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The Chronology of Third Molar Eruption in the Croatian Population

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A B S T R A C T

Dental age estimation is common in orthodontics, paedodontics, paleodontology and forensic dentistry. The aim of this study was to assess chronological course of eruptive developmental phases of third molar and to establish parameters for the Croatian population. Sample of this study consisted of 1249 orthopantomograms of 530 (42.4%) male and 719 (57.6%) female subjects, aged 10 to 25 years. Eruptive phases were classified in 4 stages. No significant sex difference was found. Established chronology of the third molar eruption can be used as a standard for the assessment of dental age in clinical and forensic research on samples of Croatian population.

Key words: *age determination by teeth, tooth eruption, third molar, forensic dentistry*

Introduction

Dental age estimation is common in orthodontics, paedodontics, paleodontology and forensic dentistry[1–3]. In forensic dentistry, identification can be achieved if pre-mortal information is provided, and if that is missing, it can be established by means of a dental profile. Dental age and gender estimation are most frequent determinants in dental profile creation[4,5]. The Homeland War that took place in Croatia from 1991 till 1995 urged the need for dental identification in Croatia and for dental age estimation as a part of it[6,7]. Today procedures of dental age estimation of living persons are gaining frequency in Europe due to a high number of illegal immigrants without credible identification documents[8,9]. As the age of legal majority ranges from 14 to 18 in many European countries, and in Croatia it is 18 years, radiographic assessment of the degree of third molar development is essential for forensic age estimation of adolescents and young adults[10,11].

Numerous methods are currently used for dental age estimation. One of the most frequent is Demirjian's method, which has gained its popularity by use on various ethnic groups of children[12–21]. Mostly all methods are based on developmental phases of permanent teeth as seen on orthopantomograms (OPGs). Contrary to other permanent teeth, third molars are less frequently used for dental age determination due to their variability in position, size, time of formation and time of eruption[22]. However, in the age span of 16–23 years of age the third molars are the only teeth still in development and thereby very important for dental age calculation[23,24].

The aim of this study was to assess chronological course of eruptive developmental phases of third molars and to establish parameters for a sample of Croatian population that can be used for age estimation in clinical and forensic dentistry.

Materials and Methods

Sample of this study consisted of 1249 OPGs of 530 (42.4%) male and 719 (57.6%) female subjects, aged 10 to 25 years (median age was 14 years, Table 1), with known

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TABLE 1
AGE AND SEX DISTRIBUTION OF THE SAMPLE

Chronological Age	Gender		All N (%)
	Males (N)	Females (N)	
10	8	3	11 (0.9%)
11	80	72	152 (12.2%)
12	85	81	166 (13.3%)
13	65	91	156 (12.5%)
14	62	80	142 (11.4%)
15	29	54	83 (6.6%)
16	27	48	75 (6.0%)
17	33	54	87 (7.0%)
18	28	53	81 (6.5%)
19	18	25	43 (3.4%)
20	26	30	56 (4.5%)
21	17	43	60 (4.8%)
22	21	27	48 (3.8%)
23	17	29	46 (3.7%)
24	14	27	41 (3.3%)
25	0	2	2 (0.2%)
TOTAL	530 (42.4%)	719 (57.6%)	1.249 (100.0%)

dates of birth. Panoramic radiographs were collected during three years (2006–2008) from a number of dental offices in Croatia and from the archives of the Department of Dental Anthropology, School of Dental Medicine, University of Zagreb. The radiological examinations took place during the years 1995 to 2007. This investigation used only OPGs with at least two third molars with normal shape, in a non-retruded position and without pathological changes. In total, 4474 third molars were analyzed; there were 2247 upper and 2227 lower molars (Table 2).

Eruptive phases were classified in 4 stages, from A to D[25]. Stage A: Occlusal plane covered with alveolar bone (Figure 1). Stage B: Alveolar emergence; complete resorption of alveolar bone over occlusal plane (Figure 2). Stage C: Gingival emergence; penetration of gingival by at least one dental cusp (Figure 3). Stage D: Complete emergence in occlusal plane (Figure 4).

Fig. 1. Mandibular third molar in Stage A. The crown is completely formed within the dental follicle but the root has not yet begun to develop. The occlusal plane is covered with alveolar bone.

