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ORIGINAL ARTICLE

Are Environmental Factors Effective in Congenitally Missing Teeth? A Multicenter Study

Halenur Altan[1], Alem Coşgun[2], Sümeyra Akkoç[3], Rabia Erağca[4]

[1]Department of Pediatric Dentistry, Faculty of Dentistry, Gaziosmanpasa University, Tokat, Turkey. 0000-0003-3648-5989
[2]Department of Pediatric Dentistry, Nimet Bayraktar Oral and Dental Health Hospital, Kayseri, Turkey. 0000-0001-6586-6700
[3]Department of Pediatric Dentistry, Faculty of Dentistry, Gaziosmanpasa University, Tokat, Turkey. 0000-0002-7266-2017
[4]Department of Pediatric Dentistry, Faculty of Dentistry, Gaziosmanpasa University, Tokat, Turkey. 0000-0002-3992-4943

Author to whom correspondence should be addressed: Assistant Professor Halenur Altan, Department of Pediatric Dentistry, Faculty of Dentistry, Gaziosmanpasa University, Ali Sevki Erek Yerleskesi, 60100, Tokat, Turkey. Phone: +90 5057523376. E-mail: halenuronat@gmail.com.

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Abstract

Objective: To examine the prevalence of congenital absence of permanent teeth other than third molar teeth in non-syndromic children in the Black Sea and Mediterranean Regions of Turkey, and the correlation between gender and distribution sites in the jaws. **Material and Methods:** Panoramic radiographs and clinical records of 9831 children (5025 girls, 4806 boys) in the Mediterranean Region and 11372 children (5540 girls, 5832 boys) in the Black Sea region were examined. All panoramic radiographs were evaluated by a dentist. The permanent tooth, which was not seen in radiography, was recorded as a congenitally missing tooth, and the fact that the tooth was not extracted was confirmed by treatment records. The data were statistically evaluated by Chi-Square and t-test. **Results:** The prevalence of congenitally missing permanent teeth was 2.8% (3.52% in girls, 2.5% in boys) in the Mediterranean region and 1.63% (1.82% in girls and 1.45% in boys) in the Black Sea region. Congenitally missing permanent teeth were observed more in the maxilla compared to mandible. The teeth that most frequently have congenitally missing permanent teeth in the Mediterranean Region are mandibular second premolars, maxillary lateral incisors and maxillary second premolars, respectively. The teeth that most frequently have congenitally missing permanent teeth in the Black Sea region are mandibular second premolars, maxillary second premolars and maxillary lateral incisors, respectively. Most of the patients had one or two teeth missing, and the lack of three or more teeth was rare. **Conclusion:** In this study, which is performed in different climatic characteristics of Black Sea and Mediterranean Regions, the frequency of congenitally missing teeth is similar.

Keywords: Prevalence; Tooth Abnormalities; Anodontia; Radiography, Panoramic.

Introduction

The lack of teeth is one of the important factors that should be taken into account during the intraoral examination. The presence and order of teeth inform the dentist about the course of the development of teeth and are influential in the treatment to be performed. Developmental deficiencies observed in the number of teeth are regarded as an anomaly. While the congenital absence of one or more teeth is called hypodontia, the congenital absence of six or more teeth other than third molar teeth is called oligodontia and the congenital absence of all teeth is called anodontia [1,2].

Congenitally missing teeth are not considered as an important health problem although they are among the most frequently encountered anomalies. However, it was reported that this anomaly may cause disorders in speech, aesthetic and muscle functions in people [3].

Although the etiology of congenitally missing teeth is not fully explained, local [4], systemic [5] and genetic [6] factors are suggested to be effective. It is reported that local factors may lead to congenitally missing teeth depending on the reasons such as squeezing in germ formation in the relevant region, ruptures occurring in dental lamina, the lack of space in the region, functional anomalies in dental epithelium, problems occurring in the formation of mesenchymal tissue or the ruptures occurring during embryonic fusion of the upper jaw and the medial nasal process [7]. With respect to environmental factors, it is reported that trauma, chemotherapy, radiotherapy, thalidomide derivative drugs by mother during her pregnancy and insufficient nourishment of the mother, trauma, infections (rubella, syphilis), radiation and hormonal changes may cause congenitally missing teeth [8,9].

Oligodontia can be etiologically isolated and independently visible without accompanying any clinical presentation and also may occur due to a part of various syndromes or severe systemic disorders. Congenitally missing teeth such as oligodontia and hypodontia may be encountered in many different syndromes. Hypohidrotic ectodermal dysplasia, Down syndrome and cleft lip and palate are the most important syndromes. The syndromes that are less often seen and present with oligodontia are Oto-palato-digital syndrome, Oculo-Facial-Cardio Syndrome, Rieger Syndrome and Bloch Sulzberger Syndrome [9-11]. In cases where oligodontia is a part of such syndromes, various changes are also observed in other systems of the body [11]. Furthermore, PAX9 gene is also thought to play an important role in the development of teeth. It has been reported that the mutations in PAX9 coding chain affect the development of teeth and lead to the formation of hypodontia and oligodontia [12].

