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Third molar development in relation to chronological age in Romanian children and young adults

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Abstract: Examination of the developmental stage of third molars using orthopantomograms can be a useful tool for chronological age determination in the field of legal and forensic medicine. The aim of this study was to assess third molar third molar developmental stages in a sample of Romanian population, to determine chronologic age estimates based on developmental stages, to compare third molar development by sex, age and location. Orthopantomograms of 250 Romanian patients, from the Department of Orthodontics from Universitary Hospital "Sf. Spiridon" Iasi, aged between 11-25 years old, were examined and third-molar developmental stages were evaluated based on Nolla's classification. Linear regression analysis was performed to correlate third molar development and chronological age, and other statistical analyses were performed to determine relation between sex, age and location. Results showed a strong correlation between age and molar development (r^2 = 0.93 and r^2 =0.95 for males in the upper and lower jaw and r^2 = 0.92 and r^2 = 0.94 for females). Males achieve third molar development earlier than females and upper third molars exhibit a greater degree of development than lower third molars at the same chronological age.

Key words: third molar, orthopantomography, developmental dental stage, chronological age

The dental age can be assessed amongst children with greater accuracy. This is because many teeth are undergoing development and calcification simultaneously.

However, this accuracy decreases with the completion of a person's dental development. For the juvenile age group, there are two methods of identification: the morphological examination of skeletal features and radiological examination of the development of third molars [1].

The morphological and radiological examinations of third molars make up a part of the orthodontic, pedodontic and oral surgical treatments and provide valuable information for the clinicians. Late in adolescence, after formation of the premolars and canines, only the third molars continue to develop. According to several studies, although the third molars are the most variable teeth in the dentition, they remain the most reliable biologic indicator available for estimation of age during the middle teens and early twenties [2]. The precision of age determination using third molars is crucially important when there is a need to determine the juvenile or adult status of an individual when no valid document is available.

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Furthermore, this form of age estimation can be applied to assess the age of a patient suffering from amnesia and also specimens of forensic or anthropological importance [3].

However, even though this method is one of the best for estimating the adolescent ages, uncertainties emerge mainly from the remarkable biological variability of the third molars among all the permanent teeth, frequencies of agenesis and discrepancies between the growth of the maxillary and the mandibular third molars [4].

The aim of this study was to assess third molar third molar developmental stages in a sample of Romanian population, to determine chronologic age estimates based on developmental stages, to compare third molar development by sex and age and to compare these data with the results of previous studies.

Materials and Methods

The material consisted of 250 orthopantomograms taken at the Department of Orthodontics, "Sf. Spiridon" Universitary Hospital, Iasi, Romania, in the period from 2000-2006. There were taken into study 250 subjects with known chronologic age, 171 female and 79 male patients, aged from 11 to 25 (mean of 13,96) years. We considered the age limit of 11 years for an accurate radiological evidence of third molar even though Gravely[5] found the peak formation period at the age of nine years. The criteria for inclusion in the sample were the availability of adequate quality and no history of medical or surgical disease that could affect the presence and development of third molars. All orthopantomograms were taken with the same device Strato-X and were evaluated using a magnifying glass on a standard viewing box in a darkened room for improved visualization. The radiographs were examined separately by two observers who noted the presence or absence of third molars and their development score using the formation stages described by Nolla [6]:

0. absence of crypt; no sign of tooth development is apparent;
1. presence of crypt; crypt is formed but no mineralization has begun;
2. initial calcification; amelogenesis has begun on the cusp tips;
3. one-third of crown completed;
4. two-thirds of crown completed;
5. crown almost completed; morphologically, the crown has mineralized to just short of the cervical margin;
6. crown completed, but root formation has not yet begun;
7. one-third of root completed;
8. two-thirds of root completed;
9. root almost completed; full root length has been achieved, but the apex is still opened;
10. root completed; apical end of root completed and apex is closed.

To assess reliability, 70 randomly selected radiographs were re-examined 1 month after initial examination by the same observers, and inter- and intra-observer agreement was determined using the Wilcoxon – matched pairs signed-ranks test. Statistical analysis was performed using the SPSS 15.0 package (SPSS Inc., Chicago, IL) for Windows.

Results

Repeated scorings of a sub-sample of 70 radiographs indicated no significant intra- or inter-observer differences (p.0.05). Intra-observer consistency was rated at 92%, whereas inter-observer agreement was 85%.

The sample consisted of 250 subjects, 68, 4% (n = 171) female and 31, 6% (n = 79) male, age ranged between 11 and 25 years, mean age 13, 96 years. Patients with all four third

molars represented 180 (72%) from 250 subjects; 12, 8 % (n = 32) subjects had one third molar missing, 7, 2% (n = 18) had agenesis of two third molars, 4,4 % (n = 11) had missing three third molars and 9 (3,6%) patients had no sign of third molar development. Total number of third molar taken into study was 863, 425 in the upper arch and 438 in the lower arch. Table 1 shows the distribution of the different numbers of third molars detected into study.

