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The effect of tooth agenesis on dentofacial structures

Sema Yüksel and Tuba Üçem
Department of Orthodontics, Faculty of Dentistry, Gazi University, Ankara, Türkiye

SUMMARY The purpose of this study was to investigate the effect of tooth agenesis on dentofacial structures according to the location of the absent teeth. A total of 74 subjects were classified to three main groups and four subgroups according to the location of the absent teeth. Thirteen subjects without tooth agenesis were selected as the control group. All subjects were evaluated cephalometrically. As a result it can be concluded that tooth agenesis has little effect on dentofacial structures. Although there were statistically significant differences between groups, generally mean values were within the normal range.

Introduction

Tooth agenesis is a frequent entity in the permanent dentition and introduces an imbalance in potential maxillary and mandibular dental arch length. This possibility must therefore be borne in mind when evaluating a patient for orthodontic treatment (Joondeph and McNeill, 1971; McNeill and Joondeph, 1973; Nik-Noriah, 1989).

It has been reported that the maxillary lateral incisors and mandibular second premolar are the most common teeth showing agenesis (Muller *et al.*, 1970; Wisth *et al.*, 1974; Dermaut *et al.*, 1986). Generally, if only one or a few teeth are missing, it is accepted that the absent tooth will be the most distal tooth of any type (Proffit, 1986).

As it is expected that there might be changes in dentofacial structures after extraction (Jacobs 1965, Luppanapornlarp and Johnston, 1993), it seems logical that tooth agenesis can affect dentofacial structures compared with normal. The effects of hypodontia have been reported as a decrease of tooth size and dental arch (Baum and Cohen, 1971; Rune and Sarnäs, 1974; Wisth *et al.*, 1974).

Literature review of the subject showed that there were few studies on the effect of tooth agenesis on dentofacial structures (Roald *et al.*, 1982; Woodworth *et al.*, 1985; Dermaut *et al.*, 1986). However some of the studies ignored the location of tooth agenesis and some of them concentrated on one type of location only (e.g. congenital absence of maxillary lateral incisors). Having a general concept about the skeletal, dental and soft tissue deviations from normal, related to the location of the absent tooth can help treatment planning.

This study aimed to investigate the effects of tooth agenesis by specifying the groups according to the location of absent teeth.

Subjects and methods

A total of 74 subjects (41 girls, 33 boys) were selected from the files of patients referred for treatment to the Orthodontic Clinic of the Gazi Dental Faculty, Ankara, Türkiye. The congenital absence of teeth was determined by clinical and radiographic examination. According to the location of the absent tooth, subjects were classified to three main groups. In order to evaluate the differences between unilateral and bilateral tooth agenesis subjects four subgroups were formed.

Main groups

Anterior tooth agenesis group. In this group the maxillary lateral incisor was absent in 24 patients, the maxillary central incisor in two, the mandibular central incisor in five and the mandibular lateral incisor in six. It must be emphasized that some of the subjects had more than one missing tooth. In total, there were 35 subjects (19 girls, 16 boys) with a mean age of 11.1 years (range 8.8–13.8 years) (Table 1).

Posterior tooth agenesis group. In this group 22 subjects had congenital absence of the mandibular second premolar, two of the maxillary second premolar and in one case there was agenesis of the maxillary first premolar. In this group, some of the patients had more than one missing tooth. This group consisted of 24 subjects (12 girls, 12 boys) with a mean age of 11.5 years (range 9.1–14 years) (Table 1).

Anterior and posterior tooth agenesis group. These patients had a minimum of three or more missing teeth (e.g. mandibular second premolars, maxillary lateral incisors and mandibular central incisors were absent in the same case). The group consisted of 15 subjects (10 girls, 5 boys) with a mean age of 11.5 years (range 9.4–14.2 years) (Table 1).

Subgroups

Unilateral anterior tooth agenesis group. This group consisted of 16 subjects (9 girls, 7 boys) with a mean age of 10.8 years (range 8.8–12.6 years). In 14 of them, the maxillary lateral incisor was absent and in two cases the mandibular lateral incisor was absent (Table 2).

Bilateral anterior tooth agenesis group. The 19 subjects (10 girls, 9 boys) with a mean age of 11.4 years (range 9–13.8 years). The maxillary lateral incisors were absent in 10 subjects, the mandibular lateral incisor in four subjects, the mandibular central incisors in five subjects and

Table 1 Distribution of missing teeth in the main groups of patients*.

