba s potpuno razvijenim korijenom; s je zbroj Ai/Li otvorenih apeksa.

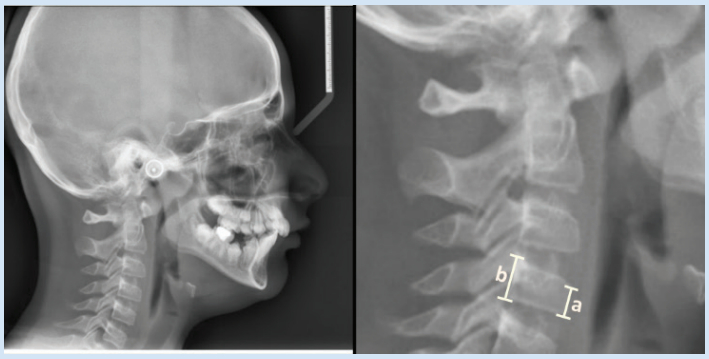

Figure 1 The measurements of mandibular teeth via Cameriere's method on a panoramic radiograph of a 9-year-old. Ai, i = 1...7 describes the width of the inner parts of the open apex. The Ai, of the tooth with two roots is the sum of the inner side width of the two open apices (Ai, i = 6, 7), . Li, i = 1....7 is the length of the tooth.

Slika 1. Mjerenje donjih zuba Camerierеovom metodom na ortopantomogramu 9-godišnjaka; Ai, i = 1...7 opisuje širinu unutarnjih dijelova otvorenog apeksa; Ai dvokorijenskoga zuba zbroj je širine unutarnje strane dvaju otvorenih apeksa (Ai, i = 6, 7), . Li, i = 1....7 je duljina zuba

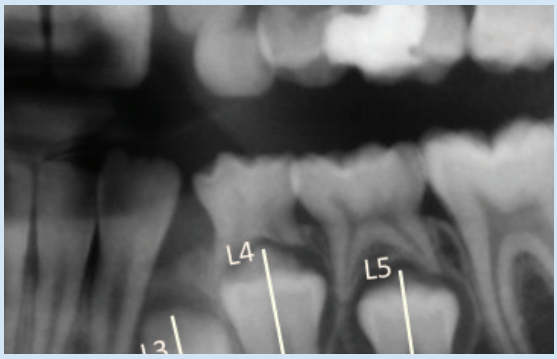

Figure 2 The measurements of (a) anterior and (b) posterior parts of the C4 vertebral body on a lateral cephalogram of a 9-year-old (Vba = 0.734).

Slika 2. Dimenzije (a) prednjega i (b) stražnjega dijela tijela kralješka C4 na lateralnom kefalogramu 9-godišnjaka (Vba = 0,734)

the number of teeth with complete root development; *s* is the sum of the Ai/Li of the open apices.

All measurements and data were introduced in Excel tables (Excel 15.0, Microsoft, Redmond, WA, USA). The analyses of randomly chosen 30 patients, were repeated after four weeks in a double-blind mode by the same (YD) and other (OCG and SA) researchers under the same circumstances. The intra- and interclass correlation coefficients between the first and the second measurements were calculated. For all measurements, the intra- and interclass correlation coefficients were between 0.839-0.995; 0.765-0.885, respectively, reflecting acceptable reliability and reproducibility of all measurements.

Statistical Analysis

The normality test of the data was conducted based on the Kolmogorov-Smirnov and Shapiro-Wilk tests. The mean difference between CA, DA, and SA was calculated for each age and sex group. According to normality results, paired t- and Wilcoxon signed-rank tests were used to compare the following pairs: CA and DA, CA and SA. The mean absolute error (MAE) was used to determine the accuracy of the DA and SA methods. The accuracy of the estimated age was defined by its proximity to CA. The Spearman's rank correlation coefficient was used to assess the correlation between DA-CA and SA-CA for both sexes and the total sample. Absolute values and percentages of CA–DA and CA–SA were calculated to determine the accuracy of over- or underestimation of the DA and SA methods in a 1-year period. The data were analyzed using the SPSS software (version 20.0; IBM, Armonk, NY), and $p < .05$ was set at the significance level in all evaluations.

Results

The mean CA was 13.00 ± 1.33 years, the mean DA was 12.71 ± 1.04 years, and the mean SA was 12.86 ± 1.55 years of all images. When the difference in age estimation

Sva mjerenja i podatci uneseni su u Excelove tablice (Excel 15.0, Microsoft, Redmond, WA, SAD). Analize nasumično odabranih 30 pacijenata ponovljene su poslije četiri tjedna u dvostruko slijepom načinu što je učinio isti istraživač (Y. D.) i drugi (O. C. G. i S. A.) istraživači u jednakim okolnostima. Izračunati su koeficijenti unutarrazredne i međurazredne korelacije između prvoga i drugoga mjerenja. Za sva su mjerenja koeficijenti unutarrazredne i međurazredne korelacije bili između 0,839 i 0,995; 0,765 i 0,885, odnosno, odražavali su prihvatljivu pouzdanost i ponovljivost svih mjerenja.

