Maturation of 2nd and 3rd Molars and Any Relation Between Maturation of 2nd Molars and Congenital Absence of 3rd Molars in Turkish Population

Türk Populasyonunda 2. ve 3. Molar Dişlerin Maturasyonları ve 2. Molarların Maturasyonu ile 3. Molarların Konjenital Eksikliği Arasındaki İlişkinin Değerlendirilmesi

Zühre AKARSLAN,[a]
Kahraman GÜNGÖR,[a]
Cemal ATAKAN[b]

[a]Department of Dentomaxillofacial Radiology, Gazi University Faculty of Dentistry,
[b]Department of Statistics Ankara University Faculty of Arts and Science, Ankara

Geliş Tarihi/*Received:* 04.01.2016
Kabul Tarihi/*Accepted:* 18.02.2016

Yazışma Adresi/*Correspondence:*
Zühre AKARSLAN
Gazi University Faculty of Dentistry, Department of Dentomaxillofacial Radiology, Ankara, TÜRKİYE/TURKEY
dtzuhre@yahoo.com

ABSTRACT Objectives: To assess the maturation stages of permanent maxillary and mandibular 2nd and 3rd molar teeth according to age and establish any relation of congenital absence of 3rd molar regarding maturation stages of 2nd molars. **Material and Methods:** Digital panoramic radiographs present in the archive of the radiology department taken from 1070 patients (678 females, 392 males; age range 4-20 years) were evaluated. The maturation stages of the teeth were assessed according to the Demirjians method (a-h stages). In addition, 'no follicle' and 'follicle' stages were also evaluated. Symmetry in maturation between teeth on the left and right quadrant was also evaluated. Descriptive statistics, Mann Whitney U test, Wilcoxon rank sum test and probability values were used for statistical analysis. **Results:** All maxillary and mandibular molar teeth of males reached to the h stage earlier than females ($p<0.05$). Maxillary and mandibular 2nd molars showed symmetric maturation among females and males ($p>0.05$). Contrary, maxillary and mandibular 3rd molars in males and maxillary 3rd molars in females did not show symmetric maturation ($p<0.05$). The probability of 3rd molar absence was too high in cases when the maxillary and mandibular 2nd molar teeth reached to the f stage and the follicle 3rd molar is absent among females and males. **Conclusion:** All 2nd and 3rd molar teeth of males completed their maturation earlier than females. These reference values for maturity of 2nd and 3rd molar teeth could be useful in age determination and the evaluation for congenital agenesis of 3rd molars.

Key Words:: Radiography; age determination by teeth; molar

ÖZET Amaç: Daimi mandibular ve maksiller 2. ve 3. molar dişlerin yaşa göre maturasyon evrelerinin incelenmesi ve 3. molar dişlerin konjenital eksikliği ile 2. molar dişlerin maturasyon evreleri arasındaki ilişkinin değerlendirilmesidir. **Gereç ve Yöntemler:** Çalışmada radyoloji kliniği arşivinde mevcut olan 1070 hastaya ait (678 kadın, 392 erkek; yaş aralığı 4-20 yıl) dijital panoramik görüntüler değerlendirildi. Dişlerin maturasyon düzeyleri Demirjian'ın yöntemine göre (a-h evreleri) incelendi. Bu yöntemin yanısıra 'folikül yok' ve 'folikül aşamasında' şeklinde değerlendirme de yapıldı. Ayrıca, sağ ve sol 3. molar dişlerin maturasyon evreleri arasında simetri olup olmadığı incelendi. Verilerin istatistiksel analizi tanımlayıcı istatistik, Mann-Whitney U testi, Wilcoxon Signed Ranks testi ve olasılık değerleri hesaplanarak yapıldı. **Bulgular:** Tüm maksiller ve mandibular 2. ve 3. molar dişlerin 'h evresine' erkeklerde kadınlara göre daha erken yaşta eriştiği saptandı ($p<0,05$). Sağ ve sol maksiller ve mandibular 2. molar dişlerin maturasyonlarının kadınlarda ve erkeklerde simetrik olduğu anlaşıldı ($p>0,05$). Buna karşın, erkeklerde maksiller ve mandibular 3. molarların, kadınlarda da maksiller 3. molarların maturasyonlarının simetrik olmadığı belirlendi ($p<0,05$). Kadınlarda ve erkeklerde maksiller ve mandibular dişlerin f evresine ulaştığı halde 3. molar dişin folikülünün hala oluşmaması durumunda ilgili çenedeki 3. molar dişin konjenital olarak eksik olma olasılığının bulunduğu saptandı. **Sonuç:** 2. ve 3. molar dişlerin erkeklerde kadınlara göre daha erken yaşta maturasyonunu tamamladığı bulgulandı. Bu dişlerin maturasyonu için elde edilen referans değerleri yaş tayininde ve 3. molar dişin konjenital eksiklik olasılığının belirlenmesinde faydalı olacaktır