	Mean age (years)	$\underline{1}$	$\overline{1}$	$\underline{2}$	$\overline{2}$	$\underline{3}$	$\overline{3}$	$\underline{4}$	$\overline{4}$	$\underline{5}$	$\overline{5}$	$\underline{6}$	$\overline{6}$	$\underline{7}$	$\overline{7}$
Anterior tooth agenesis (*n* = 35)	11.1	2	5	24	6	–	–	–	–	–	–	–	–	–	–
Posterior tooth agenesis (*n* = 24)	11.5	–	–	–	–	–	–	1	–	2	22	–	–	–	–
Anterior–posterior tooth agenesis (*n* = 15)	11.5	1	8	8	4	2	1	2	–	6	11	2	3	3	2

*Some patients had more than one missing tooth.

Table 2 Distribution of missing teeth in the subgroups of patients*.

	Mean age (years)	$\underline{1}$	$\overline{1}$	$\underline{2}$	$\overline{2}$	$\underline{3}$	$\overline{3}$	$\underline{4}$	$\overline{4}$	$\underline{5}$	$\overline{5}$	$\underline{6}$	$\overline{6}$	$\underline{7}$	$\overline{7}$
Unilateral anterior tooth agenesis (*n* = 16)	10.8	–	–	14	2	–	–	–	–	–	–	–	–	–	–
Bilateral anterior tooth agenesis (*n* = 19)	11.4	2	5	10	4	–	–	–	–	–	–	–	–	–	–
Unilateral posterior tooth agenesis (*n* = 13)	11.2	–	–	–	–	–	–	1	–	2	11	–	–	–	–
Bilateral posterior tooth agenesis (*n* = 11)	11.8	–	–	–	–	–	–	–	–	–	11	–	–	–	–

*Some patients had more than one missing tooth.

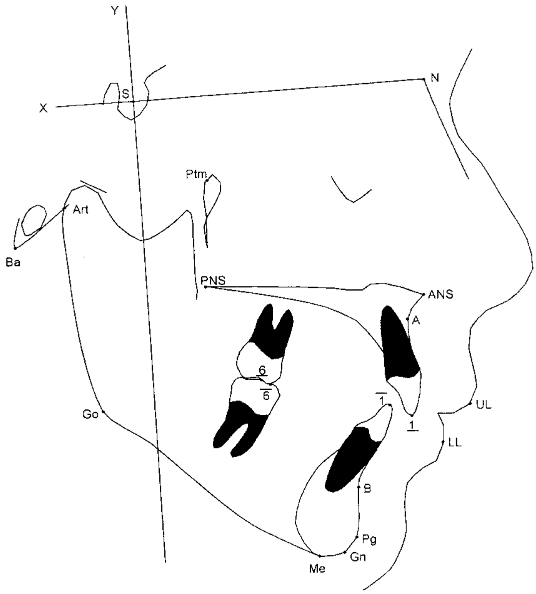

Figure 1 Landmarks and reference lines used in this study.

the maxillary central incisor in two subjects. Some patients had more than one missing tooth (Table 2).

Unilateral posterior tooth agenesis group. This group consisted of 13 subjects (6 girls, 7 boys) with a mean age of 11.2 years (range 9.1–13.4 years). In 11 subjects the mandibular second premolar was absent, in two cases the maxillary second premolar was absent and the maxillary first premolar in one case (Table 2).

Bilateral posterior tooth agenesis group. This group consisted of 11 subjects (6 girls, 5 boys) with a mean age of 11.8 years (range 9.3–14 years). All were bilateral mandibular second premolar agenesis subjects (Table 2).

Control. As the control group, 13 subjects (7 girls, 6 boys) without tooth agenesis and malocclusion were selected (mean age 10.5 years).

The data for this work was based on measurements obtained from lateral cephalograms. SN plane was used as the x-axis, and the y-axis, which is perpendicular to SN at sella, was used in some linear measurements (Figure 1). Linear measurements were taken perpendicular to the y-axis. Figures 2, 3 and 4 show angular and linear skeletal measurements and dental measurements.