TABLE 2
NUMBER OF THIRD MOLARS ACCORDING TO GENDER

Tooth	Males (N)	Females (N)	Total (N)
18	474	645	1120
28	477	650	1127
38	474	644	1118
48	472	637	1109
Total	1897	2577	4474

OPG evaluation was performed by a single investigator (H.B.).

Statistics

Difference in chronology of third molar eruption between males and females was tested using t-test. Spear-

Fig. 2. Mandibular third molar in Stage B, alveolar emergence. The roots have started to develop and there is complete resorption of alveolar bone over occlusal plane.

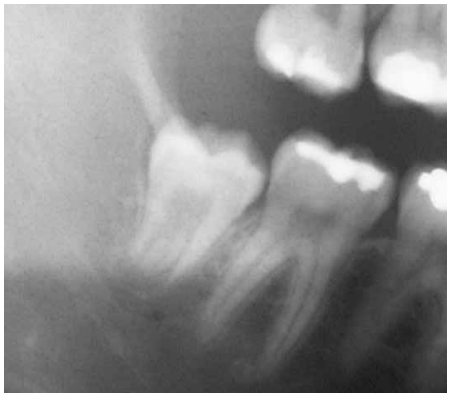

Fig. 3. Mandibular third molar in Stage C, gingival emergence. The roots have developed to two-thirds of their length and the tooth has started to erupt, although it has not yet reached the occlusal plane of the adjacent second molar.

Fig. 4. Mandibular third molar in Stage D, complete emergence in occlusal plane. The roots have completely developed, including closure of the apices, and the tooth has reached the level of the occlusal plane of the adjacent second molar.

man's correlation coefficients were computed to assess correlation between eruptive stages of left and right third molars. Statistical analysis was performed by MedCalc program (MedCalc Inc., F. Schoonjansen, Mariakerke, Belgium).

Results

On a repeated random sample of 50 OPGs, performed after three weeks, identical findings were observed, so kappa value (confirming intra-examiner reliability) was 1.

TABLE 3
STATISTICAL DATA ON THE AGE OF EMERGENCE OF TEETH 18, 28, 38 AND 48, BY STAGE, IN MALES

Tooth	Stage	N	Percentiles					Average	
			0.	25.	50.	75.	100.	Mean	SD
			Min.	LQ	Med.	UQ	Max.		
18	A	266	10.0	11.2	12.3	13.5	22.5	12.6	1.5
	B	78	12.0	14.4	16.0	17.5	21.0	16.1	1.9
	C	62	15.6	18.0	19.3	21.0	24.6	19.6	2.1
	D	68	17.0	20.0	22.0	23.0	24.5	21.3	1.9
28	A	254	10.0	11.2	12.2	13.4	22.5	12.6	1.6
	B	78	12.0	14.4	16.0	17.5	21.0	16.1	1.9
	C	61	15.6	18.0	19.3	21.0	24.6	19.5	2.1
	D	61	17.5	20.1	22.1	23.0	24.5	21.4	2.0
38	A	284	10.0	11.4	12.4	13.5	17.5	12.6	1.6
	B	69	13.0	15.0	16.0	17.8	22.4	16.6	2.1
	C	51	15.6	18.0	18.7	21.0	24.6	19.4	2.3
	D	70	17.5	20.0	22.0	23.0	24.5	21.2	3.0
48	A	284	10.0	11.6	12.5	13.6	21.0	12.5	1.6
	B	67	13.0	15.0	16.0	17.4	22.4	16.4	2.0
	C	57	15.6	18.0	19.0	21.0	24.6	19.5	2.2
	D	64	15.5	19.7	21.0	22.9	24.5	20.9	2.0

Table 3 shows results on eruptive phases for third molars in males, and Table 4 the equivalent results in females.

