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## Korelacija između stadija zrelosti cervikalne kralježnice i dentalne dobi u saudijskom uzorku

### *Correlation between Cervical Vertebral Maturation Stages and Dental Maturation in a Saudi Sample*

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#### Sažetak

**Svrha rada:** Svrha je ovoga istraživanja usporediti stadij sazrijevanja cervikalne kralježnice i dentalnu dob s analizom stupnja kalcifikacije zuba. **Ispitanici i metode:** U istraživanje je bilo uključeno 405 ispitanika odabranih među ortodontskim pacijentima saudijskog podrijetla koji su došli u Kliniku za ortodonciju specijaliziranoga stomatološkog centra u zapadnoj regiji Saudijske Arabije. Dentalna dob procijenjena je prema stupnju razvoja gornjih i donjih trećih kutnjaka, a skeletna zrelost prema stadiju sazrijevanja cervikalne kralježnice. Statistička analiza provedena je primjenom Kruskal-Wallisova, Mann-Whitneyjeva, Chi-kvadrat i t-testa te Spearmanove korelacije za usporedbu među skupinama. **Rezultati:** Žene su bile mlade od muškaraca prema stadijima sazrijevanja cervikalne kralježnice. CS1 – CS2 prikazuje razdoblje prije vrhunca rasta, CS3 – CS5 je pubertetski rast, a CS6 razdoblje nakon vrhunca rasta. Prosječna dob i standardna devijacija za stadije CS2, CS3 i CS4 bila je  $12,09 \pm 1,72$  godine,  $13,19 \pm 1,62$  i  $14,88 \pm 1,52$ . Spearmanov koeficijent korelacije između sazrijevanja cervikalne kralježnice i dentalne dobi kretao se između 0,166 i 0,612 te 0,243 i 0,832 za oba spola za gornje i donje treće kutnjake. Razine značajnosti za sve koeficijente postavljene su na 0,01 i 0,05. **Zaključak:** Rezultati ovog istraživanja pokazuju da je skeletna zrelost za oba spola rasla s porastom dentalne dobi. Kad je riječ o ženama, zabilježeno je ranije skeletno sazrijevanje. Ovo istraživanje zahtijeva daljnju analizu na većem uzorku koji obuhvaća cijelu denticiju.

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#### Ključne riječi

vratna kralježnica, dob, određivanje pomoću skeleta; umnjak; kalcifikacija zuba

#### Uvod

Ortodontska terapija najučinkovitija je tijekom puberteta, pa su zato procjena i predviđanje rasta važni u planiranju liječenja dentalnih i maksilofacijalnih anomalija (1, 2). Za procjenu rasta i zrelosti stručnjaci se koriste mnogim parametrima kao što su visina, tjelesna težina, sekundarna seksualna obilježja te razvoj zubnoga i koštanoga tkiva. Dentalna zrelost može se odrediti na temelju stadija formiranja zuba, a mnoga su istraživanja pokazala da je dentalna dob povezana sa skeletnom zrelošću. Trenutačno se analiza cervikalnih kralježaka intenzivno upotrebljava za procjenu skeletne zrelosti zbog jednostavnosti i ponovljivosti iz rutinskoga dijagnostičkog lateralnog kefalograma za ortodontsku terapiju (3, 4). Nekoliko autora uočilo je da su razvojni stadiji pojedinih zuba u korelaciji sa skeletnom zrelošću (5). Ipak, vrlo je malo istraživanja (6, 7) o povezanosti između stupnja kalcifikacije zuba i stadija zrelosti cervikalne kralježnice (CVM). Cilj ovog istraživanja je odrediti korelaciju između stadija zrelosti cervikalne kralježnice i dentalne zrelosti na temelju stupnja kalcifikacije trećih kutnjaka.