Anahtar Kelimeler Radyografi; dişlerden yaş tespiti; azı dişi

doi: 10.5336/dentalsci.2016-49925

Turkiye Klinikleri J Dental Sci 2016;22(2):115-21

Dental age determination is useful on diagnosis, treatment goals, treatment planning, and the eventual outcome of orthodontic treatment, forensic science, archaeology, and anthropology.[1,2]

Radiographic images have become an essential aid for human identification, particularly with the refinement of techniques and the incorporation of information technology resources. It is a simpler and cheaper method for age determination compared with histological and biochemical methods.[1]

Panoramic radiography is a commonly used radiographic technique in dental clinics for producing an image of the maxillary and mandibular teeth and their supporting structures.[3] Evaluation of tooth calcification stages from panoramic radiographs might be clinically useful as a maturity indicator of the pubertal growth period.[1] A method described by Demirjian[4] is widely used in studies for the assessment of maturation of teeth. It identifies eight calcification stages for each tooth, ranging from the calcification of the tip of a cusp to the closure of the apex.[4] Researches showed high inter and intra-observer agreement levels[5-7] and correlation between estimated and real age.[8-10]

Up to now several studies have been undertaken in different populations to explore the usefulness of the third molar as a reliable age indicator[11-13] as the development of these teeth starts in childhood and continues during or late adolescence. These studies showed that dental development varies slightly between different populations, making population-specific studies necessary.[14] In addition, correlation between the 2nd molar maturation stage and third molar congenital absence according to the method of Demirjian from panoramic radiographs has also been reported.[4,15]

Based upon this evidence, the aim of this study was to establish maturation ages for permanent 2nd and 3rd molars and to assess any relation between maturation stage of 2nd molars and agenesis of 3rd molar in Turkish children and young adults having no dentoalveolar anomaly.

MATERIAL AND METHODS

In this retrospective study, digital panoramic radiographs (Veraviewepocs 2D, Morita USA) of 1070 patients with an age range of 4-20 present in the radiology archive were evaluated. The examined patients reflect the Turkish population since Ankara is a city where individuals form every province of Turkey come to receive health care.

The patient selection criteria included:

-To be Turkish and with mother and father having Turkish nationality.

-Having no signs of trauma, medical or surgical disease.

-All maxillary and mandibular 2nd molar teeth were erupted in normal position or the buds of these teeth were in normal position.

Patient exclusion criteria included:

-Inadequate radiographic image clarity.

-One or more excess or absent teeth in the dentition; except for 3rd molars and/or pathology affecting teeth formation or jaws.

The developmental stage of each maxillary and mandibular permanent 2nd molar and presence and development stages of 3rd molars were assessed according to the method described by Demirjian et al.[4] Stage 0 representing 'no follicle' and stage 1 representing 'follicle' were added to this method (Figure 1).

The panoramic radiographs were evaluated on a 17 inch monitor under subdued lightning in a

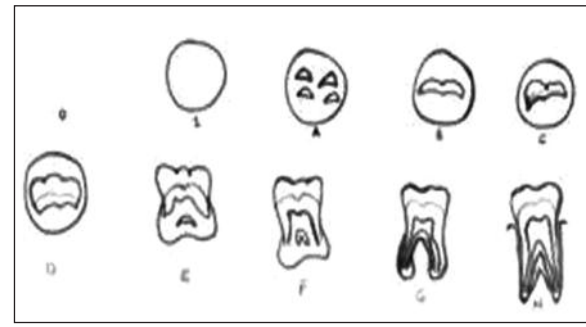

FIGURE 1: Schematic drawings of the developmental stages of the teeth (modified from Demirjian et al.)[4] Figure legend: Schematic drawings of the developmental stages of the teeth (modified from Demirjian et al.)[4]

quiet room. The radiographs were evaluated by two maxillofacial radiologists having at least 10 years of experience in the field. Any disagreement during stage description of the teeth was solved by forced consensus.