Overall, no significant differences were found in third molar development between males and females except

TABLE 4
STATISTICAL DATA ON THE AGE OF EMERGENCE OF TEETH 18, 28, 38 AND 48, BY STAGE, IN FEMALES; SEX DIFFERENCE TESTED BY T-TEST

Tooth	Stage	N	Percentiles					Average		Sex difference
			0.	25.	50.	75.	100.	Mean	SD	p-value
			Min.	LQ	Med.	UQ	Max.			
18	A	289	10.0	12.0	13.0	14.0	18.0	12.9	1.7	0.081
	B	150	12.5	14.2	16.0	17.0	22.3	15.8	2.2	0.418
	C	105	15.0	18.0	20.0	22.0	24.5	19.9	2.2	0.304
	D	102	17.0	20.0	21.5	23.4	25.4	21.6	2.0	0.427
28	A	289	10.7	12.0	13.0	14.0	18.0	12.9	1.6	0.136
	B	154	12.5	14.2	16.0	17.0	22.3	15.9	2.3	0.448
	C	115	15.0	18.0	20.0	22.0	24.5	19.9	2.2	0.816
	D	92	17.0	20.2	22.0	23.4	25.4	21.7	2.0	0.313
38	A	310	10.5	12.0	13.0	14.0	21.0	13.0	2.0	0.003*
	B	140	12.0	14.5	16.0	18.0	22.3	16.2	2.1	0.211
	C	85	15.0	18.0	20.0	21.4	24.5	19.8	2.3	0.319
	D	109	17.0	20.0	22.0	23.5	25.4	21.6	2.1	0.293
48	A	298	10.5	12.0	13.0	14.0	19.5	13.0	1.9	0.028*
	B	143	12.0	14.6	16.0	18.0	24.5	16.1	2.2	0.750
	C	89	15.0	18.0	20.0	22.0	24.3	19.8	2.2	0.215
	D	107	17.0	20.0	21.3	23.4	25.4	21.4	2.1	0.079

*statistically significant difference between males and females ($p<0.05$)

for the stage A for mandibular molars, where development was somewhat retarded in females (Table 4).

Statistical analysis revealed a high Spearman's correlation coefficient between developmental stages of right and left third molars. Of upper molars there were 454 pairs in males and 615 in females, and Spearman's coefficient was 0.99 for males and females. Of lower molars there were 454 pairs in males and 603 in females, and Spearman's coefficient was 0.98 for males and females.

Discussion

Tooth development and course seem to be independent of exogenic factors such as malnutrition, disease or impaction thus representing base for age determination[26]. This is especially useful in childhood when observing dentition stages results in highly accurate age assessments. Numerous published studies on dental age estimation have assessed developmental phases of crown and root of permanent teeth[12–21,27,28].

Third molars development is important criterion for dental age estimation in adolescents. Several studies showed that chronological course of wisdom tooth mineralization varies slightly between different populations and races. Mincer et al. did not obtain statistically significant differences in dental development in a study on 823 Caucasian and Afro-American subjects[29]. Contrary to that, other research on Caucasian and Afro-American populations showed different results; Gorgani et al.[30] reported complete crown mineralization in Afro-American subjects 1–2 years earlier than in Caucasian subjects. Harris and McKee[31] studied 655 white and 335 black US citizens; the black citizens reached the early developmental stages of third molars at about one year younger age.

Research performed by Rantanen[32] investigated the clinical emergence of third molars in a total of 2218 Finnish subjects ranging in age from 16 to 24 years. The median age of upper and lower wisdom tooth eruption was determined to be 21.7 and 21.8 years in males and 23.3 and 23.0 years in females. Our results for complete clinical emergence are similar for males – the median age was 21.0–22.1 years – but in our sample there was no delay in eruption in females as was noted in Finnish sample, and the median age was 21.3–22.0 years in females.

Levesque et al.[33] investigated sexual dimorphism in the development of the mandibular third molar on French-Canadian sample. Alveolar emergence occurred at a median age of 17.2 years in males and 17.7 years in females, which is about 1.5 year later when compared to the Croatian sample from our study. Clinical emergence (corresponding to the stage C in our investigation) occurred at the median age of 18.5 years in males and 19.0 years in females, which is about 0.4 and 1 year earlier then in Croatian males and females, respectively. However, Levesque et al. recorded clinical emergence from dental casts, while we did from OPG-s, so this comparison might be biased by the use of different methodology.