#### Introduction

Orthodontic treatment is most favorable and effective during pubertal growth and hence growth assessment and prediction are significant in planning treatments for dental and maxillofacial abnormalities (1, 2). To evaluate the growth assessment and maturation many features such as body height, body weight, secondary sexual characteristics, dental and skeletal development are used. Dental maturity can be determined by the stage of tooth formation and numerous studies have found that dental maturity is associated with skeletal maturity. At present, analysis of cervical vertebrae is extensively used to evaluate skeletal maturity due to its simplicity and reproducibility from a routine diagnostic lateral cephalogram for orthodontic treatment (3, 4). Various authors have noted that developmental stages of certain teeth show a high correlation with skeletal maturity (5). Yet few studies (6, 7) have been carried out to determine the association between tooth calcification stage and cervical vertebral maturation (CVM) stage. The aim of the present study was to investigate the correlation between the CVM stages

## Ispitanici i metode

Ovo istraživanje obuhvatilo je ukupno 405 pacijenata koji su se liječili u Klinici za ortodontiju specijaliziranih stomatoloških centara u zapadnoj regiji Saudijske Arabije. Svi sudionici bili su saudijskog podrijetla. Odabrani su digitalni ortopantomogrami i lateralni kefalogrami u kombinaciji s kliničkim zapisima 255 djevojčica i 150 dječaka u dobi od 9 do 20 godina. Kriteriji za uključivanje bili su:

- kvalitetan digitalni ortopantomogram i lateralni kefalogram
- bez bolesti ili intervencija koje utječu na razvoj ili prisutnost trećih kutnjaka.

Pacijenti su isključeni iz istraživanja prema sljedećim kriterijima:

- bilo kakve kongenitalne anomalije zuba ili kongenitalne anomalije drugoga, trećega i četvrtoga cervikalnog kralješka, poput fuzije između cervikalnih kralježaka ili prisutnosti sekundarnih osikula
- pacijenti koji su imali bilo kakve sistemske bolesti koje bi mogle utjecati na rast (poput prehrambenih poremećaja, endokrinih poremećaja, sindroma i dugotrajne konzumacije lijekova).

*Dentalna zrelost:* Dentalna dob analizirana je prema fazama kalcifikacije gornjih i donjih trećih kutnjaka. Razvoj zuba kategoriziran je u različite skupine – od A (najmanji stupanj razvoja) do H (potpuni razvoj) (8).

*Skeletna zrelost:* Skeletna zrelost vrjednovana je skeletnom dobi i to korištenjem metode stadija zrelosti cervikalne kralježnice (CVM), procjenjujući morfologiju (oblik i donji granični konkavitet) triju cervikalnih kralježaka (C2, C3 i C4) prema šest stupnjeva zrelosti (C1 – C6) koje su predstavili Bacetti i suradnici (9, 10).

Sve digitalne radiografije pregledane su na istom računaru. Faze razvoja cervikalne kralježnice i formiranje zuba za svakog je pacijenta procijenio ortodont, bez poznavanja dobi ili spola.

## Statističke metode

Analiza je obavljena korištenjem statističkog paketa SPSS V22.0 (IBM Corporation, New York, SAD). Razlika u proporciji analizirana je Kruskal-Wallisovim H-testom, nakon čega je slijedio Mann-Whitneyjev U-test za usporedbu među skupinama i Chi-kvadrat test. Razlika u srednjim vrijednostima analizirana je t-testom. Stadiji razvoja kutnjaka stavljeni su u korelaciju s razvojnim stadijima cervikalne kralježnice koristeći se Spearmanovim koeficijentom korelacije. Svi statistički testovi bili su dvostrani, a razina značajnosti postavljena je na  $p < 0,05$ .

## Rezultati

Tablice 1. i 2. pokazuju distribuciju stadija zrelosti gornjih i donjih trećih kutnjaka prema dobi i spolu. U skupini od 9 do 12 godina razvojni stadiji za gornje treće kutnjake bili su C, B i D, a za donje treće kutnjake C i D, a zatim B. U

method and dental maturity using tooth calcification stages of third molars.