Variance analysis and Duncan test were used for statistical analysis. The size of the method error for measurements was calculated by the formula $\pm \sqrt{\sum d^2/2n}$, where n is the number of radiographs recorded and d is the difference between the first and second recordings. The method error for any of the variables did not exceed 0.3 mm in this study.

Results

There were no significant differences between main groups for skeletal values. The upper incisors showed a statistically significant proclination relative to the SN plane in tooth agenesis groups compared with the control group. Further the upper incisor was more protrusive both angularly and bodily relative to nasion to point A line in the posterior tooth agenesis and anterior–posterior tooth agenesis groups compared with the control group. In the anterior tooth agenesis group upper incisor values relative to NA line were smaller than in the anterior posterior tooth agenesis group (Table 3).

In the evaluation of the subgroups it was observed that the distance between the y-axis (A, ANS, PNS) was greater in the bilateral posterior tooth agenesis group compared with the unilateral posterior, anterior-posterior tooth agenesis and control groups. In addition in the bilateral posterior tooth agenesis group, SNA and SN/ANS angles were greater than in the unilateral posterior tooth agenesis and anterior–posterior tooth agenesis groups. SNA was significantly smaller in the unilateral anterior tooth agenesis group compared with the bilateral posterior tooth agenesis group (Table 4).

When considering the mandibular position, SNB was greater in the bilateral posterior tooth agenesis group than the unilateral anterior and unilateral posterior tooth agenesis and control groups. This angle was also greater in the bilateral anterior tooth agenesis group compared to the unilateral anterior tooth agenesis group.

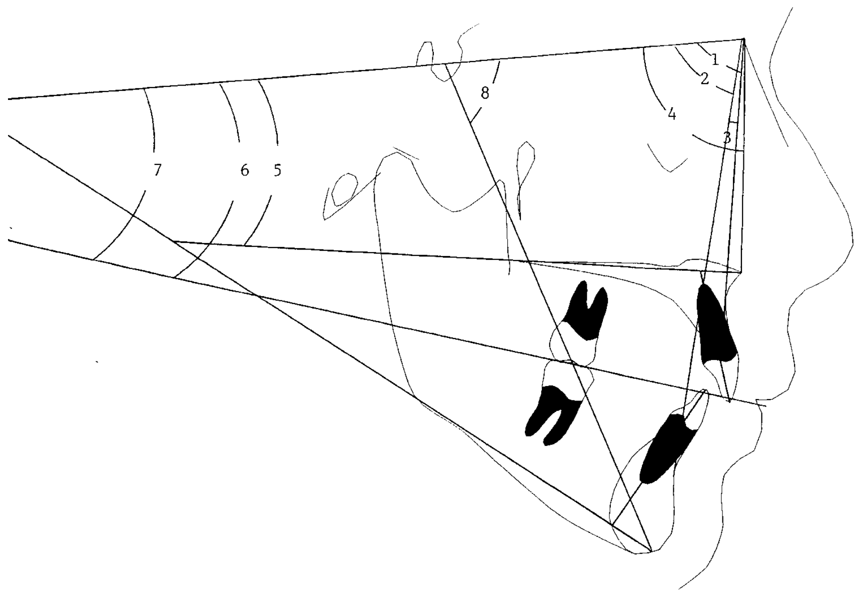

Figure 2 Angular skeletal measurements: (1) SNA; (2) SNB; (3) ANB; (4) SN/ANS; (5) palatal plane to SN; (6) occlusal plane to SN; (7) GoGNSN; (8) NSGn.

The distance between point B and the *y*-axis was greater in the bilateral anterior and bilateral posterior tooth agenesis groups than in the unilateral anterior and unilateral posterior tooth agenesis and control groups. The distance between pogonion and the *y*-axis was also greater in the bilateral anterior tooth agenesis group compared with the unilateral anterior and unilateral posterior tooth agenesis and control groups. This distance was greater in the anterior–posterior tooth agenesis groups than in the unilateral posterior tooth agenesis and control groups (Table 4).

Generally in the tooth agenesis groups, the ANB angle showed a Class l skeletal relationship (Table 4).

NSGn angle was smaller in the bilateral anterior tooth agenesis group than in the control, unilateral anterior and unilateral posterior tooth agenesis groups. It was however greater in the unilateral posterior tooth agenesis group compared with the bilateral posterior tooth agenesis group (Table 4).

