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Original Article

Growth differences in patients with dental agenesis, how its location impacts facial morphology

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Abstract *Background/purpose:* Non-formation of a tooth impacts the morphology of the alveolar bone, which may, in turn, generate an imbalance in facial growth. This retrospective case-control study aimed to determine whether observable differences exist in the facial growth of patients with dental agenesis relative to complete dentition controls.
Materials and methods: The sample comprised 75 patients with dental agenesis, and each case was paired with two controls of the same age and gender ($n = 150$). All patients were measured cephalometrically (31 variables), and both groups were compared with student's *t*- or Z-test ($P < 0.05$). Subsequently, ANOVA or Kruskal—Wallis tests ($P < 0.05$) were used to compare facial growth depending on the missing tooth's sagittal location in the dental arch (anterior or posterior agenesis); as well as its location in the affected bone (maxillary, mandibular, or both).
Results: Four measurements with significant differences were found, whereas ten were found in the sagittal location in the dental arch analysis. Regarding the affected bone, there were no affected variables.
Conclusion: it was found that patients with dental agenesis show differences in the sagittal growth of the upper jaw and in the position of the lower incisor. In the studied population,

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these changes are strongly influenced by the sagittal location of the missing tooth, while its location in the jaws does not affect facial growth.

Introduction

The absence of a tooth as a consequence of dental agenesis is accompanied by the non-formation of the alveolar bone that would have supported it. Frequently, this translates into collapsed or reduced alveolar rims.[1,2] Nevertheless, some studies demonstrate that patients affected by dental agenesis present changes limited not only to the alveolar bone but also to maxillary growth and development.[3–7] These changes are more severe as the number of absent teeth increase[4,6] and differ according to the bone affected (maxillary, mandible, or both),[4,5] and its location in the dental arch (anterior or posterior).[4,8]

Table 1 Cephalometric measurements definitions.

Cephalometric measurements	Definition
Craniofacial relation — cranial structure	
Cranial length (mm)	Cc-N (mm)
Posterior facial height (mm)	Go-Cf (mm)
Cranial deflection (°)	Ba—N/Po—Or (°)
Porion location (mm)	Po—Palatal Pl (mm)
Ramus position (°)	Po—Or/Cf—Xi (°)
Craneofacial relation — maxillary position	
Maxillary depth (°)	Po—Or/N—A (°)
Maxillary height (°)	N—Cf—A (°)
Palatal plane inclination (°)	Po—Or/palatal Pl (°)
Craneofacial relation — mandible position	
Facial angle (°)	Po—Or/N—Pg (°)
Facial Axis (°)	Ba—N/Pt—Gnl (°)
Mandibular plane angle (°)	Go—Me/Po—Or (°)
Total face height (°)	N—Ba/Pm—Xi (°)
Facial taper (°)	N—Pg/Go—Me (°)
Maxillo-mandibular relationships	
Convexity (mm)	A/N—Pg (mm)
Mandibular corpus length (mm)	Xi—Pm (mm)
Mandibular arc (°)	Dc—Xi/Xi—Pm (°)
Lower face height (°)	ANS—Xi—Pm (°)
Dental relationships — maxillary dentition	
Upper incisor protrusion (mm)	A1/A—Pg (mm)
Upper incisor — Frankfort plane (°)	A1—A2—Po—Or (°)
Upper incisor inclination (°)	A1—A2/A—Pg (°)
Upper molar location (mm)	Palatal Pl—A6 (mm)
Dental relationships — mandibular dentition	
Lower incisor protrusion (mm)	B1/A—Pg (mm)
Lower incisor inclination (°)	B1—B2/A—Pg (°)
Lower incisor extrusion (mm)	B1—occlusal Pl (mm)
Lower Incisor — mandibular plane (°)	B1—B2/Go—Me (°)
Dental relationships — maxillary/mandibular dentition	
Interincisal angle (°)	A1—A2/B1—B2 (°)
Molar relation (mm)	A6—B6 (mm)
Overjet (mm)	B1—A1 (mm)
Overbite (mm)	B1—A1(mm)
Occlusal plane — Frankfort plane (°)	Occlusal Pl/Po—Or (°)
Esthetic	
Lower lip — E plane (mm)	Li—E Pl (mm)

The aforementioned studies report differences in facial growth of agenesis subjects, but their results differ among themselves. These discrepancies may have an ethnic basis since each racial group has distinctive facial characteristics.[9] Taking all of this into consideration, the objective of the present study was to determine whether there are differences in the facial growth of patients with dental agenesis compared to controls with complete dentition.