## Materials and methods

The present study consisted of a total of 405 patients attending orthodontic clinics of the specialized dental centers in western region of Saudi Arabia. All participants of the study were only of Saudi origin. Digital panoramic radiographs and lateral cephalograms along with clinical records of 255 girls and 150 boys aged 9-20 years were selected. The inclusion criteria were:

- A high quality digital panoramic radiograph and lateral cephalogram
- No history of medical or surgical disease affecting the presence and development of third molar teeth.

The following exclusion criteria were considered and the following patients were excluded from the investigation:

- Patients with any congenital tooth anomalies or congenital anomalies of the 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> cervical vertebrae such as fusion between cervical vertebrae or presence of secondary ossicle were eliminated.
- Patients having any systemic diseases that could affect growth (such as nutritional disturbance, endocrine disorders, syndromes, and long term consumption of medication) were excluded.

*Dental maturity:* The assessment of dental maturity was done according to the calcification stages of upper and lower third molar teeth. The development of teeth was categorized into different groups, ranging from A (least development) to H (complete development) (8).

*Skeletal maturity:* The Skeletal maturity was evaluated by skeletal age using cervical vertebra maturation (CVM) stage method, assessing the morphology (shape and inferior border concavity) of three cervical vertebrae (C2, C3, and C4) consisting of six maturity stages (C1-C6) presented by Bacetti et al. (9,10).

All digital radiographs were viewed on the same computer. The stages of cervical vertebra development and tooth formation of each patient were assessed by an orthodontist without having knowledge of age or gender.

## Statistical method

The analysis was performed using the Statistical Package SPSS statistic V22.0 (IBM Corporation, New York, USA). The difference in proportion was tested using Kruskal-Wallis H followed by Mann-Whitney U test for inter group comparison, and Chi-Square tests. The difference in mean was tested using t-test. Molar stages were correlated with cervical vertebra developmental stages using the Spearman's correlation coefficient. All statistical tests were two-sided, and the significance level was set at  $p < 0.05$ .

## Results

Table 1 and 2 show the distribution of upper and lower third molar stages according to age and gender. In 9-12 years group the common upper third molar stages were C, B and D respectively, while the common lower third molar

**Tablica 1.** Distribucija ispitanika sa stadijima razvoja gornjih trećih kutnjaka prema dobi i spolu  
**Table 1** Distribution subjects with upper third molar stages according to age and gender:

Dob u godinama • Age in years	Stadiji razvoja gornjih trećih kutnjaka • Upper third molar stages									Ukupno • Total
	A	B	C	D	E	F	G	H	NA	
9-12	6	32	38	28	8	0	0	0	28	140
13-16	0	12	52	138	72	38	8	10	12	342
≥ 17	0	0	0	34	28	76	66	122	2	328
Kruskal-Wallis H, p 0,0001 • Kruskal-Wallis H, p value 0.0001										
Spol • Gender	A	B	C	D	E	F	G	H	NA	
Muški • Male	2	20	42	60	36	38	8	68	26	300
Ženski • Female	4	24	48	140	72	76	66	64	16	510
Chi-kvadrat, p 0,0001 • Chi-square, p value 0.0001										

**Tablica 2.** Distribucija ispitanika sa stadijima razvoja donjih trećih kutnjaka prema dobi i spolu  
**Table 2** Distribution subjects with lower third molar stages according to age and gender:

Dob u godinama • Age in years	Stadiji razvoja donjih trećih kutnjaka • Lower third molar stages									Ukupno • Total
	A	B	C	D	E	F	G	H	NA	
9-12	6	28	48	34	8	0	0	0	16	140
13-16	4	16	48	148	90	12	4	14	6	342
≥ 17	0	0	4	30	40	72	60	122	0	328
Kruskal-Wallis H, p 0,0001 • Kruskal-Wallis H, p value 0.0001										
Spol • Gender	A	B	C	D	E	F	G	H	NA	
Muški • Male	6	18	50	70	46	20	8	68	14	300
Ženski • Female	4	26	50	142	92	64	56	68	8	510
Chi-kvadrat, p 0,0001 • Chi-square, p value 0.0001										

ovoj dobnoj skupini nije bilo stadija F, G i H. U skupini od 13 do 16 godina bili su prisutni svi razvojni stadiji trećih kutnjaka, a najčešći je bio stadij D. U dobnoj skupini djece starije od 17 godina, razvojni stadij H bio je najčešći na gornjim i donjim trećim kutnjacima. U ženskoj skupini ovoga saudijskog uzorka, najčešći razvojni stadij trećeg kutnjaka bio je D, a u muškoj skupini D i H.

U tablici 3. je distribucija kronološke dobi za sve ispitanike prema razvojnim stadijima cervikalne kralježnice. Srednja dob i standardna devijacija za stadije 3 i 4 bile su 13,19 ±

stages were C and D and B, there were no F, G and H stages in this age group. In 13-16 years group all third molar stages were present, the most common stage was stage D. In the age group more than 17 years, H stage of third molar was the most common in upper and lower third molars. In the female group of this Saudi sample the most common stage of third molar was stage D, while in the male group the common stages were stage D and H.

Table 3 shows the distribution of chronological ages for all subjects grouped by cervical vertebra developmental stag-

**Tablica 3.** Distribucija kronološke dobi svih ispitanika prema stadijima sazrijevanja cervikalne kralježnice  
**Table 3** Distribution of chronological ages for all subjects grouped by CVS:

Stadiji sazrijevanja cervikalne kralježnice • Cervical vertebra developmental stages	n	Dob (srednja ± SD) • Age (Mean ± SD)	Spol • Gender	n	Dob (srednja ± SD) • Age (Mean ± SD)	P t-test • P valve t-test
CS1	34	10.62 ±1.2	Muški • Male	22	10.73 ±1.31	0.12
			Ženski • Female	12	10.42 ±1.06	
CS2	34	12.09 ±1.72	Muški • Male	21	12.14 ±1.67	0.16
			Ženski • Female	13	12 ±1.85	
CS3	50	13.19 ±1.62	Muški • Male	25	14.14 ±1.19	0.07
			Ženski • Female	25	12.24 ±1.43	
CS4	88	14.88 ±1.52	Muški • Male	26	15.08 ±0.87	0.18
			Ženski • Female	62	14.79 ±1.72	
CS5	67	16.97 ±2.05	Muški • Male	23	18.17 ±1.92	0.08
			Ženski • Female	44	16.34 ±1.84	
CS6	132	18.55 ±1.52	Muški • Male	33	19.05 ±1.38	0.14
			Ženski • Female	99	18.39 ±1.54	

1,62 i  $14,88 \pm 1,52$ ; žene su bile mlađe od muškaraca u cervikalnim stadijima.

Tablica 4. prikazuje koeficijente korelacije između razvojnih stadija cervikalne kralježnice i trećih kutnjaka u gornjoj i donjoj čeljusti.

es. The mean age and standard deviation for cervical stage 3 and 4 were  $13.19 \pm 1.62$  and  $14.88 \pm 1.52$  respectively; the females were younger than males in these cervical stages.

Table 4 shows the correlation coefficients between cervical vertebra developmental stages and third molar stages of subjects in both upper and lower third molars.