The mean age and standard deviation (SD) for 'no follicle' and tooth development stages (a,b,c,d, e,f,g,h) was calculated for each tooth examined in the study. Any difference between mean ages of all teeth stages for genders were evaluated with Mann-Whitney U test. Symmetry in maturation of teeth present on maxilla and mandible was assessed with Wilcoxon Signed Ranks test. Probability values of maxillary and mandibular 3rd molars absence were calculated for the total of the sample and genders.

RESULTS

According to the analysis of the verifying data, 63.4% of the patients were female and 36.6% were male. The patients were aged between 4 and 20 years old (mean: 15.36, sd:3.92).

Among all evaluated teeth, 96 (9.0%) of right maxillary 3rd molar, 89 (8.3%) of left maxillary 3rd molar, 74(6.9%) of right mandibular 3rd molar and 80(7.5%) of mandibular left 3rd molars were congenitally absent.

'Stage a' was only present for one patient and could not be assessed for maxillary and mandibular 2nd molars. On the other hand, an evaluation could be made for maxillary and mandibular 3rd molars. These teeth started to calcify at approximately 9 years and no significant difference was present between genders. Maxillary and mandibular 2nd molars reached to 'h stage' in 17.50 years , 17 years and 3rd molars in 19 years , 18 years in females and males respectively. Significant difference was present between the 'h stage' for right and left maxillary and mandibular 2nd and 3rd molar teeth between females and males ($p<0.05$). All molar teeth of males completed their maturation earlier than females (Tables 1 and 2).

Maxillary and mandibular 2nd molars showed symmetric maturation among females and males ($p>0.05$). Contrary, maxillary and mandibular 3rd molars in males and maxillary 3rd molars in females did not show symmetric maturation ($p<0.05$) (Table 3).

The probability of 3rd molar absence was too high in cases when the maxillary and mandibular 2nd molar teeth reached to the f stage in the total, and among females and males and the follicle 3rd molar is absent (Tables 4-7).

DISCUSSION

Radiography is a simple and cheap method for the assessment of teeth maturation.[1] Krailassiri et al.[1] suggested that tooth calcification stages from

TABLE 1: Mean and SD for the maturation stages of the 2nd molars.

	17			27			37			47		
	Mean SD			Mean SD			Mean SD			Mean SD		
Stage	Female	Male	p-value	Female	Male	p-value	Female	Male	p-value	Female	Male	p-value
e	9.44 1.42	9.78 1.03	0.051	9.44 1.42	9.80 1.036	0.046*	9.34 1.18	9.88 0.99	0.006*	9.34 1.18	9.88 0.99	0.006*
f	9.94 0.87	10.28 0.79	0.341	9.94 0.873	10.25 0.81	0.423	10.00 0.93	10.30 7.95	0.561	10.00 0.935	10.30 0.79	0.561
g	12.30 2.12	12.20 1.74	0.931	12.30 2.12	12.20 1.74	0.931	12.93 2.21	12.75 1.966	0.668	12.93 2.21	12.75 1.96	0.668
h	17.56 2.19	17.17 1.96	0.005*	17.56 2.19	17.17 1.96	0.005*	17.71 2.09	17.41 1.86	0.018*	17.71 2.09	17.41 1.86	0.018*

17: Right maxillary 1st molar 27: Left maxillary 1st molar 37: Left mandibular 1st molar 47:Right mandibular 1st molar.
SD: Standard deviation.

TABLE 2: Mean and SD for the maturation stages of the 3rd molars.

