Original Article

Dentofacial Morphology in Third Molar Agenesis

A. Burcu Altan, DDS, MS, PhD;[1,*] E. Alper Sinanoğlu, DDS, MS, PhD;[2] Ebru Üçdemir, DDS;[3] Songül Sandalci, DDS;[4] and Ali ihya Karaman, DDS, MS, PhD[5]

ABSTRACT

Objective: In the literature, some studies show a relation between tooth agenesis and craniofacial morphology, whereas other authors conclude that dental agenesis exerts little influence on dent facial structures. The objective of this study was to determine the existence of any relation between bilateral agenesis of the maxillary and/or mandibular third molars and the anteroposterior dimensions and vertical growth pattern of the jaws.

Subjects and Methods: Sixty-eight subjects between the ages of 13 and 17 years with bilateral agenesis of maxillary third molars (group I, n=37), bilateral agenesis of the mandibular third molars (group II, n=19), and agenesis of all third molars (group III, n=12) as well as 33 subjects without third molar agenesis (group IV) were selected from the radiology archive. A before and after treatment orthopantomograph and the pretreatment cephalometric radiograph of the subjects were used. Several angular and linear parameters representing the anteroposterior dimensions and vertical growth pattern of the jaws were measured on cephalometric radiographs. The data were analyzed by Kolmogorov-Smirnov test, analysis of variance for 1 factor, and independent-samples *t* test. Statistical significance was set at $p<0.05$.

Results: When the agenesis groups (groups I, II, and III) were compared with the control group, it was found that all parameters representing the anteroposterior dimensions of both jaws (A-Ptm, CoA, ANS-PNS, CoB, CoGn, CoPog, and ABRB) were significantly smaller in all agenesis groups ($p<0.05$). The parameters reflecting the vertical growth pattern did not represent any difference among the groups ($p>0.05$).

Conclusion: In subjects with bilateral or total third molar agenesis, the anteroposterior dimensions of both jaws were smaller in comparison with subjects without tooth agenesis. Vertical growth pattern of the jaws did not differ among the groups. (*Turkish J Orthod* 2015;28:7–12)

KEY WORDS: Dentofacial morphology, Third molar agenesis

INTRODUCTION

Dental agenesis or hypodontia is the most common morphologic anomaly among all populations and has been increasing in recent decades.[1,2] The incidence of agenesis has been reported to vary from 2.6% to 11.3% depending upon demographic and geographic profiles.[3] In the white population, the teeth most frequently missing, in order of prevalence, are the third molars, mandibular second premolars, and maxillary lateral incisors.[4]

The third molar is a tooth characterized by its varying presence or absence in dentition.[5] Agenesis of this tooth is frequent, varying from zero among an unspecified sample of craniums in Tasmania to 49% in an unspecified sample of Hungarian craniums. Other radiographic studies of white populations reported prevalences between 9% and 30%.[6] Recently, a prevalence of 23.8% was found in an East Anatolian population.[7]

Third molar agenesis has been associated with tooth number and structure anomalies. Some authors have attested that third molar agenesis predisposed subjects to reduced size and delayed development of certain teeth.[8–10] Garn et al[11] concluded that when a third molar is absent,

[1]Assistant Professor, Kocaeli University, Faculty of Dentistry, Department of Orthodontics, Kocaeli, Turkey

[2]Assistant Professor, Kocaeli University, Faculty of Dentistry, Department of Dentomaxillofacial radiology, Kocaeli, Turkey

[3]Research Assistant, Kocaeli University, Faculty of Dentistry, Department of Orthodontics, Kocaeli, Turkey

[4]Research Assistant, Kocaeli University, Faculty of Dentistry, Department of Orthodontics, Kocaeli, Turkey

[5]Professor, Kocaeli University, Faculty of Dentistry, Department of Orthodontics, Kocaeli, Turkey

***Corresponding author:** A. Burcu Altan, Kocaeli Üniversitesi Dişhekimliği Fakültesi Ortodonti AD. 41190 Yuvacık Kocaeli, Turkey. Tel: 00905323182779 E-mail: burcuk12@yahoo.com

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agenesis of the remaining teeth is 13 times more likely.