**Tablica 4.** Korelacijski koeficijenti između stadija sazrijevanja cervikalne kralježnice i trećih umnjaka kod ispitanika  
**Table 4** Correlation coefficients between cervical vertebra developmental stages and third molar stages of subjects:

	Stadiji sazrijevanja cervikalne kralježnice • Cervical vertebra developmental stages					
	CS1	CS2	CS3	CS4	CS5	CS6
Stadiji gornjih trećih umnjaka • Upper third molar stages	0.267 <sup>a</sup>	0.166 <sup>b</sup>	0.287 <sup>a</sup>	0.246 <sup>a</sup>	0.612 <sup>a</sup>	0.198 <sup>b</sup>
Stadiji donjih trećih umnjaka • Lower third molar stages	0.287 <sup>a</sup>	0.243 <sup>a</sup>	0.471 <sup>a</sup>	0.634 <sup>a</sup>	0.536 <sup>a</sup>	0.832 <sup>a</sup>
Dob u godinama • Age in years	0.732 <sup>a</sup>	0.542 <sup>a</sup>	0.532 <sup>a</sup>	0.486 <sup>a</sup>	0.631 <sup>a</sup>	0.429 <sup>a</sup>

<sup>a</sup> korelacija je statistički značajna na razini 0,01 • correlation is significant at 0.01 level; <sup>b</sup> korelacija je statistički značajna na razini 0,05 • correlation is significant at 0.05 level

## Rasprava

Mnogi biološki pokazatelji, poput sazrijevanja koštano-gzgloba (11), cervikalnih kralježaka (9, 10) i razvoja zuba (12), korišteni su za procjenu razvojne dobi. Osim rendgenske snimke ručnog zgloba, za procjenu koštanog sazrijevanja stručnjaci se koriste i analizom CVM-a. Na kefalogramu se razvojne promjene cervikalnih kralježaka koriste za procjenu stupnja fiziološke zrelosti pojedinca koji raste i za izračunavanje koštane dobi. Mnogi istraživači slažu se da se evaluacija cervikalnih kralježaka na rutinskom lateralnom kefalogramu lubanje može upotrijebiti za predviđanje mandibularnog rasta (9, 13 – 15). CVM objašnjava cijelo razdoblje pubertetskog rasta bilježeći sve značajne faze kraniofacijalnog razvoja tijekom adolescencije i mlade odrasle dobi koja vrijedi za oba spola (9, 10, 16). Malo je autora koji povezuju dentalnu i skeletnu zrelost (16, 17). Prema nekoliko istraživanja, dentalna zrelost sa stupnjem kalcifikacije zuba smatra se značajnim biološkim čimbenikom (18). Istraživanja su pokazala da je CVM pouzdan postupak za procjenu skeletne zrelosti (5, 9, 16, 17, 19). Uz to, ne zahtijeva dodatnu ekspoziciju x-zračenju, osim za rutinski lateralni kefalogram.

U ovom radu istraživala se povezanost između sazrijevanja vratnih kralježaka i dentalne dobi saudijske djece. Neki autori otkrili su da razvojni stadiji određenih zuba, kao što su očnjaci i drugi kutnjaci, značajno koreliraju sa skeletnom zrelošću (3, 4, 19, 20). No razvoj trećeg kutnjaka pokazao je najveću varijabilnost u usporedbi sa svim ostalim zubima (21).

U ovom je istraživanju za procjenu skeletne zrelosti korišten stadij zrelosti cervikalnih kralježaka na lateralnom kefalogramu, rutinskoj dijagnostičkoj snimci koja se upotrebljava u ortodontskoj terapiji. Istraživanje je analiziralo povezanost između dentalne dobi na temelju trećeg kutnjaka i skeletne zrelosti procjenom stupnja zrelosti cervikalnih kralježaka. U nedavno objavljenom istraživanju Chena J. i suradnika stupnjevi dentalne kalcifikacije korišteni su za utvrđivanje dentalne zrelosti, a skeletna zrelost procijenjena je CVM metodom, pri čemu je utvrđena statistički značajna korelacija između