In the evaluation of dental values, in the tooth agenesis groups, upper incisor position relative to SN and NA was more protrusive compared to the control group. Among the tooth agenesis groups the most retrusive position of the upper incisors was seen in the bilateral anterior tooth agenesis group (Table 4).

The distance between the lower incisors and the *y* axis was greater in the bilateral posterior tooth agenesis group than all groups except the bilateral anterior tooth agenesis group. There were no statistically significant differences between groups in the distance from Steiner's soft tissue plane to upper and lower lip (Table 4).

With regard to the *y* axis, the upper molar in the control group and the lower molar both in the control and anterior-posterior tooth agenesis groups, was positioned distally in comparison with the bilateral anterior and bilateral posterior tooth agenesis groups (Table 4).

Discussion

The role of tooth agenesis on the developing malocclusion and its importance in orthodontic treatment planning still needs to be investigated.

Some researchers have shown that in cases of hypodontia the maxilla was more retrognathic

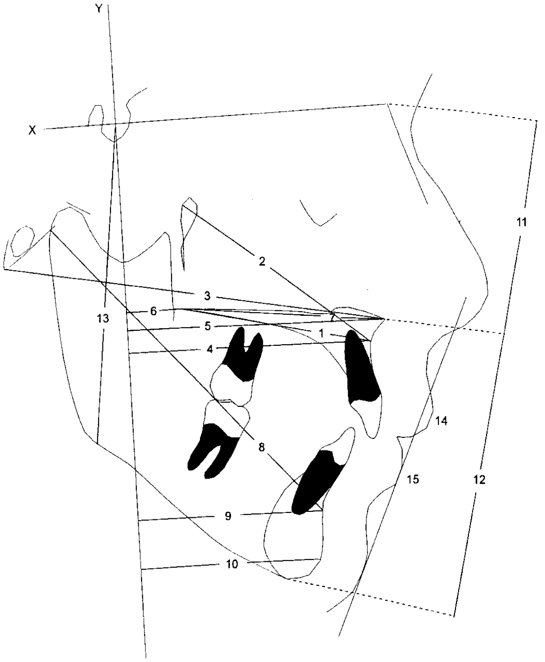

Figure 3 Linear skeletal measurements: (1) PNS–A; (2) PTM–A; (3) Ba–ANS; (4) A–Y; (5) ANS–Y; (6) PNS–Y; (7) ANS–PNS; (8) Art–B; (9) B–Y; (10) Pg–Y; (11) N–ANS; (12) ANS–Me; (13) S–Go; (14) upper lip to Steiner's S plane; (15) lower lip to Steiner's S plane.

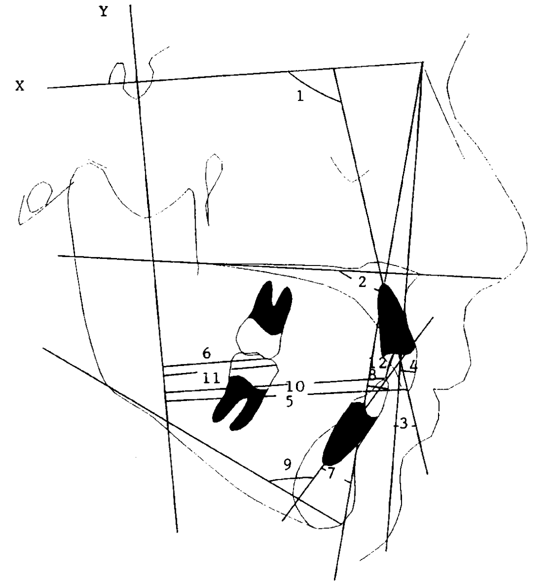

Figure 4 Angular and linear dental measurements: (1) Upper incisor to SN (degree); (2) Upper incisor to palatal plane (degree); (3) Upper incisor to NA (degree); (4) Upper incisor to NA (mm); (5) Upper incisor to *y*-axis (mm); (6) Upper molar to *y*-axis (mm); (7) Lower incisor to NB (degree); (8) Lower incisor to NB (mm); (9) Lower incisor to GoGn (degree); (10) Lower incisor to *y*-axis (mm); (11) Lower molar to *y*-axis (mm); (12) Interincisal angle.