Statistička analiza

Test normalnosti podataka proveden je s pomoću Kolmogorov-Smirnovljeva i Shapiro-Wilkova testa. Srednja razlika između CA-e, DA-e i SA-e izračunata je za svaku dobnu i spolnu skupinu. Prema rezultatima normalnosti, upareni t-test i Wilcoxonov test s predznakom korišteni su za usporedbu sljedećih parova: CA i DA, te CA i SA. Srednja apsolutna pogreška (MAE) korištena je za određivanje točnosti DA i SA metoda. Točnost procijenjene dobi određena je prema blizini CA-e. Za procjenu povezanosti DA-CA i SA-CA za oba spola i ukupni uzorak korišten je Spearmanov koeficijent korelacije. Apsolutne vrijednosti i postotci CA–DA i CA–SA izračunati su da bi se odredila točnost precijenjenih ili podcijenjenih DA i SA metoda u razdoblju od jedne godine. Podatci su analizirani u softveru SPSS (verzija 20.0; IBM, Armonk, NY), a $p < 0,05$ postavljen je kao razina značajnosti u svim procjenama.

Rezultati

Srednja vrijednost CA-e bila je 13,00 ± 1,33 godine, srednja vrijednost DA-e iznosila je 12,71 ± 1,04 godine, a srednja vrijednost SA-e bila je 12,86 ± 1,55 godina za sve slike. Kada

Table 2 Mean, mean absolute error (MAE), minimum and maximum difference values between CA–DA, as well as for CA–SA in both sexes.
Tablica 2. Srednja vrijednost, srednja apsolutna pogreška (MAE), minimalne i maksimalne vrijednosti razlike između CA–DA-e, te za CA–SA-e u oba spola

	Chronological Age - Dental Age • Kronološka dob – Dentalna dob	Mean Absolute Error • Srednja apsolutna pogreška		
	Mean (SD) • Srednja vrijednost (SD)	Mean (SD) • Srednja vrijednost (SD)	Min	Max
Female • Ženski	0.397 (1.108)	0.920 (0.730)	-2.584	3.337
Male • Muški	0.252 (1.105)	0.919 (0.657)	-2.092	2.758
p†	0.359	0.209		
	Chronological Age - Skeletal age • Kronološka dob – Skeletna dob	**Mean Absolute Error • Srednja apsolutna pogreška**		
	Mean (SD) • Srednja vrijednost (SD)	**Mean (SD) • Srednja vrijednost (SD)**	**Min**	**Max**
Female • Ženski	0.449 (1.292)	1.273 (1.860)	-3.970	4.286
Male • Muški	0.077 (1.851)	0.978 (1.479)	-5.101	3.208
p†	0.209	0.508		

SD: Standard deviation • Standardna devijacija, † Independent sample t test: $p < .05$ • t test za nezavisne uzorke: $p < .05$

Table 3 Accuracy percentages of DA and SA estimation in absolute values differed from CA for both sexes.
Tablica 3. Postotci točnosti procjene DA-e i SA-e u apsolutnim vrijednostima razlikuju se od CA-e za oba spola

	Dental Age • Dentalna dob		Skeletal Age • Skeletna dob	
	Female • Ženski %	Male • Muški %	Female • Ženski %	Male • Muški %
±0.25	13.84	17.7	17.64	20.48
±0.50	39.23	27.84	31.61	38.55
±0.75	50	49.36	42.64	51.80
±1.00	**62.30**	**59.49**	**52.20**	**60.24**
±1.25	69.23	73.41	61.02	67.46
±1.50	76.15	79.74	74.26	74.69
±1.75	82.30	89.87	80.14	79.51
±2.00	86.92	93.67	91.17	87.95
>2.00	13.08	6.33	8.83	12.05

DA: Dental Age according to Cameriere's method • Dentalna dob prema Camerieeovoj metodi; Skeletal Age according to Vba method • Skeletna dob prema Vba metodi; F: Female • ženski, M: Male • muški
Note • Napomena: ±1 dental and skeletal age deviation percentages for both sexes are shown in bold. • ±1 devijacije dentalne i skeletne dobi za oba spola prikazane su podebljano.

and MAE in the groups were compared, no significant differences were found between females and males (p >0.05; Table 2). The accuracy percentages of the samples that correspond to the absolute values of CA–DA and CA–SA within ±0.25, ± 0.50, ± 0.75, ± 1.00, ± 1.25, ± 1.50, ± 1.75, ± 2.00, and above ± 2.00 are shown in Table 3. The accuracy percentages of the DA estimation were 62.3 % for females and 59.49% for males, while those of the SA estimation were 52.2 % for females and 60.24 % for males in the absolute difference values within one year (Table 3).