## Discussion

Many biological indicators such as skeletal maturation of hand-wrist (11), cervical vertebrae (9, 10) and dental development (12) have been used to evaluate for developmental age estimation. In addition to hand-wrist radiographs, the evaluation of CVM was used for assessing the skeletal maturation. On cephalometric radiographs, the developmental changes of cervical vertebrae were used to evaluate the degree of physiological maturity of a growing individual and also to calculate the bone age. Many researchers agree that evaluation of cervical vertebrae with routine lateral skull cephalograms are correlated and can be used to predict mandibular growth (9, 13-15). CVM explains the complete pubertal growth period by recording all significant phases in craniofacial growth during adolescence and young adulthood which is valid for both genders (9, 10, 16). Few researchers suggested a slight association between dental and skeletal maturity (16, 17). According to some studies, dental maturity with levels of calcification of teeth is considered to be a significant biologic factor (18). Some researchers have found that CVM is a reliable method for skeletal maturity assessment (5, 9, 16, 17, 19) Furthermore, they concluded that an additional x-ray exposure, apart from the routine lateral cephalometric projection, is not required.

This study investigated the interrelationship between cervical vertebrae maturation and dental ages of Saudi children. Some authors have found that developmental stages of certain teeth such as canines and second molars have a strong correlation with skeletal maturity (3, 4, 19, 20). However, the timing of third molar development showed the highest variability compared to all other developing teeth (21).

In the present study, an assessment of skeletal maturity was done using the CVM on lateral cephalogram, and a routine diagnostic radiograph was used for orthodontic treatment. The study investigated the interrelationship of dental age using the third molars and skeletal maturity by assessing the maturity stages of cervical vertebrae. A recent study by Chen J *et al.*, dental calcification stages were used to determine dental maturity, while skeletal maturity was evaluated

stupnja kalcifikacije zuba i zrelosti cervikalne kralježnice (6).

Distribucija kronološke dobi svih ispitanika prema stadiju sazrijevanja vratnih kralježaka prikazana je u tablici 3. Na temelju procjene CVM-a, srednja kronološka dob djevojaka bila je nešto niža negoli dječaka, pri čemu je svaki stadij nastupio ranije kod ženskih negoli muških ispitanika. U fazi CS2 i CS4 srednja kronološka dob bila je  $12,09 \pm 1,72$  godina i  $14,88 \pm 1,52$  godina (tablica 3.). U CVM metodi CS1 – CS2 pokazuje razdoblje prije vrhunca rasta, CS3 – CS5 je pubertetski rast, a CS6 razdoblje nakon vrhunca rasta (tablica 3.). Ovi rezultati u skladu su s ranijim istraživanjima Baccettija i suradnika (9, 10). Rezultati dobiveni Spearmanovim koeficijentom korelacije između sazrijevanja cervikalnih kralježaka i zuba kretali su se između 0,166 i 0,612, 0,243 i 0,832 za oba spola za gornje i donje treće kutnjake. Razine značajnosti za sve koeficijente postavljene su na 0,01 i 0,05 (tablica 4.).

Prema stajalištu nekoliko istraživača, proučavanje odabranih zuba umjesto cijele denticije daje veće koeficijente korelacije između dentalne i skeletne zrelosti, jer se smanjuje vjerojatnost slučajnih pogrešaka (17, 22, 23). Čini se da se povezanost između zuba i kostura razlikuje prema zemljopisnim regijama i rasama / etničkim skupinama (24).

U ovom istraživanju stupnjevi kalcifikacije zuba korišteni su za određivanje dentalne zrelosti, a skeletna zrelost vrjednovana je CVM metodom koja se naširoko upotrebljava. Mala, ali statistički značajna korelacija pronađena je između stupnja kalcifikacije zuba i zrelosti cervikalne kralježnice. Koeficijenti korelacije između stupnjeva kalcifikacije gornjih trećih kutnjaka i skeletne zrelosti bili su slabo pozitivni i varirali su od 0,166 do 0,0287, osim za stupanj CS5 za koji je postojala umjerena pozitivna korelacija (tablica 4.). Za donje treće kutnjake zabilježena je umjerena pozitivna korelacija između cervikalne kralježnice (CS4, CS5 i CS6) i razvojnih stadija u rasponu od 0,471 do 0,832.