Due to the same method of evaluation, our findings can be reliably compared to those of Olze et al. who investigated third molar eruption in Japanese[25], black South African[34] and German populations[10] and found significant population differences[35]. Table 5 shows median age values at different eruptive stages in Croatians, Japanese, black South Africans and Germans. At the stage B of third molar eruption, alveolar emergence, Croatian males and females were the most advanced with the median age of 16.0 years, followed by South African males and females. At the stage C, gingival emergence, Croatian males were again the most advanced with the median age values of 18.7–19.3 years, while South African, Japanese and German males reached the target stage on average 1.5, 2.3 and 2.7 years later, respectively. When reaching stage C, with the median age of 20.0 years, Croatian females were between South African and German females, while Japanese females reached the target stage the oldest. In Croatian males stage D, complete eruption in the occlusal plane, occurred 0.6–1.8 years earlier than in Japanese and South African males, while Croatian females were on average 0.6 years ahead in comparison to Japanese and South African females. Croatians were even more advanced comparing to Germans – complete clinical emergence occurred on average 2.4 years earlier in Croatian males and 1 year earlier in Croatian females.

Olze et al. did not find significant sex differences except in the German sample, where females were younger in most of the target stages[10,25,34]. We did not find significant sex difference of chronological course in third molar eruption in the Croatian sample, except for the stage A in mandibular molars, where development was slightly retarded in females. Levesque et al.[33] accepted 0.3 yr as a significant sex difference and found Canadian boys more

TABLE 5
MEDIAN VALUES FOR THE AGE OF ALVEOLAR (STAGE B), GINGIVAL (STAGE C) AND COMPLETE CLINICAL EMERGENCE (STAGE D) OF THIRD MOLARS IN JAPANESE[25], BLACK SOUTH AFRICAN[34], GERMAN[10] AND CROATIAN POPULATIONS, BY GENDER

Stage	Tooth	Japanese		South African		German		Croatian	
		M	F	M	F	M	F	M	F
B	18	20.6	20.4	17.7	17.2	21.2	18.4	16.0	16.0
	28	20.7	20.6	18.6	16.7	21.7	18.5	16.0	16.0
	38	21.4	20.6	17.8	15.5	22.5	18.7	16.0	16.0
	48	21.8	20.8	16.4	14.6	21.9	18.5	16.0	16.0
C	18	21.5	20.9	20.5	19.2	21.3	20.2	19.3	20.0
	28	21.1	21.1	20.7	19.0	20.9	20.3	19.3	20.0
	38	21.8	21.6	20.2	17.6	22.3	20.2	18.7	20.0
	48	20.9	21.0	20.8	19.9	22.7	20.2	19.0	20.0
D	18	22.7	22.4	22.8	22.3	24.0	24.2	22.0	21.5
	28	22.8	22.3	22.8	22.2	24.5	22.3	22.1	22.0
	38	22.8	22.2	22.6	22.2	24.0	22.2	22.0	22.0
	48	22.8	22.2	22.8	22.4	24.2	22.4	21.0	21.3

M – male; F – female

advanced than girls in alveolar and clinical emergence. Meinl et al.[11] and Gunst et al.[23] found a trend for earlier development of the wisdom teeth in males than females in samples of Austrian and Belgian Caucasians.

A very high correlation coefficient between left and right molar in the same jaw was found in both males and females, which is in accordance with previous studies[11,23,25].

From discussion above, it is obvious that there are substantial differences in the chronology of the wisdom tooth eruption between different ethnic groups, and even between Caucasian populations. However, the differences are not attributable only to the ethnicity, but also to the deviating age distribution of the different samples and to the interobserver error. The use of population-specific standards is recommended to enhance the accuracy of forensic age estimation in living subjects. This study gives chronology of the wisdom tooth eruption based on the large sample, which can be used as a standard for the assessment of dental age in clinical and forensic work in Croatian population.

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KRONOLOGIJA NICANJA TREĆEG KUTNJAKA U HRVATSKOJ POPULACIJI

SAŽETAK

Određivanje dentalne dobi uobičajeno je u ortodonciji, pedodonciji, paleodontologiji i forenzičkoj stomatologiji. Svrha ovog istraživanja bila je odrediti kronološki slijed razvojnih faza nicanja trećeg kutnjaka i ustanoviti parametre za hrvatsku populaciju. Uzorak se sastojao od 1249 ortopantomograma 530 (42.2%) muških i 719 (57.6%) ženskih ispitanika u dobi 10 do 25 godina. Faze nicanja klasificirane su u 4 stupnja. Nisu nađene značajne spolne razlike. Ustanovljena kronologija nicanja trećeg kutnjaka može se upotrijebiti kao norma za određivanje dentalne dobi u kliničkim i forenzičkim istraživanjima na uzorcima iz hrvatske populacije.