Original Article

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Craniofacial morphology in individuals with increasing severity of hypodontia

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ABSTRACT

Introduction: Tooth agenesis has an impact on craniofacial morphology. The aim of this study was to investigate the craniofacial morphology of individuals with increasing severity of hypodontia in Macedonian population.

Materials and methods: The material comprised X - rays (OPG and profile) of 60 patients with congenitally missing teeth and 40 X - rays (OPG and profile) of patients, with normal occlusion and complete dentition, selected as the control group, aged 10-15 years, in both sexes. All subjects were evaluated cephalometrically. According to the number of missing teeth, subjects were subdivided into three groups: group A - mild (1-2), group B - moderate (3-6), and group C - severe (≥ 7 congenitally missing permanent teeth).

Results: The results showed significant differences in the craniofacial size and morphology between the groups. Maxilla and mandible were retrognathic, and the maxillary length was significantly reduced in all three hypodontia groups compared to the controls. The ANB angle decreased as the number of missing teeth increased, and the patients with more severe hypodontia showed tendencies to a Class III skeletal relationship. The lower anterior face height was significantly reduced only in the severe hypodontia group. An important finding is also retroclination of the maxillary incisors in the mild and moderate hypodontia groups and greater anterior inclination in the severe hypodontia group. The lower incisors displayed retroclination and the interincisal angle was increased in all three hypodontia groups. The incisor inclination was reflected by a reduction in the protrusion of the lips.

Conclusions: Our findings suggest that agenesis has a negative influence on the craniofacial morphology according to the number of missing teeth and leads to aesthetic and functional disturbances.

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INTRODUCTION

Missing teeth are one of the most common developmental anomalies in children. Specific terms are used to describe the nature of tooth agenesis. According to Proffit, [1] hypodontia is the congenital absence of only a few teeth, oligodontia is the absence of many but not all teeth while anodontia is the absence of all teeth. The prevalence of hypodontia in the general population varies from 2.3% to 10.1% (excluding third molars). [2-5] Hypodontia can be associated with a cleft lip and palate, [6,7] and with more than 50 syndromes, [8,9] or may present as an isolated entity. [10,11] Oligodontia is rarer condition and its prevalence in the permanent dentition is between 0.15% and 0.45%. [4,12] The congenital absence of teeth occurs more frequently in girls at a ratio of 3:2. [2,13,14] The mandibular second premolar and maxillary lateral incisor are the most commonly missing teeth. [13-20]

Tooth agenesis has a negative influence on the craniofacial morphology and leads to aesthetic and functional disturbances. The effects of hypodontia have been reported as a reduction in tooth size and dental arch dimensions. [3,13,21-23] Craniofacial deviations as retrognathic maxilla, reduced lower face height and increased overbite have also been registered in patients with

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tooth agenesis. [23-27] Deep bite and Class I skeletal relationship was more frequently found in patients with agenesis than in patients without missing teeth. [28,29]

The severity of hypodontia is an important factor in craniofacial morphology. However, only a few authors have investigated the influence of different numbers of missing teeth on craniofacial morphology. [24,25,30-32] Bondarets and Mc Donald [24] found that individuals with severe hypodontia had the typical facial characteristics unique to hypodontia, with reduced vertical dimensions.

A decrease in vertical jaw relation and mandibular plane inclination in persons with severe hypodontia was observed by Øgaard and Krogstad [25] and Nodal et al. [30] Chung et al. [31] and Acharya et al. [32] found that severe hypodontia had a significant effect on a skeletal relationship.

The aim of this study was to investigate the craniofacial morphology of individuals with increasing severity of hypodontia in Macedonian population.