	18			28			38			48		
	Mean SD			Mean SD			Mean SD			Mean SD		
Stage	Female	Male	p-value	Female	Male	p-value	Female	Male	p-value	Female	Male	p-value
No follicle	10.96 4.87	8.70 3.56	0.019*	10.26 4.55	8.33 2.98	0.063	8.27 2.57	8.66 3.58	1.000	7.32 2.55	9.27 3.89	0.060
Follicle	9.13 0.30	9.43 0.55	0.370	9.10 0.59	8.56 0.80	0.170	8.90 1.20	9.02 0.59	0.132	8.67 0.90	8.76 0.95	0.608
a	9.71 1.20	9.64 0.65	0.936	9.80 1.00	9.00 0.63	0.074	9.58 1.10	9.55 1.14	1.000	9.25 0.55	9.74 1.17	0.149
b	9.27 0.46	10.38 1.16	0.001*	9.10 0.316	10.06 0.93	0.001*	9.94 1.16	10.78 1.35	0.029*	10.00 1.29	10.75 1.24	0.019*
c	11.26 1.59	11.03 1.48	0.547	11.44 1.67	11.04 1.39	0.310	12.39 1.39	11.06 1.34	0.000*	12.26 1.50	11.54 1.95	0.032*
d	13.60 1.91	13.06 1.79	0.180	13.22 1.80	13.40 1.93	0.555	14.61 2.00	13.86 2.21	0.108	14.29 2.10	13.52 2.20	0.075
e	15.31 1.83	14.67 1.97	0.035*	15.27 1.79	14.76 2.08	0.133	15.59 1.84	15.71 2.12	0.220	15.68 1.93	15.52 2.074	0.868
f	16.68 1.87	16.72 1.55	0.588	16.92 1.86	16.72 1.55	0.843	17.16 1.81	16.24 1.75	0.005*	16.97 1.89	16.87 1.74	0.589
g	17.60 1.55	16.92 1.34	0.024*	17.66 1.59	16.91 1.42*	0.016	17.98 1.42	17.00 1.60	0.001*	18.04 1.42	17.00 1.52	0.000*
h	19.23 0.98	18.83 1.02	0.001*	19.22 0.98	18.74 1.07	0.000*	19.53 0.79	19.53 1,04	0.000*	19.50 0.79	18.95 1,04	0.000*

18: Right maxillary 1**st** molar 28: Left maxillary 1**st** molar 38: Left mandibular 1**st** molar 48:Right mandibular 1**st** molar.
SD: Standard deviation

panoramic radiographs might be clinically useful as a maturity indicator. According to this we evaluated the maturity stages of all maxillary and mandibular molar teeth form panoramic radiographs.

The mean age for starting of calcification could not be evaluated for the maxillary and mandibular 2nd molars as 'stage a' was only present for one maxillary 2nd molar in 1 female patient and not for mandibular 2nd molars. Maxillary and mandibular 3rd molars started to calcify (stage a) at approximately 9 years. No significant difference was present between females and males. Our results show slight difference with Uzamış et al.[16] who evaluated 400 panoramic radiographs and reported that the earliest age for maxillary 3rd molar crypt formation was 8 years, and 7 for mandibular 3rd molars among Turkish children.

Maxillary and mandibular 2nd molars matured in 17.50, 17 years and 3rd molars in 19, 18 years in females and males respectively. All molar teeth of males completed their maturation earlier than females. Svanholt and Kjaer reported a significant difference in dental maturity between males and females; except for the maxillary 2nd premolar favoring earlier maturation among females.[17] They also reported that mandibular canines matured significantly earlier than the maxillary canines in females and no significant difference was observed in the maturation of the premolars and 2nd molars between the jaws. Contrary to our results regarding

TABLE 3: Comparison of molar teeth present in the right and left quadrant of females and males (Wilcoxon Signed Ranks test).

Tooth no	Female p-value	Male p-value
27-17	1.000	0.157
47-37	1.000	1.000
28-18	0.700	0.001*
48-38	0.001*	0.000*

TABLE 4: Maxillary 2nd and 3rd molar maturity and probability of congenital absence of maxillary 3rd molars in the total sample.

17 Stage	18 crypt stage or later N	18 crypt not occurred N	Probability of 18 occurrence	27 Stage	28 crypt stage or later N	28 crypt not occurred N	Probability of 28 occurrence
a	0	1	1.000	a	0	0	0.000
b	0	7	1.000	b	0	8	1.000
c	1	4	0.800	c	1	4	0.800
d	1	30	0.967	d	1	30	0.967
e	50	32	0.390	e	50	3	0.382
f	60	1	0.016	f	60	2	0.032
g	129	2	0.155	g	131	0	0.000
h	733	19	0.026	h	738	14	0.018

TABLE 5: Mandibular 2nd and 3rd molar maturity and probability of congenital absence of mandibular 3rd molars congenital absence in the total sample.

37 Stage	38 crypt stage or later N	38 crypt not occurred N	Probability of 38 occurrence	47 Stage	48 crypt stage or later N	48 crypt not occurred N	Probability of 48 occurrence
a	0	0	0.000	a	0	0	1.000
b	0	5	1.000	b	0	5	0.900
c	1	9	0.900	c	1	9	0.890
d	1	38	0.974	d	4	35	0.175
e	61	13	0.175	e	61	13	0.017
f	56	5	0.081	f	60	1	0.016
g	164	8	0.046	g	168	4	0.023
h	707	2	0.002	h	702	7	0.009

TABLE 6: Probability of congenital absence of maxillary 3rd molars according to maturation stages of maxillary 2nd molars among genders.