Table 1 Distribution of examined third molars in both jaws

	Total	Upper right third molar (M3UR)	Upper left third molar (M3UR)	Lower right third molar (M3LR)	Lower left third molar (M3LL)
Third molars	863	210	215	222	216
Missing third molars	137	40	35	28	34

Table 2 and Table 3 show the mean values, minimum and maximum, using Nolla's classification, according to age and gender for upper third molars and lower third molars, respectively.

		Age (years)	Mean	Minimum	Maximum
Female	**Upper third molar (M3U)**	11	3.17	1	5
		12	4.13	1	7
		13	4.74	1	8
		14	5.24	2	8
		15	5.93	4	7
		16	6.00	2	10
		17	6.14	5	8
		18	7.89	6	10
		>18	9.25	4	10
Male	**Upper third molar (M3U)**	11	3.57	2	6
		12	4.64	1	7
		13	5.19	3	7
		14	5.00	4	6
		15	5.70	3	7
		16	6.83	3	8
		17	7.33	7	8
		>18	9.89	9	10

Table 3 Mean, minimum and maximum values for the mineralization stages of the upper third molar in relation to age and sex in the study population

		Age (years)	Mean	Minimum	Maximum
Female	**Lower third molar (M3L)**	11	2.42	1	4
		12	3.36	1	6
		13	3.81	2	7
		14	4.50	1	7
		15	4.91	2	8
		16	6.20	1	9
		17	5.80	4	8
		18	8.18	4	10
		>18	9.00	4	10
Male	**Lower third molar (M3L)**	11	3.25	2	5
		12	3.60	1	9
		13	4.31	1	7
		14	4.45	3	6
		15	5.60	4	7
		16	6.44	3	9
		17	7.67	7	8
		>18	10.0	10	10

Table 2 Mean, maximum and minimum values for the mineralization stages of the lower third molar in relation to age and sex in the study population

The graphic representations from Fig. 1 and Fig. 2 show that no significant differences were found in third-molar development between males and females, altghough, for both upper and lower molars, almost in all age groups there is a slight developmental advance in males than in females. Also, there are small differences between the developmental stage in the same age group of the upper and lower third molars; the maxillary third molar was commonly more advanced than the mandibular one.

We used multiple regression coefficients to assess the correlation between third molar development, according to Nolla's calssification, and chronological age. Statistical analysis (Figure 3 and Figure 4) showed a strong correlation between age and third molar development for males ($r^2 = 0.93$ in the upper jaw and $r^2 = 0.95$ in the lower jaw) and females ($r^2 = 0.92$ for maxillary third molars and $r^2 = 0.94$ for mandibular third molars.

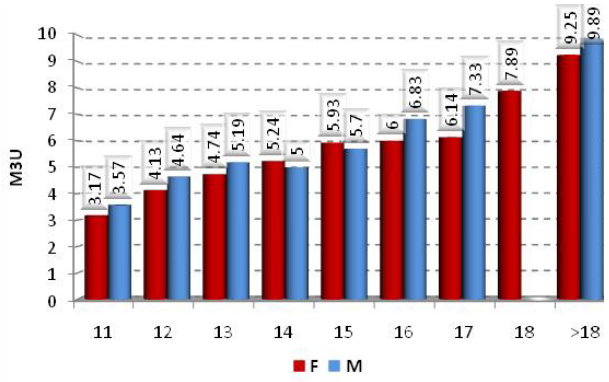

Fig. 1 Mean values for upper third molars (M3U) mineralization stages according to age and sex

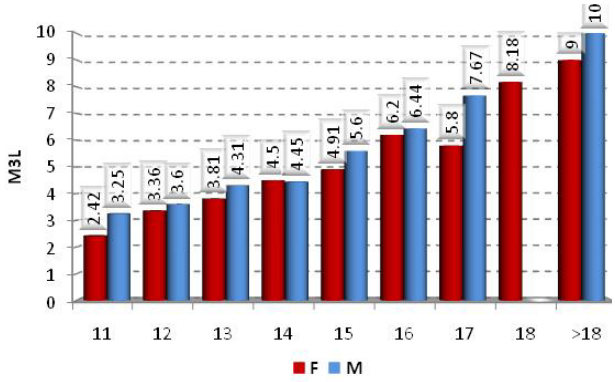

Fig. 2 Mean values for lower third molars (M3L) mineralization stages according to age and sex