Significant overestimations of females in the DA method were detected in the age group between 10.00 and 11.99 when compared with CA ($p < .05$; Table 4). On the contrary, the DA method revealed significant underestimations for females between 13.00 and 14.99 years of age ($p < 0.05$; Table 4). The SA method significantly underestimated females between 13.00 and 14.99 years of age compared with CA ($p < 0.05$; Table 4).

In males, the DA method significantly overestimated the age in the groups between 9.00 and 11.99, but significantly underestimated the ages between 13.00 and 14.99 compared with CA ($p < 0.05$; Table 4). The SA estimation was only sig-

se usporede razlike u procjeni dobi i MAE u skupinama, nisu ustanovljene značajne razlike između ženskoga i muškoga spola (p > 0,05; tablica 2.). Postotci točnosti uzoraka koji odgovaraju apsolutnim vrijednostima CA–DA i CA–SA unutar ± 0,25, ± 0,50, ± 0,75, ± 1,00, ± 1,25, ± 1,50, ± 1,75, ± 2,00 i iznad ± 2,00 prikazani su u tablici 3. Postotci točnosti procjene DA-e bili su 62,3 % za ženski spol i 59,49 % za muški spol, a oni u procjeni SA-e 52,2 % za ženski spol i 60,24 % za muški spol u vrijednostima apsolutne razlike unutar jedne godine (tablica 3.).

Značajno precjenjivanje dobi za ženski spol u DA metodi zabilježeno je u dobnoj skupini između 10,00 i 11,99 godina u usporedbi s CA-om (p < 0,05; tablica 4.). Nasuprot tomu, DA metoda dovela je do značajnog podcjenjivanja kad je riječ o ženskom spolu u dobi između 13,00 i 14,99 godina (p < 0,05; tablica 4.). SA metoda pokazala je značajno podcjenjivanje dobi za ženski spol između 13,00 i 14,99 godina u usporedbi s CA-om (p < 0,05; tablica 4.).

Kod muškog spola DA metoda pokazala je značajno precjenjivanje dobi u skupinama između 9,00 i 11,99 godina, ali značajno podcjenjivanje u dobi između 13,00 i 14,99 godina u usporedbi s CA-om (p < 0,05; tablica 4.). Procjena

Table 4 A comparison of the means of CA and DA using Cameriere's method and the differences between CA and SA using Vba in different age groups and sexes.

Tablica 4. Usporedba srednjih vrijednosti CA-e i DA-e korištenjem Camerieeove metode i razlika između C-a i **SA-e** korištenjem Vba-e za različite dobne skupine i spolove