In the studies carried out, the most frequently encountered teeth with congenital absence are the third molar teeth. It is followed by missing mandibular second premolar teeth and maxillary lateral incisors, respectively. The rare missing teeth are maxillary front incisors, maxillary and mandibular canines, and first premolars. The lack of these teeth is usually encountered in oligodontia cases. Congenitally missing teeth can be unilateral or bilateral [8,11].

In recent years, clinicians have emphasized that the prevalence of congenitally missing teeth is gradually increasing. The possible reasons for this situation can be listed as recent developments in imaging techniques, patients' increased awareness of their dental conditions, and the environmental factors that affect the phenotype and cannot be identified [13,14].

The prevalence and comparative distributions of the congenital absence of permanent teeth other than third molar teeth in non-syndromic children in two centers in the Black Sea and the Mediterranean regions were examined to reveal the effect of environmental factors in congenitally missing teeth.

Material and Methods

Study Design and Data Collection

It was carried out as a retrospective study in which the panoramic radiographs were taken from a total of 9831 children (5025 girls, 4806 boys) admitted to Mustafa Kemal University Faculty of Dentistry Department of Pediatric Dentistry located in the Mediterranean region between the years 2013-2014 and a total of 11372 children (5540 girls, 5832 boys) admitted to Gaziosmanpaşa University Faculty of Dentistry Department of Pediatric Dentistry located in the Black Sea region between the years 2017-2018 were scanned and clinical records were examined. The children included in the study were between 8-14 years old.

The patients with tooth extraction, cleft lip and palate, and systemic disorders in medical history and clinical records were excluded from the study. Furthermore, the cases that may lead to missing teeth depending on the factors such as trauma, periodontal disease or caries were not included in the study. In this study in which missing third molar teeth were not taken into consideration, the distribution of congenitally missing permanent teeth according to teeth, jaws, and gender were examined.

All panoramic radiographs were evaluated by a dentist. The permanent tooth which was not seen in radiography was recorded as a congenitally missing tooth, and the fact that the tooth was not extracted was confirmed by treatment records.

Statistical Analysis

The data obtained were statistically evaluated by Chi-Square and t-test. Analyses were completed by using the Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA) version 20.0 program. The statistical significance for all analyses was set at $p < 0.05$.

Ethical Aspects

The study protocol was approved by the Gaziosmanpasa University Clinical Research Local Ethics Committee (18-KAEK-287). Written consent was obtained from parents.

Results

In panoramic radiographs taken from a total of 9831 children (5025 girls, 4806 boys) in the Mediterranean region, congenitally missing permanent teeth were found in 276 children (177 girls, 99 boys). The prevalence of congenitally missing permanent teeth was calculated as 2.8%. Prevalence values were calculated as 3.52% in girls and 2.5% in boys (Table 1). In panoramic radiographs taken from a total of 11372 children (5540 girls, 5832 boys) in the Black Sea region, congenitally missing permanent teeth were found in 186 children (101 girls, 85 boys). The prevalence of congenitally missing permanent teeth was calculated as 1.63%. Prevalence values were calculated as 1.82% in girls and 1.45% in boys (Table 1).

Table 1. Prevalence of congenitally missing permanent teeth in the Black Sea Region and Mediterranean Region.

	Black Sea Region			Mediterranean Region		
	Girl	Boy	Total	Girl	Boy	Total
N	101	85	186	177	99	276
Total	5540	5832	11372	5025	4806	9831
Prevalence (%)	1.82%	1.45%	1.63%	3.52%	2.5%	2.8%

It was determined that 582 congenitally missing permanent teeth in the Mediterranean Region were present in 414 girls and 168 boys. It was determined that 320 congenitally missing permanent teeth in the Black Sea Region were present in 204 girls and 116 boys. It was determined that the most commonly missing teeth in the Mediterranean Region were mandibular second premolars, maxillary lateral incisors, and maxillary second premolars, respectively. It was determined that the most commonly missing teeth in the Black Sea were mandibular second premolars, maxillary second premolars, and maxillary lateral incisors, respectively. It was determined that the lack of teeth was often symmetrical both in the Black Sea and Mediterranean regions (Tables 2 and 3).

Table 2. Distribution of Congenitally Missing Permanent Teeth in the Mediterranean Region.