MATERIALS AND METHODS

The study population was comprised of 60 individuals with congenital absence of one or more teeth (excluding third molars), without a history of tooth extraction, aged from 10.1 to 15 years, who were patients at the Department of Orthodontics, Faculty of Dentistry, University of Skopje. Children with ectodermal dysplasia, cleft lip and palate, or other craniofacial syndromes were not included in the study group. Forty children with normal occlusion and complete dentition, aged from10.2 to 15 years, patients at the Department of Paediatric Dentistry, Faculty of Dentistry, University of Skopje, were selected as the control group. The patients were from both sexes. None of the patients had undergone previous orthodontic treatment. Written permission has been obtained from the parents of the children included in the study. The study was approved by Teaching and Science Research Council of Ss. Cyril and Methodius University of Skopje.

The congenital absence of teeth was determined by clinical and radiographic examination using orthopantomogram (OPG). According to the number of missing teeth, subjects were subdivided into three groups: group A - mild (1-2), group B - moderate (3-6), and group C - severe (≥7 congenitally missing permanent teeth). The number and average ages of the study groups are presented in Table 1. The craniofacial morphology was determined by cephalometric analysis of standardized lateral cephalometric radiographs with 15 angular and 10 linear parameters. The cephalometric points and measurements used in this study are shown in the Figure 1 and Table 2.

All statistical calculations were performed by computer programs (Minitab, 1991). [33] Cephalometric analyzes were handled manually twice by one investigator (CBM). The error of measurement was estimated by τ, calculated according to the formula $\tau=\tau d2/2n$, where d is the difference between the repeated measurements and n is the sample size (Dahlberg, 1940). [34] In the statistical handling of linear measurements, the values were corrected for radiographic enlargement.

An analysis of variance (ANOVA) was used for simultaneous analysis of the differences between the means in hypodontia subgroups and the control group. Aditional Tukey's multiple comparisons tests were used for the range of means if the probability of significance was < 0.05.

Table 1. *The number and average ages of girls and boys in the control and the different hypodontia groups*

	Control group		Group A 1-2		Group B 3-6		Group C ≥7	
	n	Age	n	Age	n	Age	n	Age
Girls	20	12.5±0.3	19	12.1±0.4	6	12.5±0.7	6	13.1±0.3
Boys	20	12.3±0.3	18	11.9±0.4	7	12.4±0.5	4	12.7±0.5
Total	40		37		13		10	

Figure 1. *Cephalometric points. N, nasion; S, sella; Ba, basion; Sna, anterior nasal spine; A, point A; B, point B; Snp, posterior nasal spine; Pg, pogonion; Gn, gnathion; Go, gonion; Ls,Labrale superius ; Li, Labrale inferius.*