Age • Dob	Sex • Spol	N	CA Mean (SD) • Srednja vrijednost (SD)	DA Mean (SD) • Srednja vrijednost (SD)	AD (CA-DA) Mean (SD) • Srednja vrijednost (SD)	MAE(SD) (CA-DA)	p (CA*DA)	SA Mean (SD) • Srednja vrijednost (SD)	AD (CA-SA) Mean (SD) • Srednja vrijednost (SD)	MAE(SD) (CA-SA)	p (CA*DA)
9–9.99	F	2	9.51 (0.63)	11.32 (0.45)	-1.81 (0.34)	1.67(0.34)	0.10 ¥	9.29 (0.00)	0.21 (0.84)	0.85 (0.72)	0.13 ¥
	M	4	9.67 (0.37)	11.35 (0.44)	-1.67 (0.39)	1.81(0.39)	**0.00 ¥***	10.43 (0.90)	-0.75 (0.62)	0.21 (0.06)	0.17 ¥
	Total	6	9.62 (0.30)	11.34 (0.40)	-1.72 (0.33)		0.22 ¥	10.05 (0.91)	-0.43 (0.82)		0.38 ¥
10–10.99	F	8	10.54 (0.37)	11.45 (0.73)	-0.91 (0.93)	1.13(0.76)	**0.01 ¥***	11.48 (2.24)	-0.94 (0.71)	0.67 (0.61)	0.28 ¥
	M	7	10.54 (0.28)	11.55 (0.46)	-1.01 (0.93)	0.81 (0.44)	**0.01 ¥***	12.36 (2.12)	-1.81 (0.71)	2.07 (2.08)	0.06 ¥
	Total	15	10.57 (0.29)	11.45 (0.70)	-0.88 (0.59)		0.42 ¥	11.73 (2.05)	-1.16 (2.09)		0.54 ¥
11–11.99	F	18	11.49 (0.32)	11.98 (0.69)	-0.48 (0.83)	0.78 (0.65)	**0.02 ¥***	11.96 (1.08)	-0.47 (1.20)	0.85 (0.96)	0.12 ¥
	M	14	11.37 (0.31)	12.28 (0.76)	-0.90 (0.71)	0.67 (0.53)	0.00 ¥*	11.96 (1.37)	-0.58 (1.24)	1.02 (0.61)	0.20 ¥
	Total	32	11.52 (0.31)	12.05 (0.68)	-0.53 (0.77)		0.64 ¥	11.90 (1.09)	-0.37 (1.19)		0.32 ¥
12–12.99	F	24	12.46 (0.24)	12.28 (0.80)	0.18 (0.93)	0.75 (0.55)	0.34 ¥	12.15 (1.47)	0.31 (1.50)	1.15 (1.11)	0.32 ¥
	M	11	12.37 (0.31)	12.77 (0.93)	-0.39 (1.13)	0.94 (0.53)	0.22 ¥	12.61 (1.54)	-0.23 (1.14)	0.95 (0.90)	0.59 ¥
	Total	35	12.48 (0.25)	12.36 (0.16)	0.12 (0.98)		0.21 ¥	12.41 (0.27)	0.07 (1.52)		0.86 ¥
13–13.99	F	40	13.47 (0.27)	12.92 (0.89)	0.54 (0.86)	0.72 (0.64)	0.00 †*	12.98 (1.15)	0.48 (1.15)	1.25 (1.97)	0.01 ¥*
	M	22	13.47 (0.31)	13.12 (0.85)	0.34 (0.84)	0.83 (0.59)	**0.02 †***	12.87 (1.21)	0.60 (1.26)	0.90 (0.92)	0.06 †
	Total	62	13.47 (0.28)	12.99 (0.87)	0.48 (0.85)		0.07 ¥	12.94 (0.14)	0.53 (1.18)		0.70 ¥
14–14.99	F	38	14.41 (0.27)	13.37 (0.84)	1.03 (0.88)	1.12 (0.85)	**0.00 †***	13.79 (1.26)	0.61 (1.23)	1.08 (0.81)	0.00 ¥*
	M	28	14.43 (0.37)	13.37 (0.44)	1.06 (0.98)	1.06 (0.84)	**0.00 ¥***	14.37 (0.90)	0.06 (0.93)	0.79 (0.52)	0.00 †*
	Total	66	14.42 (0.30)	13.38 (0.93)	1.04 (0.92)		**0.00** †*	14.03 (1.16)	0.39 (1.14)		0.00 ¥*

F: Female • ženski, M: Male • muški, N: number • broj, SD: Standard Deviation • standardna devijacija, CA: Chronological age • kronološka dob, DA: Dental Age • dentalna dob, AD: Age Difference • razlika u godinama, SA: Skeletal age • skeletna dob, MAE: Mean Absolute Error • srednja apsolutna pogreška, ¥ Paired t-test • upareni t-test, † Wilcoxon test: * p<.05 • Wilcoxonov test: * p<.05

Table 5 Correlation between DA, SA, and CA in both sex and the total sample.
Tablica 5. Korelacija između DA-e, SA-e i CA-e u oba spola i u ukupnom uzorku

		Female • Ženski	Male • Muški	Total • Ukupno
Dental Age • Dentalna dob	r	0.589	0.563	0.581
	*p**	**0.000**	**0.000**	**0.000**
Skeletal Age • Skeletna dob	r	0.617	0.597	0.602
	*p**	**0.000**	**0.000**	**0.000**

Dental Age according to Cameriere method • Dentalna dob prema Camerieeovoj metodi; Skeletal Age according to Vba method • skeletna dob prema Vba metodi, $p < .05$. * Spearman's rank correlation coefficient test • $p < .05$. * Spearmanova korelacija.

Table 6 Comparison of CA, DA, and SA for both sexes and the total sample.
Tablica 6. Usporedba CA-e, DA-e i SA-e za oba spola i ukupni uzorak

	Mean (SD) • Srednja vrijednost (SD)			*p*		
	Chronological Age • Kronološka dob (CA)	Dental Age • Dentalna dob (DA)	Skeletal Age • Skeletna dob (SA)	CA-DA	CA-SA	DA-SA
Female • Ženski	13.04 (0.28)	12.68 (0.81)	12.77 (1.27)	**0.000**	**0.003**	0.907
Male • Muški	12.88 (0.33)	12.80 (0.55)	13.02 (0.52)	**0.028**	0.594	**0.027**
Total • Ukupno	12.96 (0.30)	12.74 (0.68)	12.89 (0.89)	**0.000**	0.054	0.130

CA: Chronogical age; DA: Dental Age according to Cameriere method • Dentalna dob prema Camerieeovoj metodi; SA: Skeletal Age according to Vba method • Skeletna dob prema Vba metodi; F: Female • ženski, M: Male • muški. T: Total. †Independent sample t test: $p < .05$ • t test za nezavisne uzorke: $p < .05$

nificant in the males' age group of 14.00–14.99 years compared to CA ($p < 0.05$; Table 4).