U istraživanju koje su proveli Chen i suradnici, CVM i stupanj kalcifikacije zuba, osim trećih kutnjaka, korelirali su u rasponu od 0,601 do 0,911. Krailassiri i suradnici (25) te Uysal i suradnici (17) pronašli su slabe korelacije, a Ğngstrom i suradnici (26) snažnu korelaciju. U ovom saudijskom uzorku pronađena je slaba pozitivna korelacija između stadija sazrijevanja cervikalnih kralježaka i gornjega trećeg kutnjaka u rasponu od 0,166 do 0,0287, osim za stupanj CS5 kod kojega je postojala umjerena pozitivna korelacija. Za donje treće kutnjake ustanovljena je umjerena pozitivna korelacija između razvojnih stadija cervikalne kralježnice CS4, CS5 i CS6, u rasponu od 0,471 do 0,832. Mnogi su istraživači naveli da je sazrijevanje mandibularnog oćnjaka snažnije povezano s pubertetskim rastom od bilo kojega drugog zuba (4), a neki sugeriraju da drugi pretkutnjak ima najveću korelaciju s koštanim sazrijevanjem (25). Zaključeno je da drugi kutnjak ima prednost zbog svojega duljeg razdoblja razvoja do kasnije dobi u odnosu na druge zube (5, 27, 28).

Skeletna zrelost porasla je zajedno s povećanjem dentalne dobi za oba spola. Kod ženskih ispitanika zabilježeno je raniji početak svakog stadija skeletnog sazrijevanja. U jednoj fazi na vrhuncu rasta te su razlike bile najveće. Sve korelacije između skeletne i dentalne zrelosti bile su statistički značajne.

by CVM method and statistically significant correlation was found between tooth calcification stage and cervical vertebra maturation stage (6).

A distribution of chronological ages of all subjects according to cervical vertebra maturation stages is shown in Table-3. Based on CVM assessment, the mean chronologic age of girls was slightly lower than that of boys, with each stage being constantly earlier in female than in male subjects. In stage CS2 and CS4, the mean chronologic age was  $12.09 \pm 1.72$  years and  $14.88 \pm 1.52$  years respectively (Table-3). In CVM method, CS1-CS2 show the period before the peak of growth, during CS3-CS5 it's the pubertal growth spurt and CS6 is the period after the peak of the growth (Table-3). The results of the present study are in compliance with those obtained in earlier studies by Baccetti *et al.* (9, 10). The results of Spearman correlation coefficients between cervical vertebrae and dental maturation were between 0.166 and 0.612, 0.243 and 0.832 for both genders for upper and lower third molars respectively. The significance levels for all coefficients were the same at 0.01 and 0.05 (Table-4).

According to a number of researchers, the study of several selected teeth rather than the entire dentition gives higher correlation coefficients between dental and skeletal maturity since the probability of accidental errors will be reduced (17, 22, 23). The association between the teeth and skeleton also appear to vary among geographic regions and races/ethnic groups (24).

In the current study, dental calcification stages were used to determine dental maturity and skeletal maturity was evaluated by CVM method, which is a widely used method. A low but statistically significant correlation was found between tooth calcification stage and cervical vertebra maturation stage. The correlation coefficients between calcification stages of upper third molars and skeletal maturity was a weak positive and was ranging from 0.166 to 0.0287, except for CS5 stage in which there was a moderate positive correlation [Table-4]. For lower third molars, there was a moderate positive correlation between cervical vertebra (CS4, CS5 and CS6) and the developmental stages ranging from 0.471 to 0.832.