More recently, few studies have evaluated the relation between different kinds of agenesis and craniofacial structure.[4,12–15] Kawanishi[16] claimed that the same genes might regulate both craniofacial and tooth morphogenesis. Some authors have shown a relation between agenesis of different teeth and retrognathic maxillas of reduced size.[4,12–14] In the study of Barrachina and Bravo[14] suggested that although hypodontia has a limited influence on craniofacial morphology, agenesis affects the maxilla more than the mandible. On the other hand, other researchers have concluded that dental agenesis exerts little influence on dentofacial structures[13] and that the typical dentofacial structure in persons with advanced hypodontia may be due to dental and functional compensation rather than to a different growth pattern.[15]

In the literature, some studies have been carried out to evaluate the relation of third molar agenesis with the anteroposterior dimensions of the jaws.[17–20] In one such study, Sanchez et al[17] found a relationship between third molar agenesis and craniofacial shape. Furthermore, Kajii et al[18] suggested that agenesis of the third molars does not depend on anteroposterior dimensions of the mandible but, instead, on anteroposterior dimensions of the maxilla. Celikoglu and Kamak[21] attested that agenesis of the third molar depends on sagittal malocclusions rather than the vertical patterns of the skeletal malocclusion. On the other hand, Ades et al[19] observed that persons with third molars that erupted into satisfactory function did not have a different mandibular growth than those with congenitally missing third molars.

On the basis of these facts, the objective of this study was to determine whether or not bilateral agenesis of the maxillary and/or the mandibular third molars and the anteroposterior dimensions of the jaws and vertical growth pattern were related.

SUBJECTS AND METHODS

Sixty-eight subjects between the ages of 13 and 17 years with bilateral agenesis of maxillary third molars (group I, n=37), bilateral agenesis of mandibular third molars (group II, n=19), or agenesis of all third molars (group III, n=12) as well as 33 subjects without third molar agenesis (group IV) were selected from the radiology archive of Kocaeli University, Faculty of Dentistry. A before and after treatment orthopantomograph of each patient was used to determine presence or absence of third molars. The pretreatment cephalometric radiographs were used to carry out cephalometric analysis that involved linear and angular measurements. All radiographs used in the present study were taken with the same x-ray machine (Planmeca, Proline 2002CC, Helsinki, Finland). The cephalometric radiographs were hand-traced and measured in the same manner by the same person. All linear and angular measurements were carried out with a gauge to the nearest 0.1 mm and recorded exactly as measured without correction for magnification. The following parameters were evaluated in this study[4,17] (Figs. 1 and 2):

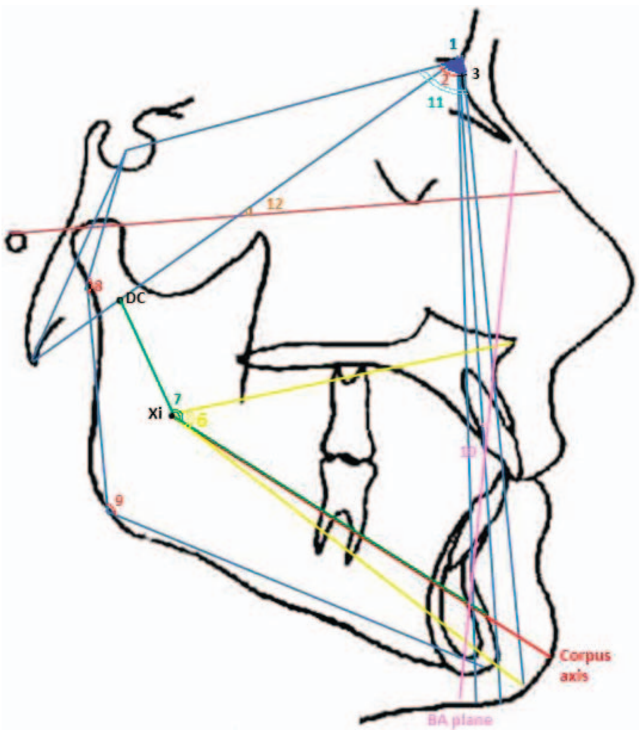

Figure 1. Angular measurements[4,17]: (1) SNA; (2) SNB; (3) ANB; (4) GoGnSN; (5) FMA; (6) Lower facial height (LFH); (7) Mandibular arch (MA); (8) Articuler angle (Ar); (9) Gonial angle (Go); (10) NaPog-BA; (11) BaNaA; (12) NaBaFH.