In the case of females, the DA estimation values of MAE varied from 0.72 years in the 13–13.99 age group to 1.67 years in the 9–9.99 age group (Table 4). For males, the DA estimation values of MAE varied from 0.67 years in the 11–11.99 age group to 1.81 in the 9–9.99 age group (Table 4). The SA estimation values of MAE for females 10 to 13 years old varied between 0.67 and 1.25 years. The SA estimation values of MAE for males 9 to 10 years old are between 0.21 years to 2.07. These data are presented in Table 4.

According to the Spearman correlation coefficient (r) test to perform sex and total sample analysis (CA-DA and CA-SA), a moderate correlation (between 0.563 and 0.602) was found to be statistically significant ($p < 0.05$) for all methods (Table 5). When comparing CA, DA, and SA for both sexes and total samples, there were significant differences between CA and DA ($p < 0.05$). There was a significant difference between CA and SA for only females ($p < 0.05$) (Table 6).

Discussion

DA and SA estimation methods play an important role in clinical and forensic dentistry in terms of diagnosis, treatment planning, and legal processes (14). Various methods have been presented based on dental and skeletal growth parameters obtained in radiographs. To the best of our knowledge, this is the first study that compares Cameriere's methods of determining C4 for SA reformulated by Gulsahi et al. (14) with open apex DA estimation (8) in children. The results of the study showed that both DA and SA methods resulted in different estimations of a certain age and sex groups compared to CA. Therefore, it may be concluded that the SA

SA-e bila je značajna samo u dobnoj skupini dječaka od 14,00 do 14,99 godina u usporedbi s CA-om ($p < 0,05$; tablica 4.).

U slučaju ženskog spola, MAE procijenjene vrijednosti DA-e varirale su od 0,72 godine u dobnoj skupini između 13 i 13,99 godina do 1,67 godina u dobnoj skupini od 9 do 9,99 godina (tablica 4.). Za muški spol varirale su MAE procijenjene vrijednosti DA-e od 0,67 godina u dobnoj skupini od 11 do 11,99 godina do 1,81 u dobnoj skupini od 9 do 9,99 godina (tablica 4.). MAE procjene vrijednosti SA-e za djevojčice u dobi od 10 do 13 godina varirale su između 0,67 i 1,25 godina. MAE procjene vrijednosti SA-e za muškarce u dobi od 9 do 10 godina kretale su se između 0,21 i 2,07 godina. Ovi podatci nalaze se u tablici 4.

Prema Spearmanovu testu koeficijenta korelacije (r) za analizu spola i ukupnog uzorka (CA-DA i CA-SA), umjerena korelacija (između 0,563 i 0,602) pokazala se statistički značajnom ($p < 0,05$) za sve metode (tablica 5.). Uspoređujući CA, DA i SA za oba spola i ukupne uzorke, uočene su značajne razlike između CA-e i DA-e ($p < 0,05$). Postojala je značajna razlika između CA-e i SA-e samo za ženski spol ($p < 0,05$) (tablica 6.)

Rasprava

Metode za procjenu DA-e i SA-e važne su u kliničkoj i forenzičkoj stomatologiji u smislu dijagnoze, planiranja terapije i pravnih procesa (14). Prikazane su različite metode temeljene na parametrima rasta i razvoja zuba i skeleta vidljivima na rendgenskim snimkama. Koliko znamo, ovo je prvo istraživanje koje uspoređuje Camerieeovu metodu određivanja SA-e s pomoću C4 koju su preformulirali Gulsahi i suradnici (14) s procjenom DA-e na temelju otvorenog apeksa (8) kod djece. Rezultati istraživanja pokazali su da su DA i SA metode rezultirale različitim procjenama određenih dobnih i spolnih skupina u usporedbi s CA-om. Zato se može zaključiti da

estimation method may provide more accurate results compared to the DA method with children of both sexes aged between 9.00 to 13.00 in the estimation of CA. ($p<0.05$)