(Sarnäs and Rune, 1983) and shorter (Wisth *et al.*, 1974), and the ANB angle was smaller (Sarnäs and Rune, 1983; Göyenç, 1993). Woodworth *et al.* (1985) stated that patients with bilateral congenital absence of maxillary lateral incisors showed a Class III tendency, and the upper and lower anterior and posterior face heights were significantly less than normal. Conversely, Roald *et al.* (1982) reported that hypodontia has little effect on the general growth pattern.

In this study, all tooth agenesis groups showed a Class 1 skeletal relationship in the antero-posterior direction and this finding is in agreement with Dermaut *et al.* (1986). However, Woodworth *et al.* (1985) claimed that in cases of bilateral congenital absence of maxillary lateral incisors, the anterior cranial base and maxillary length were shorter and the maxilla was more retrognathic. In that study, the wide age range in comparison with our group may be responsible for this conflict.

In evaluating the subgroups, the most striking skeletal difference was the protrusive position of the maxilla and mandible in the bilateral posterior tooth agenesis group. However the mandibular and maxillary values were within the normal range. Dermaut *et al.* (1986) emphasized that deep bite cases were observed more often in hypodontia patients. Woodworth *et al.* (1985) pointed out the tendency of forward mandibular rotation in the bilateral congenital absence of maxillary lateral incisors. In parallel with those findings, NSGn was found to be smaller in our bilateral anterior tooth agenesis group. However, this was not reflected on the GoGnSN, which was one of our specific measurements; it seems that in all tooth agenesis groups the mean values for GoGnSN were within normal range.

Table 3 Means, standard deviations, comparison and statistical analysis of the variables of tooth agenesis groups and the control group

	Control group, *n* = 13 (1)		Anterior tooth agenesis, *n* = 35 (2)		Posterior tooth agenesis, *n* = 24 (3)		Anterior–posterior tooth agenesis, *n* = 15 (4)		*P*
	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	
Angular skeletal dimensions									
SNA	79.42	3.91	80.13	3.47	80.49	5.03	78.47	3.45	
SNB	75.39	2.98	76.57	3.32	77.3	5.78	76.63	3.78	
ANB	4.04	2.03	3.56	2.44	3.17	3.77	1.83	2.81	
SN/ANS	84.69	3.63	86.43	4.91	86.19	5.63	84.03	3.51	
Palatal plane to SN	9.51	3.46	7.82	2.49	8.06	2.99	8.61	2.87	
Occ. plane to SN	20.73	2.68	18.17	3.47	18.23	4.43	17.23	5.77	
GoGn/SN	33.31	3.72	31.99	4.97	34.31	5.61	31.23	3.65	
NSGn	69.23	2.08	67.47	3.81	69.06	4.99	67.93	4.28	
Linear skeletal dimensions									
PNS–A	46.35	2.43	47.37	3.85	46.96	3.28	46.53	2.34	
Ptm–A	48.85	3.51	49.99	3.44	50.65	3.87	49.71	3.95	
Ba–ANS	92.65	5.57	95.4	5.75	94.51	6.72	94.97	4.01	
A–Y	57.69	3.93	60.47	5.05	60.02	5.75	57.73	4.12	
ANS–Y	63.42	3.49	66.33	4.69	66.11	5.41	63.43	4.54	
PNS–Y	13.12	2.69	15.04	3.52	15.27	3.81	13.53	3.91	
ANS–PNS	50.81	2.19	51.26	2.94	52.06	3.85	51.01	2.71	
Art–B	91.69	5.85	94.83	6.17	95.38	5.86	94.91	5.95	
B–Y	44.51	4.42	48.11	6.49	47.67	9.73	46.77	6.77	
Pg–Y	43.77	4.76	47.94	7.18	46.12	10.22	46.43	7.82	
N–ANS	52.92	3.45	52.47	3.92	53.01	4.63	51.81	3.87	
ANS–Me	58.31	5.84	62.21	6.23	63.61	6.19	61.43	4.64	
S–Go	71.51	6.91	73.61	6.31	75.31	6.32	73.51	4.24	
Soft tissue dimensions									
Upper lip to S plane	0.85	1.91	0.17	1.79	1.11	2.51	1.91	–0.35	
Lower lip to S plane	0.46	2.05	0.47	2.34	1.67	2.39	0.13	1.91	
Dental dimensions									
$\underline{1}$–SN	97.58	5.84	101.11	7.59	103.54	6.71	104.41	7.05	1 < 2,3,4*
$\underline{1}$–palatal plane	107.85	4.54	108.26	7.98	109.75	7.62	111.81	6.65	
$\underline{1}$–NA (deg)	17.92	4.79	20.84	6.85	22.52	6.12	25.37	5.12	1 < 3,4/2 < 4*
$\overline{1}$–NA (mm)	3.35	1.55	3.9	2.18	4.92	2.24	5.27	1.99	1 < 3,4/2 < 4*
$\underline{1}$–Y	55.8	4.88	58.97	6.74	60.29	6.79	57.67	6.41	
$\underline{6}$–Y	24.15	4.12	28.2	5.21	28.11	5.91	25.53	5.23	
$\overline{1}$–NB (deg)	25.88	7.23	23.64	7.32	24.91	6.03	22.73	8.12	
$\overline{1}$–NB (mm.)	4.65	1.84	4.81	2.05	5.61	1.61	4.23	2.15	
$\overline{1}$–GoGn	97.12	8.35	93.53	6.61	93.33	8.31	93.23	8.55	
$\overline{1}$–Y	53	4.67	56.63	6.08	57.42	7.79	54.67	6.19	
$\overline{6}$–Y	26.77	4.48	30.39	5.27	29.83	6.18	27.43	5.28	
$\underline{1}'$–$\overline{1}$	131.54	10.07	131.23	9.24	130.21	13.36	130.21	8.67	