Materials and methods

This retrospective, cross-sectional study was implemented under a case-control design. A non-random sample was made using the dental records of subjects who had attended an orthodontic clinic in the period from August 2014 to December 2018; all subjects with dental agenesis who presented within that period were included in the study. All patients had dental casts, panoramic and lateral cephalometric X-rays, and clinical photographs; as such, no subject was submitted to unnecessary clinical or radiographical studies. Individuals with incomplete records, a history of previous orthodontic treatment, or a syndrome or condition such as cleft lip and palate were excluded.

In order to establish the presence of dental agenesis, the following diagnostic criteria were considered: no mineralization of tooth crown visible on orthopantomograms or a full-mouth set of periapical radiographs, and no evidence of tooth extraction;[10] third molars were excluded. After reviewing the archives of the orthodontic clinic, 81 dental agenesis patients were identified, six of which were ultimately excluded for a total of 75 subjects comprising the case group. Each case was paired with two full-teeth controls (including third molars) of the same gender and age. A total of 150 individuals formed the control group.

The craniofacial growth of the entire sample was evaluated with the Dolphin Imaging software version 11.8. All cephalometric measurements (31 total variables) are shown in Table 1 and Fig. 1. All cephalometric analyses were performed by the same operator, which was calibrated prior to each use.

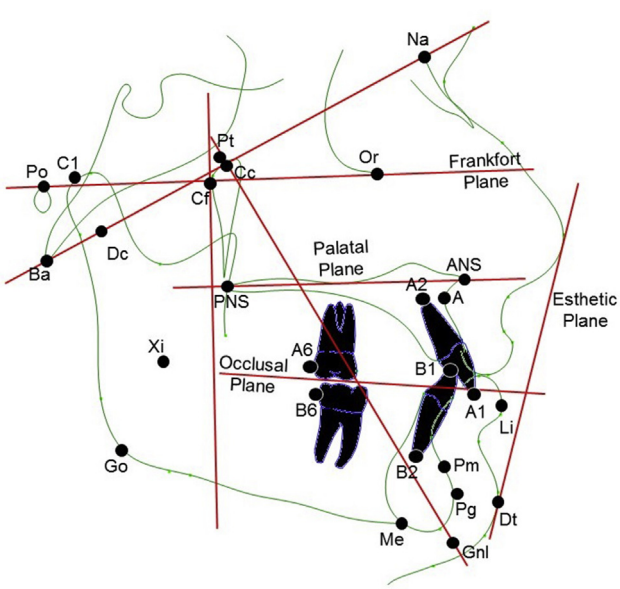

Figure 1 Points and cephalometric planes.

All cases and controls were compared and analyzed in order to determine whether location of the absent tooth affected facial growth; to this end, the sample was divided into the following classifications:

1. Sagittal dimension within the dental arch. In this case, the sample was organized in three groups: patients with anterior agenesis (group 1), those with posterior agenesis (group 2), and controls (group 3).
2. Affected bone. In this case, four groups were constructed: maxillary agenesis (group 1), mandibular agenesis (group 2), both maxillaries involved (group 3), and controls (group 4).

Method of error

In order to calibrate the operator responsible for performing the cephalometric analyses, 40 patients from the sample were randomly selected for inclusion in a pilot study. The same procedure was repeated one week later and, using a student's *t*-test, both measurements were compared. This test demonstrated the absence of a systematic method of error ($P = 0.49$).