Tooth Number	Girl			Boy			Total
	Symmetrical N	Asymmetrical N	Total N	Symmetrical N	Asymmetrical N	Total N	
12	27	9	26	12	6	18	54
13	3	-	3	-	-	-	3
14	9	-	9	-	-	-	9
15	27	9	36	6	3	9	45
16	-	-	-	-	-	-	-
22	27	9	36	12	-	12	48
23	3	-	3	-	-	-	3
24	9	6	15	-	-	-	15
25	27	6	33	6	3	9	52
26	-	-	-	-	-	-	-
31	9	3	12	12	-	12	24
32	6	-	6	-	3	3	9
33	3	3	6	-	-	-	6
34	3	3	6	-	-	-	6
35	63	18	81	27	12	39	120

36	3	-	3	-	--	-	3
37	3	-	3	-	-	-	3
41	9	3	12	12	-	12	27
42	6	6	12	-	3	3	15
43	3	-	3	-	-	-	3
44	3	-	3	-	-	-	3
45	63	36	99	27	24	51	150
46	3	-	3	-	-	--	3
47	3	-	3	-	-	-	3

Table 3. Distribution of Congenitally Missing Permanent Teeth in the Black Sea Region.

Tooth Number	Girl			Boy			Total
	Symmetrical N	Asymmetrical N	Total N	Symmetrical N	Asymmetrical N	Total N	
12	9	3	12	13	7	20	32
13	1	-	1	-	-	-	1
14	1	-	1	-	1	1	2
15	15	5	20	14	4	18	38
16	-	1	1	-	-	-	1
22	9	4	13	14	3	17	30
23	1	-	1	-	-	-	1
24	1	1	2	-	-	-	2
25	17	7	21	13	2	15	36
26	-	-	-	1	-	1	1
31	2	1	3	5	-	5	8
32	2	1	3	7	1	8	11
33	-	-	-	-	-	-	-
34	-	-	-	-	1	1	1
35	43	12	55	32	16	48	103
36	1	-	1	-	-	-	1
37	1	-	1	1	-	1	2
41	2	2	4	5	1	6	10
42	2	1	3	7	-	7	10
43	-	-	-	-	-	--	-
44	-	-	-	-	1	1	1
45	43	16	59	32	7	39	98
46	1	-	1	-	-	-	1
47	1	-	1	1	-	1	2

It was determined that there was a statistically significant difference in terms of congenitally missing permanent teeth by gender both in the Black Sea and Mediterranean regions ($p<0.05$) (Table 4).

Table 4. Association between gender and congenitally missing teeth.

Gender	Black Sea Region		Mediterranean Region		Total		p-value
	N	%	N	%	N	%	
Girl	101	54.3	177	64.1	278	60.2	<0.05
Boy	85	45.7	99	35.9	184	39.8	
Total	186	100.0	276	100.0	462	100.0	

Furthermore, it was found that congenitally missing permanent teeth were more frequently observed in the mandible than maxilla in both regions, however, there was no statistical difference (p>0.05) (Table 5).

Table 5. Distribution according to mandible-maxilla regions where congenitally missing permanent teeth were observed.

Region	Black Sea Region		Mediterranean Region		Total		p-value
	N	%	N	%	N	%	
Lower Jaw	249	63.4	372	63.9	621	63.7	>0.05
Upper Jaw	144	36.6	210	36.1	354	36.3	
Total	393	100.0	582	100.0	975	100.0	

It was also determined that there was no difference between right and left half jaws in terms of congenitally missing permanent teeth in boys and girls (p>0.05) (Table 6).

Table 6. Distribution according to right-left jaw regions where congenitally missing permanent teeth were observed.

Side	Black Sea Region		Mediterranean Region		Total		p-value
	N	%	N	%	N	%	
Right Jaw	201	51.1	279	47.9	480	49.2	>0.05
Left Jaw	192	48.9	303	52.1	495	50.8	
Total	393	100.0	582	100.0	975	100.0	

Discussion

Although there are many studies published in the literature to determine the prevalence of congenitally missing teeth, no multicenter study carried out in Turkish society was found. For this purpose, a comparative prevalence study of the Mediterranean and Black Sea regions with different environmental characteristics was carried out for the first time. The prevalence of congenitally missing permanent teeth in the studies carried out in Turkey is between 2.63% and 14.1% [13,15-23]. In our study, the prevalence of congenitally missing teeth was found to be 2.8% in the Mediterranean region and 1.63% in the Black Sea region.

In our study, when the distribution by gender was evaluated, more congenitally missing permanent teeth were observed in girls (3.52% in the Mediterranean region, 1.82% in the Black Sea region) compared to boys (2.5% in the Mediterranean region, 1.45% in the Black Sea region). This result shares similarities with the studies carried out in the world and Turkey [6,16,19,21,24].