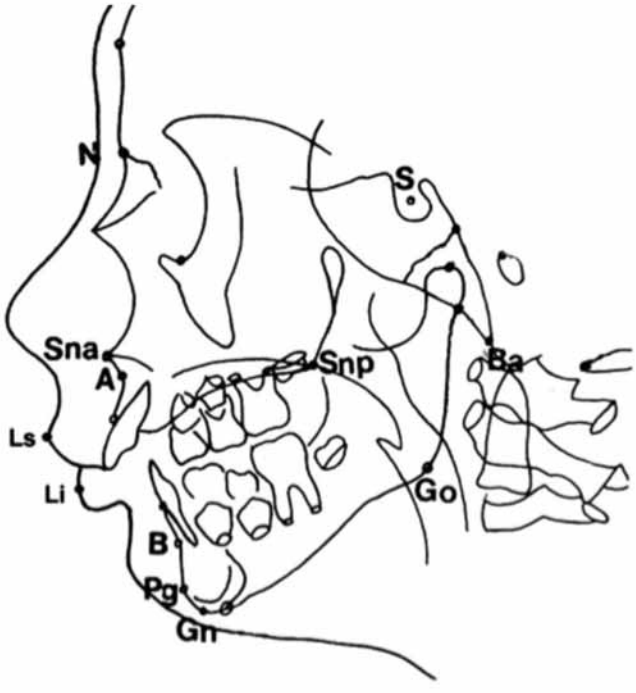

Table 2. The angular and linear measurements and their descriptions

Angular measurements	
S-N-A	Maxillary prognathism
S-N-B	Mandibular prognathism
A-N-B	Basal sagittal jaw relationship
S-N-Pg	Prognathism of the chin
NA/APg	Angle of convexity
N-S-Ba	Cranial base angle
Go angle	Angle between mandibular plane and tangent of ramus mandibule
N-S/SpPl	Angulation of maxilla relative to the anterior cranial base
N-S/OccPl	Angle between occlusal plane and cranial base
N-S/MPl	Angulation of the mandible relative to the anterior cranial base
B	Angle between maxillary and mandibular base lines
11/SN	Inclination of the maxillary incisors relative to the anterior cranial base
11/N-A	The relationship of the maxillary central incisor to the N-A line
41/N-B	The relationship of the mandibular central incisor to the N-B line
11/41	Interincisal angle
Linear measurements	
N-Sna	Upper anterior face height
Sna-Gn	Lower anterior face height
N-Gn	Anterior face height
S-Go	Posterior face height
Sna-Snp	Length of maxilla along the nasal floor
Go-Gn	Length of the mandibular corpus
11→N-A	Protrusion of the maxillary central incisor relative to the N-A line
41→N-B	Protrusion of the mandibular central incisor relative to the N-B line
Ls/EL	Upper lip to aesthetic line
Li/EL	Lower lip to aesthetic line

RESULTS

Statistical analysis didn't show any significant differences between the measurements of girls and boys in the control group. The girls and boys in the different hypodontia groups were therefore pooled to increase the sample sizes.

A comparison of the means of the angular and linear craniofacial variables between patients with tooth agenesis and control group are presented in Tables 3-5.

The results showed significant differences in the craniofacial size and morphology between the groups.

Maxilla and mandible were retrognathic shown by a significantly reduced SNA and SNB angle (Table 3). The maxillary length (Sna - Snp) was significantly reduced in all three hypodontia groups compared to the controls while the mandibular length (Go - Gn) was significantly reduced only in the group with agenesis of 1-2 teeth (Table 4).

As the severity of hypodontia increased from moderate to severe, the ANB angle decreased, and a tendency to develop a Class III skeletal relationship was noted (Table 3). The upper anterior face height (N - Sna) was average while the lower anterior face height (Sna - Gn) was significantly reduced ($P < 0.01$) only in the group with agenesis of ≥ 7 teeth (Table 4).

The upper incisors were significant retroclinated, except in the severe hypodontia group, where the incisors showed a greater anterior inclination compared to the controls. The lower incisors displayed retroclination and the interincisal angle (11/41) was increased in all three hypodontia groups (Table 5). The incisor inclination was reflected by a reduction in the protrusion of the lips (Ls/EL, Li/EL). The degree of retrusion of the lips increased with the severity of hypodontia.

DISCUSSION

The opinions of the authors for an impact of tooth agenesis on a dentofacial structure are opposed. Roald et al. [35] and Yüksel and Ucem [36] believe that agenesis has a small effect on the dentofacial structure, but Sarnäs and Rune [26] found that morphology and model of growth in children with agenesis are little bit different in regard to children without agenesis. Our findings suggest that there are differences in dentofacial morphology between individuals with tooth agenesis and individuals with complete dentition and normal occlusion, which is consistent with findings of Bondarets and Mc Donald, [24] Ogaard and Krogstad, [25] Wisth et al. [27] and Nodal et al. [30]

A few authors were researching connection between craniofacial morphology and number of missing teeth. [24,25,30-32]

Ogaard and Krogstad [25] concluded that typical dentofacial structure in individuals with a larger number of absent teeth, is due to dental and functional adjustment rather than to an altered growth pattern, but Bondarets and Mc Donald, [24] in

their comparative study in individuals with congenital absence of sixth or more teeth, concluded that this individuals had typical facial characteristics with reduced vertical dimensions, as a consequence of the limited growth of alveolar bone.