Statistical analysis

All statistical analysis was achieved with SPSS version 20. The Shapiro—Wilk and Levene's tests were employed to analyze normality of data and homogeneity of variance. Regarding the results of the previously described analysis, student's *t*-test, Z-test, or U Mann—Whitney analysis was used when comparing two samples in accordance with tests assumptions ($P < 0.05$); for three or more samples, ANOVA with Tukey as post hoc or Kruskal—Wallis tests were used ($P < 0.05$).

Ethical considerations

All data were acquired by non-invasive means, and no subject was exposed to unnecessary radiation. Additionally, written consent was obtained from all participating adults and parents or legal guardians for minors. This study was approved by the Faculty Research Board (FODO-2015-0001).

Results

The final sample comprised 225 total patients. The agenesis group ($n = 75$) had a mean age of 17.18 ± 6.07 years and comprised 74.7% women ($n = 56$) and 25.3% men ($n = 19$). The group of patients affected by dental agenesis was compared by gender, and it was found that women presented smaller mean values for cranial length, posterior facial height, and mandibular corpus length; while for the palatal plane inclination, females had a higher mean than men ($P < 0.05$) (Table 2).

When comparing the agenesis group with the controls, a significant statistical difference was found in four

Table 2 Cephalometric comparison of mean values in patients with dental agenesis by gender.

Cephalometric measurements	Females	Males	P
	$n = 56$	$n = 19$	
Craneofacial relation — cranial structure			
Cranial length (mm)	50.06	53.07	0.01*
Posterior facial height (mm)	57.94	63.65	0.001*
Cranial deflection (°)	27.96	27.28	0.346
Porion location (mm)	−39.79	−40.98	0.233
Ramus position (°)	72.81	71.47	0.292
Craneofacial relation — maxillary position			
Maxillary depth (°)	92.04	90.61	0.156
Maxillary height (°)	60.43	59.97	0.653
Palatal plane inclination (°)	10.32	8.23	0.03*
Craneofacial relation — mandible position			
Facial angle (°)	88.7	87.2	0.106
Facial axis (°)	87.33	86.47	0.446
Mandibular plane angle (°)	25.6	25.66	0.968
Total face height (°)	58.24	58.48	0.873
Facial taper (°)	65.69	67.13	0.247
Maxillo-mandibular relationships			
Convexity (mm)	3.09	3.22	0.845
Mandibular corpus length (mm)	74.36	77.98	0.016**
Mandibular arc (°)	33.97	36.61	0.116
Lower face height (°)	45.83	46.54	0.555
Dental relationships — maxillary dentition			
Upper incisor protrusion (mm)	6.86	7.71	0.283
Upper incisor — Frankfort plane (°)	119.22	118.35	0.676
Upper incisor inclination (°)	33.88	34.63	0.727
Upper molar location (mm)	15.24	14.72	0.678
Dental relationships — mandibular dentition			
Lower incisor protrusion (mm)	2.53	2.9	0.6
Lower incisor inclination (°)	24.13	26.4	0.151
Lower incisor extrusion (mm)	0.48	0.65	0.588
Lower incisor — mandibular plane (°)	92.27	94.94	0.153
Dental relationships — maxillary/mandibular dentition			
Interincisal angle (°)	121.81	118.97	0.347
Molar relation (mm)	−0.72	−0.91	0.699
Overjet (mm)	4.32	4.81	0.479
Overbite (mm)	0.96	1.44	0.423
Occlusal plane — Frankfort plane (°)	6.91	7.22	0.77
Esthetic			
Lower lip — E plane (mm)	0.04	0.58	0.501

(*) T-student ($P < 0.05$); (**) U Mann—Whitney ($P < 0.05$).

variables: maxillary depth, lower incisor protrusion, lower incisor extrusion, and overbite ($P < 0.05$). For the first two variables, the means of the agenesis group were smaller than the controls', whereas the converse was the case on the last two variables (Table 3).