It was determined that the most frequent teeth with congenitally missing permanent teeth in the Mediterranean and Black Sea regions were mandibular second premolars. Most of the studies are similar to our results [15,16,20,24-27]. The fact that the absence of second molar teeth is seen so widely is attributed to the fact that they are the latest developing teeth within their own segment 29 When the literature is reviewed, there are also studies reporting that the most frequent congenitally missing permanent teeth are upper lateral incisors [28,29].

Our results in the Mediterranean region are similar to the studies reporting that the second most frequently missing teeth are observed in maxillary lateral incisors [24,30-32]. However, there are also studies reporting that the second most frequently missing teeth are observed in maxillary second premolars, as in the Black Sea region [16,20,23].

It was claimed that missing maxillary incisors were significantly more frequent in girls, however, the relationship could not be explained. However, it is emphasized that the cause may be dimorphism based on the sex origin occurring during growth and development [33]. In our study, the lack of upper incisors was found to be significantly higher in girls in the Mediterranean region, supporting these results. However, it is totally opposite in the Black Sea region. Interestingly, the lack of bilateral lateral incisors in girls was also found to be quite high. It is also claimed that the lack of bilateral upper incisors is due to genetic origin while unilateral missing is due to a developmental anomaly, therefore, the tooth formed on one side is usually conical or microdontia [22]. Our study also supports these results.

It was previously reported that the lack of mandibular lateral and central teeth is observed less often while the lack of maxillary central, canine and 1st molar teeth is observed very rarely [34]. The data obtained in our study are also consistent with this situation. It was determined that the absence of mandibular incisors was slightly higher than maxillary central, canine and 1st molar teeth, in accordance with the literature. When congenitally missing teeth are examined by gender, it is seen that the ratios of missing teeth that are less frequently observed are close to each other.

There are studies indicating that missing teeth are frequently observed symmetrically [24,28,31,35]. In our study, similar to the literature, it was determined that congenitally missing permanent teeth were often symmetrical both in the Black Sea and Mediterranean regions. Congenitally missing teeth were most commonly observed in the right jaw region both in the Black Sea and the Mediterranean regions. It was previously reported that congenitally missing teeth were mainly in the right jaw region [36]. However, there are also studies reporting that there are more congenitally missing teeth in the left jaw region [37]. Furthermore, when the literature is reviewed, the prevalence of congenitally missing teeth is between 0.027% and 13.4% around the world [26,27,36,38-42].

In children with hypodontia, it will be appropriate to primarily administer the restorative treatments of the patient and then to evaluate from orthodontic aspect. In the following stages, the prosthetic rehabilitation of missing teeth should be planned [43-45].

Fixed prostheses applied especially at early ages may adversely affect the jaw development. Single crowns may cause problems with their large pulp and short crown lengths even if they do not affect the jaw development. Furthermore, although dental implants are permanent solutions, they are not recommended due to the complications that may occur in pediatric patients with ongoing development [44,46].

In children with oligodontia, they may cause aesthetic and functional disorders as a result of insufficiency in the development of alveolar bone height. They may lead to psychological problems in

patients. The age of the patient, the numbers of existing deciduous teeth and permanent teeth, the number and localization of missing teeth, the presence of caries in the existing teeth, occlusion, the state of supportive tissues and interocclusal distance should be taken into account in treatment planning. The patient's age is especially important in treatment planning. When it is considered that the passive eruption of the teeth continues until the age of 20, it is recommended to restore the existing deciduous teeth and to preserve them until the age of 20 [1]. In oligodontia cases, the treatment requires a multidisciplinary study.

With respect to the limitations of the study, it is seen that there are differences in the prevalence studies of congenitally missing teeth. It is thought that these differences may be caused by different methods and techniques. The factors such as whether third molar teeth are included in the study, number of patients, whether the samples are selected randomly or from a specific group (orthodontic patients), and the age range of the samples affect the results of the study carried out. It is reported that the decay formation due to insufficient oral hygiene in the societies with low socioeconomic level and the infections due to gingival disorders lead to higher prevalence of congenitally missing teeth [25].

Conclusion

In this study, which is performed in different climatic characteristics of Black Sea and Mediterranean Regions, the frequency of congenitally missing teeth is similar. Ideal treatments can be done by preventing the complications that may occur through early diagnosis of congenitally missing permanent teeth and a multidisciplinary treatment approach.

Authors' Contributions: HA and AC designed the study, performed the data collection, data analysis and interpretation, wrote the manuscript and reviewed the manuscript. SA and RE performed the data collection, data analysis and interpretation, and wrote the manuscript. All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.

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