Significantly reduced value of SNA angle in patients with different number of absent teeth determined in this study, is in compliance with findings of Wisth et al., [27] Roald et al., [35] Sarnäs and Rune [26] and Ogaard and Krogstad, [25] opposite to normal values of this parameter established of Woodworth et al., [23] Nodal et al., [30] Chung et al. [31] and Yüksel and Ucem. [36] Published results on the mandibular effects of hypodontia vary. In the present study, all three hypodontia groups showed a significant reduction in the SNB angle compared with the controls. This disagree with the findings of Wisth et al., [27] Nodal et al., [30] Chung et al. [31] and Yüksel and Ucem, [36] who founds no changes in SNB, but confirms those of Bondarets and Mc Donald, [24] who showed decreased SNB angle in persons with hypodontia.

In individuals with agenesis persist continued reductions of values of ANB angle. The degree of reduction of this angle is directly dependent of number of absent teeth, whereby its values are smallest in the severe hypodontia group. This finding is corresponding with findings of other authors. [25-27,31,32] The ANB angle decreased as number of missing teeth increased, and the patients with more severe hypodontia showed tendencies to a Class III skeletal relationship. [31,32] Increasing numbers of missing teeth resulted also in a decrease in the length of maxilla, what is consistency with the findings of Wisth et al. [27] and Woodworth et al. [23]

According to Roald et al., [35] the absence of permanent tooth buds may have a negative influence on the magnitude of growth in the maxilla, which results in reduced maxillary length.

There are opposite opinions in the literature for the length of mandible. The moderate decrease in mandibular length among patients with a different number of absent teeth established as part of this study is in accordance with the results of Ogaard and Krogstad, [25] who noted that there is no link between the size of the lower jaw and hypodontia. According to Woodworth et al., [23] significantly reduced mandibular length is in a strong correlation with the reduced maxillary length and the size of nose. On the contrary, Roald et al., [35] established the significantly greater length of mandible and reduced maxillary length in patients with agenesis. Such a finding indicates that the negative effects caused by the absence of teeth are less in the mandible than in the maxilla, what is due to the difference in their growth mechanism.

Significantly reduction of the lower face height determined in this study among the persons with more than 7 missing teeth, has a reflection on the aesthetics of the lower face third, and thus the overall aesthetics of a person. Nodal et al., [30] established that the reduction of the lower face height occurs as a result of reduced occlusal support.

An important finding in this study is also retroclination of the maxillary incisors in the mild and moderate hypodontia groups and greater anterior inclination in the severe hypodontia group. This finding could be explained by the tongue effect on the frontal teeth, or by the adaptation of tongue position in the agenesis area. There is more space for tongue if more teeth are missing.

Proclination of the upper incisors in persons with agenesis may be a compensation for the reduced degree of maxillary prognathism. [27] The increased interincisal angle and the reduction in the protrusion of the lips can be explained by the reduced lingual support from the few remaining teeth. [25]

Developmental disturbances involving the oral cavity affect the growth and development of a child. [11] The presence or absence of teeth is decided by the influence of various genes and their signaling pathways. [11] In this study we examined only the impact of number of missing teeth on the craniofacial morphology in children with non - syndromic hypodontia, and not include the impact of age on the examined parameters which is a limitation of the study.

CONCLUSION

Our findings suggest that agenesis has a negative influence on the craniofacial morphology according to the number of absent teeth and leads to aesthetic and functional disturbances.

Considering this, in individuals with tooth agenesis it is necessary to pay special attention to the craniofacial morphology in the orthodontic treatment planning. Early detection of agenesis, properly and timely conducted treatment in such patients will prevent the possible and undesirable disturbance of craniofacial morphology, and thus the consequences in relation to facial aesthetics.

