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Evaluation of the Prevalence of congenitally permanent tooth agenesis among pediatric patients in the subregion of Antalya

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ABSTRACT

Aim: This research aimed to ascertain the prevalence of congenitally permanent teeth agenesis, excluding third molars, among children residing in the subregion of Antalya, Turkey.
Material and Methods: A retrospective evaluation of panoramic radiographs from 3234 children (1567 females, 1667 males) aged 6 to 12 years was conducted. Participants with systemic illnesses, extracted teeth, ongoing orthodontic interventions, and congenital abnormalities were excluded. Chi-square test and One Sample Chi-square test were employed for comparing qualitative data.
Results: The study cohort exhibited a mean age of 9.02±1.99 years. The prevalence of congenitally permanent teeth agenesis was determined to be 1.9%, with a distribution of 2.3% among females and 1.6% among males, although no statistically significant disparity was observed between genders ($p>0.05$). Notably, a statistically significant difference in the occurrence of tooth agenesis was noted among the jaws ($p<0.05$), with a notably higher incidence observed in the mandibular region compared to the maxillary region ($p<0.05$). Mandibular second premolars represented the most frequently absent teeth, accounting for 77.9% of cases, a finding deemed statistically significant ($p<0.05$). Additionally, maxillary second premolars exhibited a notable prevalence of 15%, a proportion significantly higher than that observed for maxillary lateral incisors, mandibular lateral incisors, mandibular central incisors, and left mandibular first premolars ($p<0.05$).
Conclusion: The prevalence of congenitally teeth agenesis varies across populations. Timely and accurate diagnosis of agenesis of permanent teeth is essential to facilitate the development of a comprehensive long-term treatment strategy and improve prognostic outcomes in affected individuals.

Antalya İlindeki Çocuk Hastalarda Görülen Konjenital Sürekli Diş Eksikliği Prevalansı'nın Değerlendirilmesi

Makale Bilgisi

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ÖZET

Amaç: Bu araştırmanın amacı, Antalya ilinde yaşayan çocuklarda, üçüncü azı dişleri hariç, konjenital sürekli diş eksikliğinin yaygınlığını belirlemektir.
Gereç ve Yöntemler: 6-12 yaş arasındaki 3234 çocuğun (1567 kız, 1667 erkek) panoramik radyografileri retrospektif olarak değerlendirildi. Sistemik hastalığı olan, dişi çekilmiş, ortodontik tedavi gören ve konjenital anormallikleri olan katılımcılar çalışma dışı bırakıldı. Nitel verilerin karşılaştırılmasında ki-kare testi ve tek örneklem ki-kare testi kullanıldı.
Bulgular: Çalışma grubunun ortalama yaşı 9,02±1,99 yıl olarak belirlendi. Doğuştan kalıcı diş eksikliği prevalansı %1,9 olarak saptandı; bu oran kızlarda %2,3, erkeklerde ise %1,6 idi, ancak cinsiyetler arasında istatistiksel olarak anlamlı bir fark gözlenmedi ($p>0,05$). Çeneler arasında diş eksikliği görülme sıklığında istatistiksel olarak anlamlı bir fark belirlendi ($p<0,05$); mandibular bölgede, maksiller bölgeye göre daha yüksek bir insidans gözlendi ($p<0,05$). Mandibular ikinci küçük azı dişleri, vakaların %77,9'unu oluşturacak şekilde en sık eksik olan dişler olarak tespit edildi ve bu bulgu istatistiksel olarak anlamlıydı ($p<0,05$). Ayrıca, maksiller ikinci küçük azı dişleri %15'lik belirgin bir prevalans gösterdi ve bu oran, maksiller lateral kesici dişler, mandibular lateral kesici dişler, mandibular santral kesici dişler ve sol mandibular birinci küçük azı dişlerine göre istatistiksel olarak anlamlı derecede yüksekti ($p<0,05$).
Sonuç: Konjenital diş eksikliği prevalansı, popülasyonlar arasında değişiklik göstermektedir. Sürekli diş eksikliğinin zamanında ve doğru teşhisi, kapsamlı, uzun vadeli tedavi stratejisinin geliştirilmesini sağlamak ve etkilenen bireylerde prognostik sonuçları iyileştirmek için esastır.