Previously, the accuracy of Cameriere's DA method among Turkish children aged 8 to 15 years was evaluated (8). The Cameriere's method (9) proved to be more accurate than the Willems method (17) in estimating DA among Turkish children aged 6 to 15 (1). Thus, Cameriere's open-apex method has been used for the estimation of DA in the current study. In the literature, the accuracy of Cameriere's DA method has been evaluated for age estimation. Ozveren et al. (1) reported that Cameriere's DA method underestimated the CA of children between the ages of 11 and 14 for both sexes with an average difference of 0.37 years for females and 0.18 years for males. In addition, Cameriere's open-apex DA estimation method was found to underestimate the CA between 10 to 14 years of both sexes in Turkish children by Gulsahi et al.(8) (mean difference: 0.24 years for females and 0.47 years for males), Apaydın and Yasar (mean difference: 0.55 years for females and 0.60 years for males) (18) and Çarıkçıoğlu et al. (19) (mean difference: 0.53 years for females and 0.48 years for males). In the current study, compared to the literature, Cameriere's DA method has caused an underestimation of children of both sexes between 13.00 and 14.99 years of age.($p<0.05$) The overestimation was found in females 10.00-11.99; in males 9.00-11.99 ($p<0.05$). In the current study, the average difference of females (0.40 years) and males (0.25 years) has been similar to the literature findings. The mean absolute error (MAE) was also analyzed in the current study. In the current study, the MAE of the Cameriere's DA method was 0.92 for females and males in all age groups. Also, the age groups 9 and 14 were more likely to have larger MAE for both sexes.

Numerous SA estimation methods have been described in the literature (10–14). Changes in vertebral body shapes are one of the skeletal indicators of biological age in developing individuals, leading to the investigation of skeletal development on lateral cephalogram images (13). Cameriere et al. (13) presented the C4 vertebra method in Italian individuals aged between 5 and 15 years and reported that their method was accurate and predictable in the determination of SA. Gulsahi et al. (14) have confirmed the suitability of the Cameriere's fourth vertebrae method in Turkish children as a SA estimation method. Gulsahi et al. (14) reported no significant changes in Vba in age groups older than 14 years, hence we limited the analysis of the Vba growth pattern to the age of 15. Therefore, Cameriere's method has been used in the current study. Cameriere et al. (13) reported the MAE values of 1.34 years in males and 1.01 years in females with an increased rate around the age of 10. Gulsahi et al. (14) found that the MAEs were 0.906 years in females and 0.879 years in males for the SA estimation. Similarly, in the current study, MAE was 1.273 years in females and 0.978 years in males. In addition, in the ages of 10 to 12, underestimations were detected in females, whereas overestimations were observed in males. There were underestimations in the age groups of 13 and 14 of both sexes. According to the results concerning males, the C4 vertebra method should be chosen instead of

SA metoda procjene može dati točnije rezultate u usporedbi s DA metodom kod djece obaju spolova u dobi od 9,00 do 13,00 godina u procjeni CA-e ($p < 0,05$).

Prethodno je procijenjena točnost Camerieereove DA metode među turskom djecom u dobi od 8 do 15 godina (8). Camerieereova metoda (9) pokazala se točnijom od Willemsove (17) u procjeni DA-e među turskom djecom u dobi od 6 do 15 godina (1). Zato je Camerieereova metoda otvorenog apeksa korištena za procjenu DA-e u ovom istraživanju. U literaturi je procijenjena točnost Camerieereove DA metode za procjenu dobi. Ozveren i suradnici (1) izvijestili su da je Camerieereova DA metoda rezultirala podcjenjivanjem CA-e kod djece u dobi od 11 do 14 godina obaju spolova s prosječnom razlikom od 0,37 godina za ženski spol i 0,18 godina za muški spol. Uz to, Gulsahi i suradnici (8) otkrili su da Camerieereova metoda procjene DA-e s otvorenim apeksom podcjenjuje CA između 10 i 14 godina kod obaju spolova turske djece (srednja razlika: 0,24 godine za ženski spol i 0,47 godina za muški), Apaydın i Yasar ističu srednju razliku od 0,55 godina za ženski spol i 0,60 godina za muški (18), a Çarıkçıoğlu i suradnici (19) srednju razliku od 0,53 godine za ženski spol i 0,48 godina za muški. U ovom istraživanju, u usporedbi s literaturom, Camerieereova DA metoda pokazala je podcjenjivanje dobi kod obaju spolova između 13,00 i 14,99 godina ($p < 0,05$). Precjenjivanje je utvrđeno kod ženskog spola u dobi od 10,00 do 11,99; kod muškoga spola od 9,00 do 11,99 ($p < 0,05$). U ovom istraživanju prosječna razlika između djevojčica (0,40 godina) i dječaka (0,25 godina) bila je slična rezultatima iz literature. Srednja apsolutna pogreška (MAE) također je analizirana u ovom istraživanju. MAE Camerieereove DA metode iznosio je 0,92 za ženski i muški spol u svim dobnim skupinama. Također, dobne skupine obaju spolova od 9 do 14 godina imale su veću vjerojatnost da će imati veći MAE.