*$P < 0.05$.

Table 4 Means, SD, comparison and statistical analysis of the variables of tooth agenesis subgroups and the control group.

	Control group, $n = 13$ (A)		Unilateral anterior tooth agenesis, $n = 16$ (B)		Bilateral anterior tooth agenesis, $n = 19$ (C)		Unilateral posterior tooth agenesis, $n = 13$ (D)		Bilateral posterior tooth agenesis, $n = 11$ (E)		Anterior–posterior tooth agenesis, $n = 15$ (F)		*P*
	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	
Angular skeletal dimensions													
SNA	79.42	3.91	79.03	3.19	81.05	3.51	77.58	4.71	83.21	3.57	78.47	3.45	E > B,D,F**
SNB	75.39	2.98	74.69	2.57	78.16	3.27	75.58	4.94	79.18	6.27	76.63	3.78	E > A,B,D/C > B*
ANB	4.04	2.03	4.28	2.71	2.95	2.06	2.39	3.31	4.09	4.22	1.83	2.81	
SN/ANS	84.69	3.63	86.53	6.11	86.34	3.78	83.27	4.76	89.64	4.63	84.03	3.51	E > D,F**
Palatal plane to SN	9.51	3.46	8.44	2.25	7.29	2.61	8.39	3.48	7.68	2.38	8.61	2.87	
Occ. plane to SN	20.73	2.68	19.28	3.31	17.24	3.4	19.23	4.17	17.05	4.63	17.23	5.77	
GoGn/SN	33.31	3.72	33.72	4.62	30.53	4.89	36.01	6.11	32.32	4.41	31.23	3.65	
NSGn	69.23	2.08	69.19	3.48	66.03	3.53	70.88	4.62	66.91	4.72	67.93	4.28	C < A,B,D/E < D*
PNS-A	46.35	2.43	47.62	4.64	47.16	3.15	46.39	3.26	47.64	3.33	46.53	2.34	
Ptm-A	48.85	3.51	49.28	3.71	50.58	3.17	49.62	2.88	51.86	4.63	49.71	3.95	
Ba-ANS	92.65	5.57	96.01	6.65	94.89	4.99	92.77	6.13	96.55	7.11	94.97	4.01	
A-Y	57.69	3.93	59.28	5.19	61.47	4.85	57.26	5.43	63.27	4.37	57.73	4.12	E > A,D,F**
ANS-Y	63.42	3.49	65.31	5.21	67.18	4.18	63.96	5.35	68.63	4.43	63.43	4.54	E > A,D,F**
PNS-Y	13.12	2.69	14.51	3.55	15.51	3.52	13.53	3.89	17.31	2.56	13.53	3.91	E > A,D,F**
ANS-PNS	50.81	2.19	50.97	2.96	51.51	2.97	51.51	4.04	52.73	3.69	51.01	2.71	
Linear skeletal dimensions													
Art-B	91.69	5.85	94.44	6.26	95.37	5.93	94.23	6.74	96.73	4.55	94.91	5.95	
B-Y	44.51	4.42	44.91	5.21	50.81	6.33	44.11	9.24	51.86	8.91	46.77	6.77	C,E > A,B,D**
Pg-Y	43.77	4.76	44.21	5.65	51.07	6.93	42.61	9.73	50.27	9.58	46.43	7.82	C > A,B,D/F > A,D*
N-ANS	52.92	3.45	52.37	4.08	52.55	3.89	53.69	3.82	52.18	5.51	51.81	3.87	
ANS-Me	58.31	5.84	62.41	8.08	62.05	4.33	64.54	7.26	62.51	4.72	61.43	4.64	
S-Go	71.51	6.91	72.25	6.21	74.76	6.33	75.12	8.16	75.55	3.43	73.51	4.24	
Soft tissue dimensions													
Upper lip to S plane	0.85	1.91	1.13	1.71	0,63	1.46	0.91	3.13	1.36	1.59	1.91	–0.35	
Lower lip to S plane	0.46	2.05	1.16	2.28	0,11	2.27	1.39	2.67	2.01	2.08	0.13	1.91	
Dental dimensions													