- Angular and linear measurements for assessing sagittal dimensions and relationships: SNA, SNB, ANB, Wits appraisal, Na⊥A, Co-A, ANS-PNS (anteroposterior length of the nasal floor), A-Ptm (anteroposterior length of the maxillary basal bone), Na⊥Pog, Co-B, Co-Gn, Go-Pog (anteroposterior length of the mandibular corpus), ABR-B (anteroposterior length of the mandibular basal bone), NaB-Pog, NaPog-BA, and BaNa-A.

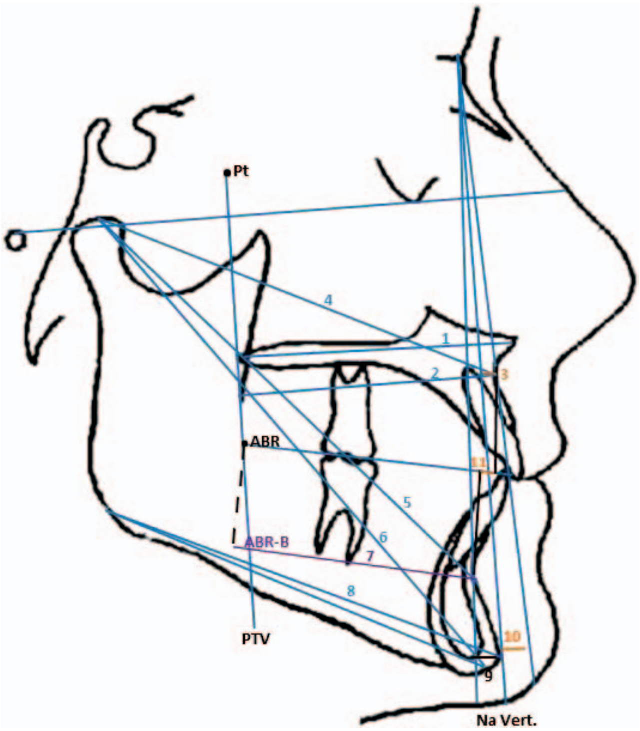

Figure 2. Linear measurements[4,17]: (1) ANS-PNS (anteroposterior length of the nasal floor); (2) A-PtV (anteroposterior length of the maxillary basal bone); (3) Na⊥A; (4) Co-A; (5) Co-B; (6) Co-Gn; (7) ABR-B (anteroposterior length of the mandibular basal bone); (8) Go-Pog (anteroposterior length of the mandibular corpus); (9) NaB-Pog; (10) Na⊥Pog; (11) Wits appraisal.

- Angular measurements for assessing vertical dimensions and relationships: FMA, GoGn-SN, articular angle (Ar), gonial angle (Go), lower facial height (LFH), mandibular arch (MA), and BaNa-FH.

Method Error

All radiographs were retraced and remeasured by the same investigator 1 month after the initial analysis. Reproducibility coefficients were found to be greater than 0.92 for both linear and angular measurements, which did not reveal any measurement error.

Statistical Analysis

Data were statistically processed by SPSS (Chicago, IL) for Windows, version 16.0. The Kolmogorov-Smirnov normality test was applied, and it was seen that data were distributed normally. Analysis of variance for 1 factor and independent-samples *t* test were performed to determine the differences among the groups. Significance for all statistical tests was predetermined at $p < 0.05$.

RESULTS

Table 1 shows the results obtained by linear and angular measurements. When the agenesis groups (groups I, II, and III) were compared with the control group, it was found that all parameters representing the anteroposterior dimensions of both jaws (A-Ptm, Co-A, ANS-PNS, Co-B, Co-Gn, Co-Pog, and ABR-B) were decreased in all agenesis groups (Table 2). The parameters reflecting the vertical growth pattern did not represent any difference among the groups.

Group I: Bilateral Agenesis of Both Maxillary Third Molars

Compared with group II, only 1 parameter (Na⊥Pog) was significantly different, revealing a more retruded pogonion in this group. The comparison with group III did not reveal any significant difference.

Group II: Bilateral Agenesis of Both Mandibular Third Molars

The ANS-PNS dimension and ANB angle were significantly smaller, and the ABR-B dimension and Na⊥Pog distance were bigger, in this group compared with group III. These findings might result from the fact that the groups were not homogenized regarding the type of skeletal malocclusion (such as ANB angle).