A study by Chen *et al.*, the CVM and dental calcification stages of the teeth except the third molars showed correlations ranging from 0.601 to 0.911. Krailassiri *et al.* (25) and Uysal *et al.* (17) have reported weak correlations, while Ğngstrom *et al.* (26) found a strong correlation. In this Saudi sample there was a weak positive correlation between CVM stages and upper molar ranging from 0.166 to 0.0287, except for CS5 stage in which there was a moderate positive correlation. For lower third molar stages, there was a moderate positive correlation between cervical vertebra developmental stages CS4, CS5 and CS6, ranging from 0.471 to 0.832. It has been recommended by many researchers that the maturation of the mandibular canine is more strongly associated with the pubertal growth spurt than any other teeth (4) and some investigators have suggested that the second premolar has the highest correlation with skeletal maturation (25). It has been concluded that the second molar has an advantage over other teeth because of its longer period of development until a later age (5, 27,28).

Postoji potreba za daljnjim istraživanjima na većem uzorku saudijske djece.

## Zaključak

S obzirom na kliničku primjenjivost i jednostavnost, metoda određivanja zrelosti cervikalne kralježnice čini se korisnim dijagnostičkim alatom. Stadij sazrijevanja cervikalne kralježnice može pomoći u određivanju razdoblja aktivnog rasta za bolji dugoročni učinak ortodontske / ortopedске terapije. Može se koristiti za određivanje vremenskog okvira intervencije radi korekcije facijalnih deformiteta. Stupanj kalcifikacije zuba bio je statistički značajno povezan sa stadijem sazrijevanja cervikalne kralježnice u saudijskoj populaciji. U planiranju ortodontske terapije korisno je razmotriti i dentalnu i skeletalnu zrelost.

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## Sukob interesa

Autor nije bio u sukobu interesa.

Skeletal maturity increased together with the increase in dental ages for both genders. A constantly earlier occurrence for each skeletal maturation stage was observed in females. At some stage, in the peak growth period, these differences were more marked. All correlations between skeletal and dental stages were statistically significant. Further research using a larger sample of Saudi children is needed to come to more reliable conclusions.

## Conclusions

Due to its practical applications, the CVM stage method appears to be a powerful diagnostic tool. The CVM stage method may be helpful for the assessment of period active growth for long term effects of orthodontic/orthopedic treatment approach. It can be used to identify the sufficient time for intervention for the late correction of facial deformities. Tooth calcification stage was significantly correlated with CVM stage in a study of Saudi sample. When planning the orthodontic treatment, it is useful to consider both dental and skeletal maturity.

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## Conflict of interest

None declared

### Abstract

**Background:** The aim of the present study was to compare the cervical vertebra maturation stages method and dental maturity using tooth calcification stages. **Methods:** The current study comprised of 405 subjects selected from orthodontic patients of Saudi origin coming to clinics of the specialized dental centers in western region of Saudi Arabia. Dental age was assessed according to the developmental stages of upper and lower third molars and skeletal maturation according to the cervical vertebrae maturation stage method. Statistical analysis was done using Kruskal-Wallis H, Mann-Whitney U test, Chi-Square test; t-test and Spearman correlation coefficient for inter group comparison. **Results:** The females were younger than males in all cervical stages. The CS1-CS2 show the period before the peak of growth, during CS3-CS5 it's the pubertal growth spurt and CS6 is the period after the peak of the growth. The mean age and standard deviation for cervical stages of CS2, CS3 and CS4 were 12.09 ±1.72 years, 13.19 ±1.62 and 14.88 ±1.52 respectively. The Spearman correlation coefficients between cervical vertebrae and dental maturation were between 0.166 and 0.612, 0.243 and 0.832 for both sexes for upper and lower third molars. The significance levels for all coefficients were equal at 0.01 and 0.05. **Conclusion:** The results of this study showed that the skeletal maturity increased with the increase in dental ages for both genders. An early rate of skeletal maturation stage was observed in females. This study needs further analysis using a larger sample covering the entire dentition.

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### Key words

Cervical Vertebrae; Age Determination by Skeleton; Third Molar; Tooth Calcification

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