U literaturi su opisane mnogobrojne metode procjene SA-e (10 – 14). Promjene u oblicima tijela kralježaka jedan su od skeletnih pokazatelja biološke starosti kod osoba u razvoju, što dovodi do istraživanja razvoja skeleta na lateralnim kefalogramskim snimkama (13). Cameriere i suradnici (13) predstavili su metodu C4 kod Talijana u dobi između 5 i 15 godina i izvijestili da je njihova metoda točna i predvidljiva u određivanju SA-e. Gulsahi i suradnici (14) potvrdili su prikladnost Camerieereove metode četvrtoga kralješka kod turske djece kao metode procjene SA. Gulsahi i suradnici (14) nisu izvijestili o značajnim promjenama Vba-e u dobnim skupinama starijima od 14 godina, stoga smo ograničili analizu uzorka rasta Vba na dob od 15 godina. Zato je u ovom istraživanju korištena Camerieereova metoda. Cameriere i suradnici (13) izvijestili su o MAE vrijednostima od 1,34 godine za muški spol i 1,01 godinu za ženski spol s povećanom stopom oko dobi od 10 godina. Gulsahi i suradnici (14) otkrili su da su MAE vrijednosti iznosile 0,906 godina kod ženskog spola i 0,879 godina kod muškog spola za SA procjenu. Slično tomu, u ovom istraživanju MAE je bio 1,273 godine kod ženskog spola i 0,978 godina kod muškog spola. Osim toga, u dobi od 10 do 12 godina utvrđeno je podcjenjivanje dobi kod ženskog spola, a precjenjivanje kod muškoga. Podcjenjivanje se dogodilo u dobnim skupinama od 13 do 14 godina

Table 7 DA and SA distribution percentages according to the Turkish Criminal Code.
Tablica 7. Postotci distribucije DA-e i SA-e prema turskom Kaznenom zakonu

CA	N	DA>12	DA<12	DA≥15	SA>12	SA<12	SA≥15
9-9.99	6	NA	100%	NA	NA	100%	NA
10-10.99	15	**26.6%**	73.3%	NA	**26.6%**	73.4%	NA
11-11.99	32	**54.5%**	45.4%	NA	**46.8%**	53.1%	NA
12-12.99	35	65.7%	**34.2%**	NA	65.7%	**34.2%**	**8.3%**
13-13.99	62	87.0%	**12.9%**	NA	83.8%	**16.1%**	**16.6%**
14-14.99	66	92.4%	**7.5%**	NA	96.9%	**3.03%**	**75%**

N: Number of individuals; CA: Chronological Age; DA: Dental Age according to Cameriere method; SA: Skeletal Age according to Vba method; Percentages of incorrect DA and SA estimations that may cause erroneous legal results are indicated in bold. • N: broj pojedinaca; CA: kronološka dob; DA: dentalna dob prema Camerierеovoj metodi; SA: skeletna dob prema Vba metodi; Postoci netočnih DA i SA procjena koje mogu uzrokovati pogrešne pravne rezultate označeni su podebljano.

the Cameriere's DA method for the ages of 9 to 11.99 and 13 to 13.99 ($p<0.05$). In females, the C4 vertebra method should be applied to ages 10 to 11.99 ($p<0.05$).

Identification is important in natural disasters, war, and forensic analysis of individuals in forensic medicine (19). Furthermore, in legal cases, the age of the child affects the punishment of the child or the convict, and 12, 15, and 18 years of age in Turkey define the age thresholds in criminal cases (19). Thus, the accuracy of the age estimation is very important for legal cases. Therefore, in the current study DA and SA scores have been compared with CA and classified for different age groups according to the Turkish Criminal Code (1) (Table 7). The DA and SA methods mistakenly estimated that 34.2 % of both males and females were younger than their actual age (in this case they were younger than 12 years). Also, these two methods detected that children aged 11–11.99 were over 12 years (54.5% and 46.8% respectively). Similar to our results, Ozveren et al. (1) using Cameriere's DA method mistakenly found that 37.9% of the children between the ages of 12 and 12.99 were under the age of 12. This should be considered in the case of a higher or lower charge when a child is guilty or when a child is the victim of a crime.

Mollabashi et al. (20) evaluated the relationship between DA and SA methods and found a significant correlation between DA and SA. Kocasarac et al. (21) compared SA method (CVM) and DA method (third molar mineralization) with CA and reported a positive correlation. In the current study, SA and DA estimation methods provided similar results compared to CA.

Conclusion

Cameriere's SA method may provide more accurate results in the estimation of CA before the age of 14. Both Cameriere's SA and DA found underestimation from 14 years of age in both sexes.

Conflicts of interest

None to declare.

u oba spola. Prema rezultatima za dječake treba odabrati metodu C4 vertebra umjesto Camerierеove DA metode za dob od 9 do 11,99 godina i od 13 do 13,99 godina ($p < 0,05$). Kod djevojčica metodu C4 kralješka treba primijeniti u dobi od 10 do 11,99 godina ($p < 0,05$).