Sagittal location within the dental arch

After dividing the agenesis group according to the sagittal location of the absent tooth within the dental arch, group 1 represented 16.44% ($n = 37$) of the total sample, group 2 represented 16.89% ($n = 38$), and group 3 represented 66.67% ($n = 150$). Mean values of the cephalometric variables for the three groups can be found in Table 4. Statistical differences were found for 10 measurements: three of these correspond to skeletal measurements on the sagittal dimension, namely porion location, maxillary depth, and facial angle; one was a vertical skeletal variable, namely mandibular plane angle; five were regarding dentition, namely upper incisor inclination, lower incisor protrusion, lower incisor extrusion, molar relation, and overbite; and from the esthetic area, the lower lip to E plane measurement also showed a difference ($P < 0.05$).

Skeletal measurements on the sagittal dimension

Concerning the porion location variable, the posterior-agenesis group had a lower mean value relative to controls. The anterior-agenesis group were found to have a lower maxillary depth average than did controls. As for the

Table 3 Cephalometric comparison of mean values for agenesis and control groups.

Cephalometric measurements	Agenesis	Control	P
	$n = 75$	$n = 150$	
Craneofacial relation — cranial structure			
Cranial length (mm)	50.82	50.73	0.86
Posterior facial height (mm)	59.39	59.82	0.797
Cranial deflection (°)	27.79	27.38	0.294
Porion location (mm)	−40.09	−38.99	0.058
Ramus position (°)	72.47	73.34	0.369
Craneofacial relation — maxillary position			
Maxillary depth (°)	91.68	92.67	0.043*
Maxillary height (°)	60.32	60.41	0.613
Palatal plane inclination (°)	9.79	10.26	0.331
Craneofacial relation — mandible position			
Facial angle (°)	88.32	88.72	0.423
Facial axis (°)	87.12	87.44	0.615
Mandibular plane angle (°)	25.61	26.43	0.319
Total face height (°)	58.3	59.17	0.219
Facial taper (°)	66.06	64.85	0.082
Maxillo-mandibular relationships			
Convexity (mm)	3.1	3.73	0.106
Mandibular corpus length (mm)	75.28	75.87	0.175
Mandibular arc (°)	34.64	33.56	0.211
Lower face height (°)	46.01	46.78	0.46
Dental relationships — maxillary dentition			
Upper incisor protrusion (mm)	7.07	7.46	0.15
Upper incisor — Frankfort plane (°)	119	119.36	0.743
Upper incisor inclination (°)	34.07	34.76	0.513
Upper molar location (mm)	15.11	15.87	0.35
Dental relationships — mandibular dentition			
Lower incisor protrusion (mm)	2.62	3.48	0.033**
Lower incisor inclination (°)	24.7	25.36	0.551
Lower incisor extrusion (mm)	0.53	0.17	0.031*
Lower incisor — mandibular plane (°)	92.95	92.62	0.678
Dental relationships — maxillary/mandibular dentition			
Interincisal angle (°)	121.09	119.86	0.306
Molar relation (mm)	−0.77	−1.19	0.135
Overjet (mm)	4.44	3.96	0.366
Overbite (mm)	1.08	0.47	0.03**
Occlusal plane — Frankfort plane (°)	6.99	7.71	0.258
Esthetic			
Lower lip — E plane (mm)	0.18	0.62	0.411

(*) *t*-student ($P < 0.05$); (**) Z test ($P < 0.05$).

facial angle cephalometric measurement, those with anterior-agenesis showed a lower mean value than the posterior-agenesis group.

Vertical skeletal measurements

The posterior-agenesis group was found to have a lower mean mandibular plane angle than did the anterior-agenesis group.

Dentition and esthetic measurements

The anterior-agenesis group presented a higher mean upper incisor inclination value relative to the posterior-agenesis group. On the other hand, the posterior-agenesis group had a smaller lower-incisor protrusion average than did controls. Meanwhile, for the lower incisor extrusion, molar relation, and overbite variables, the posterior-agenesis group showed higher means than did controls. Finally, the lower lip to E plane average for the posterior-agenesis group presented a negative average, while the anterior-agenesis group had a positive value; this difference was statistically significant ($P < 0.05$).

Affected bone

After classifying the sample according to the affected bone criteria, the distribution of groups were as follows: 14.22% ($n = 32$) of patients in group 1, 15.55% ($n = 35$) in group 2, 3.56% ($n = 8$) in group 3, and the remaining 66.67% ($n = 150$) in group 4. No cephalometric variable showed a

Table 4 Cephalometric comparison according to the sagittal location within the dental arch of the absent tooth.