Group III: Agenesis of All Third Molars

In this group, all parameters representing the anteroposterior dimensions of both jaws (A-Ptm, Co-A, ANS-PNS, Co-B, Co-Gn, Co-Pog, and ABR-B) were decreased compared with the control group.

DISCUSSION

To date, few studies have evaluated the relation between third molar agenesis and craniofacial structure, and those have revealed controversial results.[17–20] In this study, it was hypothesized that there was a relationship between bilateral agenesis of the maxillary and/or mandibular third molars and the anteroposterior dimensions of the jaws and vertical growth pattern.

In the literature, tooth agenesis (except third molars) has been associated with smaller maxillas,[12,22,23] increased mandibular length,[24] decreased gonial angulation, and mandibular progna-

Table 1. Descriptive statistics and comparison of the parameters among the groups[a]

	Group I	Group II	Group III	Group IV	*p*
GoGn-SN	36.47 ± 6.26	33.26 ± 4.49	35.0 ± 5.0	34,78 ± 6.34	0,27
FMA	29.24 ± 5.86	25.86 ± 4.18	29.87 ± 5.67	28.80 ± 4.78	0,09
LFH	43.71 ± 5.71	41.71 ± 3.65	44.50 ± 3.79	41.28 ± 5.51	0,11
Mand. Arc	148.78 ± 6.79	146.15 ± 6.84	149.29 ± 8.99	146.98 ± 5.81	0,4
Ar	142.12 ± 8.39	142.71 ± 9	144.91 ± 9.35	141.87 ± 7.72	0,74
Go	127.72 ± 5.87	125.21 ± 6.79	126.79 ± 7.65	124.87 ± 5.68	0,23
SNA	79.37 ± 3.36	78.52 ± 4.2	79.16 ± 2.99	79.15 ± 4.53	0,89
SNB	75.90 ± 3.93	76.63 ± 3.78	74.87 ± 4.04	74.39 ± 4.43	0,22
ANB	3.47 ± 3.36	1.89 ± 2.64	4.29 ± 3.70	4.78 ± 2.36	0.01**
Wits'App.	0.98 ± 4.06	0.13 ± 3.98	1.50 ± 6.25	2.50 ± 4.28	0,2
NaBPog	2.47 ± 1.82	2.5 ± 2.02	2.33 ± 1.02	2.43 ± 1.84	0,99
NaBaFH	27.16 ± 4.74	28.31 ± 2.85	28.12 ± 3.92	27.54 ± 2.52	0,68
NaPogB	6.87 ± 4.78	4.81 ± 4.65	7.79 ± 5.89	8.84 ± 5.20	0,05
Na⊥A	1.81 ± 2.91	1.44 ± 2.89	1.54 ± 3.2	2.09 ± 3.54	0,89
Na⊥Pog	7.62 ± 6.30	0.76 ± 7.45	8.8 ± 7.66	10.01 ± 6.01	0.000****
BaNaA	59.91 ± 3.21	59.52 ± 2.82	59.04 ± 3.41	60.33 ± 3.48	0,64
ANS-PNS	58.67 ± 5.16	56.97 ± 5.47	61.54 ± 4.98	64.31 ± 3.62	0.000****
APtm	56.68 ± 3.69	56.42 ± 4.87	54.70 ± 3.90	64.63 ± 3.87	0.000****
CoA	80.41 ± 4.83	80.68 ± 4.90	80.29 ± 6.17	90.84 ± 4.72	0.000****
GoPog	69.89 ± 7.80	70.86 ± 5.12	67.62 ± 4.93	80.21 ± 10.19	0.000****
ABRB	42.64 ± 4.28	44.65 ± 3.83	41.70 ± 3.89	45.71 ± 4.22	0.005**
CoB	94.37 ± 6.67	96.47 ± 5.69	93.04 ± 5.82	104.78 ± 6.78	0.000****
CoGn	105.51 ± 7.89	110.94 ± 14.41	104.45 ± 6.51	116.39 ± 6.92	0.000****

[a] Analysis of variance for 1 factor, $p < 0.05$. * $p \leq 0.05$, ** $p = 0.01$, *** $p = 0.001$, **** $p = 0.0001$.