$\underline{1}$-SN	97.58	5.84	101.26	6.54	100.9	8.73	101.92	5.25	105.41	7.46	104.41	7.05	A < E,F**
$\underline{1}$-palatal plane	107.85	4.54	108.91	7.93	107.71	8.21	108.96	9.14	110.68	5.63	111.81	6.65	
$\underline{1}$–NA (deg)	17.92	4.79	21.81	6.31	20.03	7.35	23.35	5.59	21.55	6.84	25.37	5.12	A < D,F/C < F*
$\underline{1}$–NA (mm)	3.35	1.55	4.47	2.11	3.42	2.18	5.42	2.51	4.32	1.81	5.27	1.99	A,C < D,F*
$\underline{1}$–Y	55.8	4.88	58.21	6.76	59.61	6.84	57.57	7.51	63.51	4.17	57.67	6.41	
$\underline{6}$–Y	24.15	4.12	26.09	4.68	29.97	5.06	25.76	6.33	30.86	4.09	25.53	5.23	C,E > A**
$\overline{1}$–NB (deg)	25.88	7.23	24.66	6.88	22.79	7.75	25.31	3.91	24.41	8.06	22.73	8.12	
$\overline{1}$–NB (mm)	4.65	1.84	4.91	1.93	4.71	2.19	5.85	1.16	5.32	2.01	4.23	2.15	
$\overline{1}$–GoGn	97.12	8.35	95.81	8.03	91.24	8.16	93.36	7.36	92.36	10.08	93.23	8.55	
$\overline{1}$–Y	53	4.67	54.65	6.07	58.28	5.72	54.88	7.99	60.41	6.69	54.67	6.19	E > A,B,D,F*
$\overline{6}$–Y	26.77	4.48	28.37	4.53	32.07	5.38	28.07	7.45	31.91	3.56	27.43	5.28	C,E > A,F**
$\underline{1}'$–$\overline{1}$	131.54	10.07	128.72	0.88	135.61	14.69	130.15	5.77	130.27	11.53	130.21	8.67	

$^*P < 0.05$; $^{**}P < 0.01$.

The significant protrusion in the upper incisors relative to SN and NA may be explained by adaptation of the tongue in the agenesis region. In the anterior posterior tooth agenesis group as the number of missing teeth increases, the tongue will have more space to spread. Roald *et al.* (1982) have also shown a non-significant upper incisor protrusion in their hypodontia group. The greatest value for upper incisor to SN was in the bilateral posterior tooth agenesis group and was possibly due to the protrusive position of the maxilla. It must be pointed out that despite the incisors appearing more protrusive in the tooth agenesis groups in comparison with the control group, the values for incisor positions were almost within normal range. This finding may explain why the lip position was unchanged, similar to the study of Sarnäs and Rune (1983).

Although there were statistically significant differences between groups, mean values were within normal range. However, congenital absence of teeth must be taken into consideration in treatment planning, especially for dental arch length and occlusion.

Address for correspondence

Dr Sema Yüksel
Gazi Üniversitesi
Dis Hekimliği Fakültesi
Ortodonti Anabilim Dali
06510 Emek
Ankara, Türkiye

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