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Table 3. *Comparison of angular skeletal dimensions variables of hypodontia groups and the control group*

	Variable	Group A (n=37)		Group B (n=13)		Group C (n=10)		Controls (C) (n=40)		ANOVA		Tukey's test		
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	F	P	A/C	B/C	C/C
Angular skeletal dimensions	SNA	78.6	4.6	78.9	4.9	78.1	4.4	82.2	2.6	6.837	0.000	**	**	**
	SNB	76.1	3.9	76.4	4.0	76.2	3.9	79.9	2.8	9.005	0.000	**	**	**
	ANB	2.6	3.5	2.4	3.0	1.2	5.6	3.0	0.7	3.998	0.015			*
	SNPg	77.1	4.1	77.8	4.3	77.4	4.3	78.8	2.7	1.470	0.227			
	NA/APg	4.1	7.6	5.7	6.7	-0.5	10.2	6.6	2.3	3.735	0.014			**
	NSBa	130.7	5.9	129.7	6.2	130.0	1.5	133.4	5.2	2.662	0.052			
	Go - angle	127.2	5.3	127.9	5.7	125.6	8.2	122.6	5.4	5.232	0.002	**	**	
	SN/SpPL	8.7	3.5	8.6	3.0	7.2	2.7	8.2	3.1	0.629	0.598			
	SN/ OccPL	19.1	4.0	18.1	4.0	15.1	5.7	16.1	3.2	5.123	0.002	*		
	SN/MPL	36.5	4.8	34.2	7.2	27.6	6.3	31.5	4.9	9.837	0.000	**		*
	B	27.7	4.9	26.4	6.9	23.1	7.8	23.2	5.2	4.778	0.004	**		

* P < 0.05; ** P < 0.01

Table 4. *Comparison of linear skeletal dimensions variables of hypodontia groups and the control group*

	Variable	Group A (n=37)		Group B (n=13)		Group C (n=10)		Controls (C) (n=40)		ANOVA		Tukey's test		
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	F	P	A/C	B/C	C/C
Linear skeletal dimensions	N-Sna	54.7	3.9	57.7	3.6	54.2	4.6	55.9	2.7	2.985	0.035			
	Sna-Gn	69.1	6.5	66.9	4.5	63.4	4.0	69.8	5.5	3.878	0.012			**
	N-Gn	123.4	8.9	124.6	5.0	117.8	1.6	125.5	7.1	3.048	0.032			**
	S-Go	75.9	6.2	80.5	8.1	81.3	8.5	81.7	5.2	5.915	0.001	**		
	Sna-Snp	56.0	5.4	55.4	2.3	52.3	8.8	58.5	2.0	5.415	0.002	*	*	**
	Go-Gn	75.0	5.9	74.7	6.9	75.6	4.5	78.7	3.5	4.213	0.008	*		

* P < 0.05; ** P < 0.01

Table 5. *Comparison of dental and soft tissue dimensions variables of of hypodontia groups and the control group*

	Variable	Group A (n=37)		Group B (n=13)		Group C (n=10)		Controls (C) (n=40)		ANOVA		Tukey's test		
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	F	P	A/C	B/C	C/C
Angular skeletal dimensions	11/SN	95.9	7.9	89.7	9.6	103.4	18.6	102.1	4.9	8.698	0.000	**	**	**
	11/NA	14.8	8.1	13.4	7.2	25.2	11.5	20.9	4.4	9.788	0.000	**	**	**
	11→ NA	4.9	3.5	3.2	3.4	4.9	5.9	4.9	1.5	1.066	0.367			
	41/NB	22.2	7.5	16.2	6.7	15.1	10.6	29.0	3.2	21.502	0.000	**	**	**
	41→NB	4.6	2.3	2.6	2.4	2.2	2.1	6.2	0.9	20.316	0.000	**	**	**
	11/41	137.9	12.5	151.3	14.7	141.8	21.1	125.8	5.8	17.988	0.000	**	**	**
Soft tissue dimensions	Ls/EL	-4.4	3.2	-4.2	2.6	-5.8	3.2	-2.8	1.2	5.075	0.003	**		**
	Li/EL	-3.0	3.1	-4.0	3.5	-4.3	2.7	-1.1	1.9	6.831	0.000	**	**	**

* P < 0.05; ** P < 0.01

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