tism.[25] Similarly, agenesis of third molars was related to reduced mandibular plane angle and reduced anteroposterior dimension of the maxilla.[17] In this study, the anteroposterior dimension of the maxilla was found to be reduced, in accordance with the literature. On the other hand, the anteroposterior dimension of the mandible was also observed to be reduced. This finding was not compatible with the findings of Ades et al,[19] who observed that persons with third molars that erupted into satisfactory function did not have a different mandibular growth than those with congenitally missing third molars. These conflicting results might be related in part to sampling and selection criteria, such as type of skeletal malocclusion; differences in age, gender, race, or socioeconomic condition; and inclusion or exclusion of syndromic subjects.[4]

Some studies have reported a relationship between third molar agenesis and vertical growth pattern. Sanchez et al[17] observed that mandibular plane angle, lower face height, and articular angle were decreased, and mandibular arch angle was increased, indicating a horizontal growth pattern in subjects with third molar agenesis. On the other hand, Celikoglu and Kamak[21] attested that agenesis of the third molar depends on sagittal malocclusions rather than the vertical patterns of the skeletal malocclusion. Similarly, the findings of this study revealed no relationship between vertical growth pattern and third molar agenesis.

Considering the higher incidence of third molar agenesis in subjects with skeletal Class III malocclusion (with a small maxilla and/or a large mandible) rather than subjects with skeletal Class II (with a large maxilla and/or small maxilla), Kajii et al[18] had hypothesized that the agenesis of maxillary third molars depends on the anteroposterior dimension of the maxilla, although agenesis of mandibular third molars does not depend on the anteroposterior dimension of the mandible, and the hypothesis was accepted. During subject selection for this study, we considered the type of skeletal malocclusion and planned to homogenize the groups in this regard. However, we could not find subjects with Class III malocclusion, especially for the control group, in which the subjects had all third molars. Consequently, the number of subjects with Class III malocclusion was relatively small, while the number of subjects with Class II malocclusion was the largest in this study. This might be due to the fact that Class III malocclusion is relatively rare compared with Class

Table 2. Pairwise comparison of the groups[a]

	Group I and Group II	Group I and Group III	Group I and Group IV	Group II and Group III	Group II and Group IV	Group III and Group IV
ANB	0.08	0.47	0.06	0.04*	0.000****	0.59
NaLPog	0.001***	0.58	0.11	0.007**	0.000****	0.59
ANS-PNS	0.25	0.09	0.000****	0.02*	0.000****	0.04*
A-Ptm	0.81	0.11	0.000****	0.31	0.000****	0.000****
CoA	0.84	0.94	0.000****	0.84	0.000****	0.000****
GoPog	0.62	0.35	0.004**	0.09	0.001***	0.000****
ABRB	0.09	0.5	0.000****	0.04*	0.37	0.006**
CoB	0.24	0.53	0.000****	0.11	0.000****	0.000****
CoGn	0.07	0.67	0.000****	0.15	0.07	0.000****

[a] Independent-samples *t* test, $p < 0.05$. * $p \leq 0.05$, ** $p = 0.01$, *** $p = 0.001$, **** $p = 0.0001$.

II malocclusion, and most of the subjects referred to our clinic had skeletal Class II malocclusion.

To date, some homeobox genes and growth factors have been associated with regulation of craniofacial and tooth morphogenesis. The MSX1 and MSX2 genes, which are involved in regulating and patterning craniofacial structures,[4] are also responsible for the patterning of tooth development.[26] The MSX1 mutations were found to predominantly affect agenesis of the second premolars and the third molars,[27,28] while PAX9 mutations were blamed for agenesis of maxillary molars and mandibular third molars.[29] Animal studies have shown that the MSX1 gene is necessary for direct epithelial mesenchymal interactions that initiate tooth formation.[30]

Satokata and Maas[31] observed that MSX1-deficient mice also develop characteristic phenotypic changes, including shortened mandibles, anteroposterior deficiencies in the middle third of the face, and subtle abnormalities in overall head size and cranial shape. Accordingly, the results of this study, that is, the decreased/diminished sagittal dimensions of the jaws, could be attributed to genetic defects or mutations, rather than dental and functional compensation as concluded by Ogaard and Krogstad.[15]

Some polygenetic inheritance of craniofacial deformities may also be related to genes controlling formation of third molar germs. Further investigation of the molecular genetics of tooth morphogenesis and craniofacial maturation is needed for better understanding of the relationship between them.

CONCLUSION

In subjects with bilateral or total third molar agenesis, the anteroposterior dimensions of both jaws were found to be smaller compared with subjects without tooth agenesis. The vertical growth pattern of the subjects did not differ among the groups.

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