Cephalometric measurements	Group 1	Group 2	Group 3	P
	$n = 37$	$n = 38$	$n = 150$	
Craneofacial relation — cranial structure				
Cranial length (mm)	51.13	50.52	50.73	0.853
Posterior facial height (mm)	58.95	59.81	59.82	0.649
Cranial deflection (°)	27.45	28.12	27.38	0.366
Porion location (mm)	-39.36^{ab}	-40.81^{a}	-38.99^{b}	0.041**
Ramus position (°)	72.12	72.81	73.34	0.354
Craneofacial relation — maxillary position				
Maxillary depth (°)	90.94^{a}	92.39^{ab}	92.67^{b}	0.025*
Maxillary height (°)	60.41	60.22	60.41	0.607
Palatal plane inclination (°)	10.12	9.47	10.26	0.442
Craneofacial relation — mandible position				
Facial angle (°)	87.32^{a}	89.28^{b}	88.72^{ab}	0.038*
Facial axis (°)	86.34	87.87	87.44	0.312
Mandibular plane angle (°)	27.23^{a}	24.04^{b}	26.43^{ab}	0.034*
Total face height (°)	59.12	57.5	59.17	0.275
Facial taper (°)	65.43	66.67	64.85	0.122
Maxillo-mandibular relationships				
Convexity (mm)	3.38	2.87	3.73	0.192
Mandibular corpus length (mm)	74.69	75.85	75.87	0.344
Mandibular arc (°)	34.63	34.64	33.56	0.458
Lower face height (°)	47.07	44.98	46.78	0.078
Dental relationships — maxillary dentition				
Upper incisor protrusion (mm)	7.76	6.4	7.46	0.069
Upper incisor — Frankfort plane (°)	119.79	118.24	119.36	0.653
Upper incisor inclination (°)	36.17^{a}	32.02^{b}	34.76^{ab}	0.045*
Upper molar location (mm)	14.67	15.54	15.87	0.495
Dental relationships — mandibular dentition				
Lower incisor protrusion (mm)	3.03^{ab}	2.22^{a}	3.48^{b}	0.036**
Lower incisor inclination (°)	25.34	24.08	25.36	0.692
Lower incisor extrusion (mm)	0.35^{ab}	0.7^{a}	0.17^{b}	0.041*
Lower incisor — mandibular plane (°)	93.89	92.03	92.62	0.501
Dental relationships — maxillary/mandibular dentition				
Interincisal angle (°)	118.48	123.63	119.86	0.095
Molar relation (mm)	-1.11^{ab}	-0.43^{a}	-1.19^{b}	0.021**
Overjet (mm)	4.69	4.21	3.96	0.518
Overbite (mm)	0.68^{ab}	1.47^{a}	0.47^{b}	0.026**
Occlusal plane — Frankfort plane (°)	7.35	6.64	7.71	0.416
Esthetic				
Lower lip — E plane (mm)	0.97^{a}	-0.58^{b}	0.62^{ab}	0.035*

(*) ANOVA ($P < 0.05$); (**) Kruskal Wallis ($P < 0.05$).
Different letters represent significant differences between the means.

statistically significant difference when comparing among groups ($P > 0.05$; Table 5).

Discussion

The findings of the present study showed a retrusive position of the maxilla on patients with dental agenesis, as well as a tendency of the lower incisors to be retroclined, in a more extrusive position, and with a deeper bite when compared to controls. Although these changes align with those reported by other authors,[5] their magnitude is smaller than what has been described for other ethnic groups. Likewise, this study found no differences when comparing by affected bone, which differs from results of similar papers.[5,11]

Regarding the gender comparison in the agenesis group, the results showed differences in four measurements (two sagittal and two vertical). What this analysis reveals is that in the sagittal dimension, the smaller cranial length in women accompanies a smaller mandibular body, keeping a proper maxillo-mandibular relationship. The vertical dimension behaves similarly, while the reduction of the posterior facial height tends to open the bite, the increment of the palatal plane inclination makes the opposite effect, once again helping to keep the balance in the

Table 5 Cephalometric comparison of the groups according to the affected bone.