17 Stage	Probability of 18 occurrence		27 stage	Probability of 28 occurrence	
	Female	Male		Female	Male
a	0.000	0.000	a	0.000	0.000
b	1.000	0.000	b	1.000	1.000
c	0.000	0.800	c	0.000	0.800
d	1.000	0.961	d	1.000	0.000
e	0.611	0.217	e	0.611	1.800
f	1.000	0.023	f	1.000	0.045
g	0.032	1.000	g	1.000	1.000
h	0.023	0.029	h	0.016	0.024

3rd molar teeth, Orhan et al. evaluated 1134 panoramic radiographs and reported that maxillary and mandibular 3rd molars matured generally at 20 years old both in females and males and Şişman et al.[5,14] evaluated 900 panoramic radiographs and reported that mandibular 3rd molars matured ap-

TABLE 7: Probability of congenital absence of mandibular 3rd molars according to maturation stages of mandibular 2nd molars among genders.

37 Stage	Probability of 38 occurrence		47 stage	Probability of 48 occurrence	
	Female	Male		Female	Male
a	0.000	0.000	a	0.000	0.000
b	1.000	1.000	b	1.000	1.000
c	1.000	0.833	c	1.000	0.833
d	1.000	0.965	d	0.100	0.965
e	0.218	0.142	e	0.218	0.142
f	0.235	0.022	f	1.000	0.023
g	0.047	0.045	g	1.000	0.045
h	1.000	0.010	h	1.000	0.038

proximately at 22 years. Gunst et al assessed 2513 panoramic radiographs of patients of Belgian Caucasian origin and found that males matured earlier than females.[18] In addition they reported that the chance for maturation of 3rd molars in a Caucasian individual to be older than 18 years was 96.3% or 95.1% for males and females.

Symmetry in maturation was found for maxillary and mandibular 2nd molar teeth. On the other hand, significant difference was present for maxillary and madibular 3rd molars, except for right maxillary 3rd molars in females. Svanholt and Kjaer reported differences in maturity between the left and right sides were non-significant among Danish children.[17] In addition they reported no significant differences in the maturation of the premolars and 2nd molars between the jaws. Orhan et al.[5] reported symmetry in completion of maturation of 3rd molars in both genders.

In general, for both genders, it could be said that when right and left side maxillary 2nd molars have reached the f stage and if there is no follicle of same side 3rd molar it could be concluded that the 3rd molar is congenitally missing. Likely, it could be postulated that when the mandibular 2nd molar have reached the g stage the same side 3rd molar is congenitally missing. Liversidge et al.[19] assessed 1749 radiographs belonging to White and Bangladeshi individuals and reported that as the root of the 2nd molar developed the likelihood of 3rd molar crypt formation decreased. In addition, after the half of the root of the 2nd molar has been developed the occurrence of 3rd molar crypt was unlikely. Baba-Kawano et al.[15] evaluated panoramic radiographs of 96 patients in a longitudinal study according to the method of Demirjian. They assumed that when the tooth germ of the lower third molar had not appeared at stage 7 of formation of the second molar, the probability of the third molar being missing was 100%. Moreover, they concluded that the highest correlation existed between the age at the beginning of formation of the third molar and the formation stage of the second molar and late formation of tooth germs was one of the factors that led to the congenital absence of lower third molars. The advantage of such assessment of congenital absence and maturation of 3rd molars is that it could make it possible to evaluate the congenital absence and maturation stages of the 3rd molars in cases where patients' age is not kwon.

Dentoalveolar anomaly has an influence on congenital absence of teeth. Oligodontia, the congenital absence of six or more permanent teeth, is a common developmental anomaly of human dentition having genetic basis.[20] According to the results of a study in which tooth agenesis was evaluated with two-dimensional area measurements most of the patients had significant decreases maxillary jaw size and relatively few had significant changes in mandibular jaw size.[21] Çelikoğlu et al. reported that permanent tooth agenesis, microdontia of maxillary lateral incisors, and total dental anomalies are more frequently associated with agenesis of 4 third molars than with the presence of third molars.[22] Therefore, it should be

kept in mind that the results obtained from the present study were collected from patients having no dentoalveolar anomaly and difference may be present in patients having such anomaly.