Identifikacija je važna u slučaju prirodnih katastrofa i rata te ako je riječ o forenzičkoj analizi pojedinaca u sudskoj medicini (19). Nadalje, u pravnim slučajevima dob djeteta utječe na kažnjavanje djeteta ili osuđenika, a 12, 15 i 18 godina u Turskoj definiraju dobne granice u kaznenim predmetima (19). Zato je točnost procjene dobi vrlo važna za pravne slučajeve. To je razlog da su u ovom istraživanju rezultati DA-e i SA-e uspoređeni s CA-om i klasificirani za različite dobne skupine prema turskom Kaznenom zakonu (1) (tablica 7.). DA i SA metodama pogrešno je procijenjeno da je 34,2 % pripadnika muškoga i ženskoga spola bilo mlađe od njihove stvarne dobi (u ovom slučaju bili su mlađi od 12 godina). Također, tim je dvjema metodama otkriveno da su djeca u dobi od 11 do 11,99 bila starija od 12 godina (54,5 %, odnosno 46,8 %). Slično našim rezultatima, Ozveren i suradnici (1), korištenjem Camerierеove DA metode, pogrešno su otkrili da je 37,9 % djece u dobi od 12 do 12,99 godina bilo mlađe od 12 godina. To treba uzeti u obzir u slučaju optužbe da je dijete krivo ili kada je dijete žrtva zločina.

Mollabashi i suradnici (20) procijenili su odnos između DA i SA metoda i pronašli značajnu korelaciju između DA-e i SA-e. Kocašarac i suradnici (21) usporedili su SA metodu (CVM) i DA metodu (mineralizacija trećeg kutnjaka) s CA-om i izvijestili o pozitivnoj korelaciji. U ovom istraživanju metode procjene SA-e i DA-e dale su slične rezultate u usporedbi s CA-om.

Zaključak

Camerierеova SA metoda omogućuje točnije rezultate u procjeni CA-e prije 14. godine. I Camerierеova SA i DA metoda rezultirale su podcjenjivanjem dobi od 14. godine u oba spola.

Sukob interesa

Autori nisu bili u sukobu interesa.

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Ethics approval

Bolu İzzet Baysal University Institutional Review Board (#2020-242)

Authors' contributions: **O.C.G.** -Methodology, analysis of data, drafting paper, revision of paper; **Y.D.** -Design, analysis of data, drafting paper; **S.A.**- Resources, data curation.

Suglasnost za objavu

Pacijenti su potpisali informirani pristanak za objavu svojih podataka i fotografija.

Etičko odobrenje

Institucionalni revizijski odbor Sveučilišta Bolu İzzet Baysal (br. 2020-242)

Doprinosi autora: **O. C. G.** – metodologija, analiza podataka, pisanje i revizija teksta; **Y. D. –** dizajn, analiza podataka, pisanje teksta; **S. A.** – resursi, čuvanje podataka

Sažetak

Svrha istraživanja: Procjena dobi ključna je odrednica forenzičke znanosti. Za procjenu dentalne dobi (DA) i skeletne dobi (SA) korištene su različite metode. Cilj ovog istraživanja bio je usporediti Camerieeovu DA metodu s Camerieeovom SA metodom u procjeni kronološke dobi (CA) djece. **Materijal i metode:** Ukupno 216 rendgenskih snimki 130 djevojčica i 86 dječaka (u dobi između 9 i 14,99 godina) procijenjeno je u sjeverozapadnoj Turskoj. DA je izračunat na ortopantomogramima s pomoću Camerieeove metode otvorenog apeksa. SA je određen na lateralnim kefalogramima metodom četvrtoga vratnog kralješka prema Camerieeu. DA, SA i CA podatci uspoređeni su s pomoću uparenoga t-testa i Wilcoxonova testa. **Rezultati:** Srednji CA svih skupina iznosio je 12,96 ± 0,30, srednji DA bio je 12,74 ± 0,68, a srednji SA 12,89 ± 0,89. Kod dječaka je DA metoda rezultirala podcjenjivanjem dobi između 14,00 i 14,99 godina ($p < 0,05$) i precjenjivanjem između 9,00 i 11,99 godina ($p < 0,05$). Kod djevojčica je DA metoda pokazala podcjenjivanje u dobnim skupinama od 13,00 do 14,99 godina ($p < 0,05$) i precjenjivanje u dobnim skupinama od 10,00 do 11,99 godina ($p < 0,05$). SA metodom utvrđeno je značajno podcjenjivanje kod djevojčica u dobi od 13,00 do 14,99 godina i kod dječaka između 14,00 i 14,99 godina ($p < 0,05$). **Zaključak:** Metoda procjene SA-e može dati točnije rezultate u usporedbi s metodom DA-e kod djece obaju spolova u dobi od 9,00 do 12,99 godina u određivanju CA-e.

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