Cephalometric measurements	Group 1	Group 2	Group 3	Group 4	P
	$n = 32$	$n = 35$	$n = 8$	$n = 150$	
Craneofacial relation — cranial structure					
Cranial length (mm)	50.82	50.92	50.43	50.73	0.988
Posterior facial height (mm)	59.66	58.93	60.31	59.82	0.925
Cranial deflection (°)	27.69	27.97	27.4	27.38	0.629
Porion location (mm)	−39.65	−40.7	−39.17	−38.99	0.144
Ramus position (°)	72.03	72.7	73.22	73.34	0.497
Craneofacial relation — maxillary position					
Maxillary depth (°)	91.72	91.96	90.28	92.67	0.131
Maxillary height (°)	60.22	60.49	59.95	60.41	0.962
Palatal plane inclination (°)	9.12	10.4	9.83	10.26	0.3
Craneofacial relation — mandible position					
Facial angle (°)	88.44	88.26	88.06	88.72	0.866
Facial axis (°)	87.23	86.94	87.43	87.44	0.948
Mandibular plane angle (°)	25.53	25.96	24.45	26.43	0.696
Total face height (°)	58.37	58.43	57.46	59.17	0.73
Facial taper (°)	66.02	65.76	67.48	64.85	0.283
Maxillo-mandibular relationships					
Convexity (mm)	3.02	3.47	2.01	3.73	0.197
Mandibular corpus length (mm)	76	74.79	74.55	75.87	0.28
Mandibular arc (°)	35.56	33.69	35.12	33.56	0.362
Lower face height (°)	46.13	45.9	46.05	46.78	0.71
Dental relationships — maxillary dentition					
Upper incisor protrusion (mm)	7.22	7.1	6.36	7.46	0.667
Upper incisor — Frankfort plane (°)	119.47	118.28	120.28	119.36	0.863
Upper incisor inclination (°)	34.07	33.93	34.68	34.76	0.921
Upper molar location (mm)	15.53	14.69	15.3	15.87	0.764
Dental relationships — mandibular dentition					
Lower incisor protrusion (mm)	2.87	2.53	2.05	3.48	0.165
Lower incisor inclination (°)	25.3	24.7	22.31	25.36	0.663
Lower incisor extrusion (mm)	0.52	0.51	0.63	0.17	0.194
Lower incisor — mandibular plane (°)	92.85	93.75	89.86	92.62	0.291
Dental relationships — maxillary/mandibular dentition					
Interincisal angle (°)	120.31	121.37	123	119.86	0.652
Molar relation (mm)	−0.79	−0.98	0.23	−1.19	0.156
Overjet (mm)	4.35	4.56	4.32	3.96	0.727
Overbite (mm)	1.01	1.1	1.26	0.47	0.183
Occlusal plane — Frankfort plane (°)	7.45	6.53	7.15	7.71	0.573
Esthetic					
Lower lip — E plane (mm)	0.08	0.46	−0.65	0.62	0.531

occlusion. Therefore, the analysis demonstrates some differences in size between genders but without a tendency towards a specific malocclusion.

Apparently, the sagittal location in the dental arch of the affected tooth more significantly accounts for differences in the cephalometric measurements of the population studied. It is interesting to note that some of the measurements showed differences between both agenesis groups (anterior and posterior) but not between controls. It seems that, in some of these measurements, the controls' average value falls mid-way between the mean of both agenesis groups, which accounts for why, when the analysis fails to consider the anterior or posterior location of the absent tooth, the number of cephalometric measurements affected is reduced. This phenomenon differs from the findings published by Gungor et al. (2013), which found no differences between their multiple case groups but only between case groups and controls.[4] Similarly, Yüskel & Ücem (1997) reported differences between cases and controls; however, these changes were found between anterior-agenesis patients and subjects who presented both anterior and posterior agenesis,[8] a situation shared by none of the individuals in this study. Ethnic variation remains the most plausible explanation for the dissimilarities found among papers that approach this theme; therefore, we recommend performing similar studies in other countries.