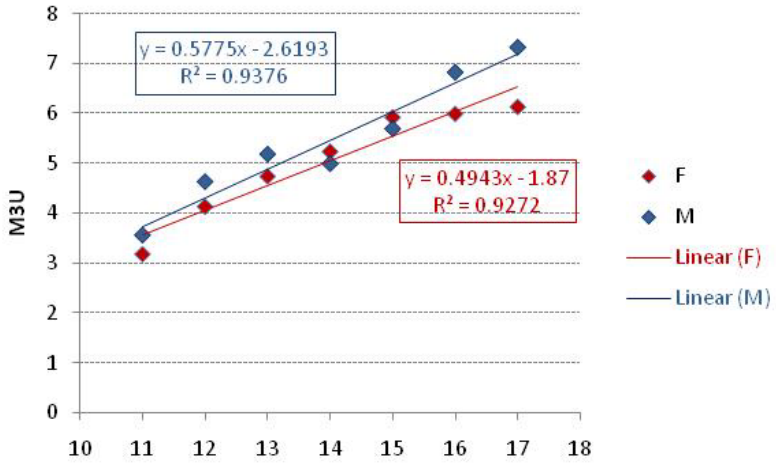

Fig. 3 Correlation between chronological age and upper third molar developmental stage in males and females

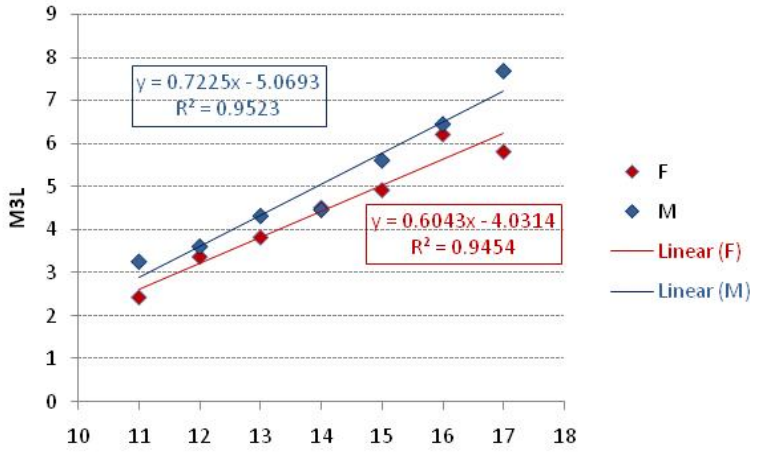

Fig. 4 Correlation between chronological age and lower third molar developmental stage in males and females

Discussions

Among methods for estimating the chronological age of the teenagers and young adults, analysis of the stage of third molar mineralization has been proposed because of the absence of other reliable biological markers during late adolescence [7,8]. Tooth mineralization is evaluated in an orthopantomogram, and dental age is estimated by comparing the dental mineralization status in a person of known or unknown chronological age with dental developmental surveys [9]. We used the system of 10 stages of Nolla [6], which gives the possibility of scoring the degree of tooth development. The review of the literature shows that many authors [2,10,11] established chrono-logical age by using different methods of stage assessment of third molars, especially those described by Demirjian [12] and Kullman [13]. In our study, we found an inter-observer agreement of 85%, closed to that reported by Lebret, cited by Dhanjal [10], 97% for the mandibular third molar.

We examined the orthopantomograms of 250 subjects, 171 females and 79, aged between 11-25 years, mean age 13.96 years, in order to study the validity, reproducibility and

applicability of Nolla's method for stage assessment of third molars for determination of the chronological age. From our sample, 70 subjects (28%) had at least one third molar missing and 9 subjects had no sign of third molar development. Similar to previous studies carried out by Baba-Kawano [14] and Kajii [15], our findings regarding third molar agenesis confirm that the frequency of missing third molars is , in descending order, one, two, three and four third molars and the frequency of the maxillary third molars agenesis is slightly higher in the maxilla (n = 75), than in the mandible (n = 62).

The results of this study show a faster development of third molars in Romanian males than females and did not differ from findings of previous studies [11]. The only small advancement of the females regarding third molar development is, in our study, in the maxilla, around the age of 14 years, before beginning of the root formation. After this stage, root formation occurs more rapidly in males than in females. This is a unique trait of third molars which expresses the sexually dimorphic character of tooth formation.

Comparing the same age groups, in upper and in lower jaw for both sexes, we conclude that the maxillary third molar exhibit a greater degree of development at the same age with the lower third molar. This means that for the same developmental stage, the chronological age established by using this method is slightly greater when third lower molar is taken into study, compared with the same subject's upper third molar. Our results are similar to those reported by Orhan [16], who didn't find any statistically significant differences between the right and left side.

We studied the significance and the strength of the correlation between developmental stage of the third molar and the chronological age. Our statistical analysis shows that $p < 0.0005$ and $r^2 > 0.90$ for both males and females, also for the maxillary and mandibular third molars, which means that developmental dental stage, using method described by Nolla, strongly correlates with the chronological age.

Conclusions

Examination of the developmental stage of third molars using orthopantomograms can be a useful tool for chronological age determination in the field of legal and forensic medicine. The described data may provide Romanian references for third molar examination; however, additional studies with a larger study population must be conducted in order to check for the reliability of this method. This research traced some guidelines concerning the sex-specific mean stages of development for each age group.

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