CONCLUSION

All maxillary and mandibular molar teeth of males matured earlier than females. All 2nd molars in both genders showed symmetric maturation. On the other hand no symmetry was present for maxillary and mandibular 3rd molars among males and maxillary 3rd molars among females. The probability of 3rd molar absence was too high in cases when the maxillary and mandibular 2nd molar teeth reached to the f stage and the follicle 3rd molar is absent. These reference values could be useful among Turks for age determination and evaluation of probability of 3rd molar agenesis.

REFERENCES

1. Krailassiri S, Anuwongnukroh N, Dechkunakorn S. Relationships between dental calcification stages and skeletal maturity indicators in Thai individuals. Angle Orthod 2002;72(2):155-66.
2. Liversidge HM, Molleson TI. Developing permanent tooth length as an estimate of age. J Forensic Sci 1999;44(5):917-20.
3. Lurie AG. Panoramic imaging. In: White SC, Pharoah MJ, eds. Oral Radiology. Principles and Interpretation. 6thed. Mosby St. Louis, Missouri: Elsiever; 2009. p.175-90.
4. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. Hum Biol 1973;45(2):211-27.
5. Orhan K, Ozer L, Orhan Al, Dogan S, Paksoy CS. Radiographic evaluation of third molar development in relation to chronological age among Turkish children and youth. Forensic Sci Int 2007;165(1):46-51.
6. Garamendi PM, Landa MI, Ballesteros J, Solano MA. Reliability of the methods applied to assess age minority in living subjects around 18 years old. A survey on a Moroccan origin population. Forensic Sci Int 2005;154(1):3-12.
7. Mincer HH, Harris EF, Berryman HE. The A.B.F.O. study of third molar development and its use as an estimator of chronological age. J Forensic Sci 1993;38(2):379-90.
8. Olze A, Schmeling A, Taniguchi M, Maeda H, van Niekerk P, Wernecke KD, et al. Forensic age estimation in living subjects: the ethnic factor in wisdom tooth mineralization. Int J Legal Med 2004;118(3):170-3.
9. Olze A, Taniguchi M, Schmeling A, Zhu BL, Yamada Y, Maeda H, et al. Studies on the chronology of third molar mineralization in a Japanese population. Leg Med (Tokyo) 2004;6(2):73-9.
10. Prieto JL, Barbería E, Ortega R, Magaña C. Evaluation of chronological age based on third molar development in the Spanish population. Int J Legal Med 2005;119(6):349-54.
11. Kullman L. Accuracy of two dental and one skeletal age estimation method in Swedish adolescents. Forensic Sci Int 1995;75(2-3):225-36.
12. Kullman L, Johanson G, Akesson L. Root development of the lower third molar and its relation to chronological age. Swed Dent J 1992;16(4):161-7.
13. Engström C, Engström H, Sagne S. Lower third molar development in relation to skeletal maturity and chronological age. Angle Orthod 1983;53(2):97-106.
14. Sisman Y, Uysal T, Yagmur F, Ramoglu SI. Third-molar development in relation to chronologic age in Turkish children and young adults. Angle Orthod 2007;77(6):1040-5.
15. Baba-Kawano S, Toyoshima Y, Regalado L, Sa'do B, Nakasima A. Relationship between congenitally missing lower third molars and late formation of tooth germs. Angle Orthod 2002;72(2):112-7.
16. Uzamiş M, Kansu O, Taner TU, Alpar R. Radiographic evaluation of third-molar development in a group of Turkish children. ASDC J Dent Child 2000;67(2):136-41.
17. Svanholt M, Kjaer I. Developmental stages of permanent canines, premolars, and 2nd molars in 244 Danish children. Acta Odont Scand 2008;66(6):342-50.
18. Gunst K, Mesotten K, Carbonez A, Willems G. Third molar root development in relation to chronological age: a large sample sized retrospective study. Forensic Sci Int 2003;136(1):52-7.
19. Liversidge HM. Predicting mandibular third molar agenesis form second molar formation. Acta Stomatol Croat 2008;42(4):311-7.
20. Frazier-Bowers SA, Scott MR, Cavender A, Mensah J, D'Souza RN. Mutational analysis of families affected with molar oligodontia. Connect Tissue Res 2002;43(2-3):296-300.
21. Tavajohi-Kermani H, Kapur R, Sciote JJ. Tooth agenesis and craniofacial morphology in an orthodontic population. Am J Orthod Dentofacial Orthop 2002;122(1):39-47.
22. Celikoglu M, Bayram M, Nur M. Patterns of third-molar agenesis and associated dental anomalies in an orthodontic population. Am J Orthod Dentofacial Orthop 2011;140(6):856-60.