Analysis of the results of the sagittal position in the dental arch demonstrated that patients with posterior-agenesis showed a farther porion location than did controls. Given that this measurement is defined as the distance between the pterygomaxillary fossae (PTF) to porion, it is to be expected that controls—who had complete dentition,

including third molars—would have a PTF in a more posterior position given that the maxillary tuberosity is influenced by the development and eruption of third molars.[7,12] Also, in patients with posterior-agenesis, it is presumed that a more anterior eruption of the molars as a consequence of the absent tooth might occur, which could affect the position of the maxillary tuberosity and the PTF.

Continuing in the sagittal dimension but now concerning the anterior-agenesis group, a tendency toward a retruded position of both jaws was found for these patients. It must be stated that, to determine the sagittal location of the jaws, both cephalometric measurements used involve points located in the anterior part of the bone. Hence, this outcome might be expected in this group; however, results from other studies differ, although these were made on Turkish subjects.[4,8] Again, it might be interesting to develop similar studies in other populations for further comparison.

Regarding the vertical dimension, posterior-agenesis affects the mandibular rotation; these patients present an anterior rotation of the mandible compared to individuals with anterior-agenesis. A similar study by Bauer et al. (2009) found that the rotation of the mandible in patients with agenesis of premolars tends to be in an anterior mode.[13] Therefore, it is logical to think that subjects with posterior-agenesis present brachycephalic characteristics as a result of the low mandibular plane angle and the reduction of the vertical dimension, as has been proposed elsewhere.[14]

Concerning dentition, it has been reported that the incisors of agenesis patients tend to be retruded and retroclined.[3,4,10,15] In this study, the group that followed this tendency towards retroclination of the incisors was the posterior-agenesis group, with some differences between the jaws. Differences in the mandible were found in controls, while differences in the maxillary were found in the anterior-agenesis group. This draws attention to the fact that patients with anterior-agenesis display a higher inclination of the upper incisors relative to the posterior-agenesis group; however, this phenomenon has been reported before.[8,11] Other authors suggest that, in patients with anterior-agenesis, the tongue undergoes a physiological adaptation to its environment. Given that the tongue has more space, it expands, provoking a pro-inclination of the anterior teeth.[8] Another explanation contends that, since the maxillary is in a retrusive position, the upper incisors compensate by proclining;[11] as has been previously said, the anterior-agenesis group of this study have maxillary retrusion, which supports this theory.

As a logical consequence of the incisors' location and inclination, the lower lip followed the pattern of these teeth; hence, in subjects with posterior-agenesis and retroclined incisors, the lip was behind the esthetic line. Meanwhile, in patients with anterior-agenesis and proinclination of the upper incisors, the lip crosses the esthetic line.

The present study found that the posterior-agenesis group had an increment in the mean value of lower incisor extrusion and overbite relative to controls. It seems that, in those patients, the bite deepens as a result of the extrusion of the lower incisors. Also, as has been previously explained, posterior-agenesis produces antero-rotation of the mandible[7,16] and retroinclination of the lower incisors, both of which are characteristics associated with marked curves of Spee, deep bites, and brachycephalic patterns.[16] In this respect, an increase in lower incisor extrusion can be added to this growing list of characteristics.

Finally, results showed that patients with posterior-agenesis presented a tendency towards developing an Angle's class II molar relationship. The underlying reason for this phenomenon may be the fact that, in the population studied, the most frequently absent tooth is the lower second premolar (excluding third molars);[17] therefore, there is no exfoliation of the deciduous lower second molars. Consequently, the first permanent molar is rendered incapable of its late mesial displacement towards the drift space, provoking a molar class II relationship.[18]

In conclusion, patients affected by dental agenesis present changes in the sagittal growth of the maxillary and the lower incisors when compared to subjects with complete dentition. In the population in this study, these changes are strongly influenced by the sagittal location in the arch of the absent tooth, whereas the location in the affected bone did not affect facial growth.

Declaration of competing interest

Authors state that there is no conflict of interests to declare.

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