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INTRODUCTION

Congenital tooth agenesis denotes an anomaly characterized by the absence of one or more teeth, attributed to various causative factors. Hypodontia, constituting the most prevalent dental anomaly, entails the developmental absence of fewer than six teeth, excluding third molars.[1] A systematic review revealed a global incidence of this anomaly affecting one in every 10 to 20 individuals.[2] Oligodontia, defined by the absence of six or more teeth (excluding third molars), contrasts with anodontia, which denotes the complete absence of all teeth.[3] Variations in tooth agenesis prevalence are contingent upon geographical, societal, and gender factors,[4] with a higher incidence noted in permanent dentition compared to primary dentition [5] eliciting both aesthetic and functional ramifications.[6]

Etiologically, congenital tooth agenesis arises from a multifactorial interplay involving genetic predisposition, environmental influences, and perturbations in dental lamina exposure to physical stimuli during tooth development, alongside anomalies in dental epithelium and mesenchymal cell proliferation.[4] The PAX9 (paired box gene 9), MSX1 (muscle segment homeobox 1), AXIN2 (axis inhibition protein 2), and EDA (ectodysplasin A) genes are critical for proper odontogenesis and are among the most frequently reported genes where mutations can disrupt normal tooth development, leading to congenital tooth agenesis.[5] While anterior region agenesis is purportedly of genetic origin, posterior region absences are often sporadic.[6,7] Such congenital defects stem from a complex interplay of general factors, encompassing genetic predispositions and syndromes, and local factors, including environmental triggers like chemo or radiotherapy, metabolic disorders, hormonal imbalances, trauma, osteomyelitis, accidental extraction of permanent teeth during primary tooth removal,[4,8,9] and endocrine disturbances.[10]

Congenitally tooth agenesis may precipitate malocclusions, periodontal complications, masticatory difficulties, alveolar bone growth deficiencies, speech impairments,[1] diastema, and deep bite,[11] and primary teeth retention, ankylosis, or infraocclusion.[12] Moreover, mandibular body length, height, and arch dimensions are often diminished in individuals with tooth agenesis.[13]

Prevalence rates of congenitally tooth agenesis range between 2.2% and 36.5%, reflecting variations attributable to age demographics, examination methodologies, regional disparities, racial diversity, and gender discrepancies.[14,15] It was also reported that the prevalence of tooth absence is higher among females compared to males.[16,17] Radiographic assessments, including periapical and panoramic radiographs, facilitate identifying the localization and number of absent teeth, while cone-beam computed tomography offers enhanced diagnostic precision.[12]

Treatment planning for congenitally permanent teeth agenesis necessitates a holistic approach, integrating considerations of age, growth and development dynamics, eruption patterns, existing dental configurations, arch space availability, facial profiles, and malocclusion status. Therapeutic modalities encompass restoration or root canal treatment of primary teeth, implantation, autotransplantation, primary teeth extraction, and fixed or removable prosthetic solutions, underscoring the significance of a multidisciplinary approach involving pediatric dentists, orthodontists, oral and maxillofacial surgeons, and prosthodontists.[6]

Scientific evidence suggests an increased prevalence of tooth agenesis in contemporary times compared to historical records.[18]

Investigations conducted within the Turkish population have reported tooth agenesis prevalence rates ranging from 1.77% to 7.54%.[19,20] Despite the abundance of data on the distribution and prevalence of congenital tooth absence, information regarding Turkish children is quite limited. The scarcity of data on this topic has motivated us to undertake this study. This study endeavors to ascertain the prevalence and characteristics of congenitally tooth agenesis among a sizable cohort of systemically healthy, non-syndromic children residing in the subregion of Antalya, Turkey.

MATERIAL and METHODS

Study design and sample

This observational, retrospective epidemiological study was conducted with the approval of the Clinical Research Ethics Committee of University of Health Sciences Antalya Training and Research Hospital (approval date: 17.02.2022; approval number: 4/8). Digital panoramic radiographs taken during dental examinations of patients presenting to Antalya Bilim University Faculty of Dentistry for various dento-maxillofacial issues between 2018 and 2022 were examined.

Inclusion criteria

i. Patients age range between 6 to 12 years old.

ii. Patients without any systemic disease or syndrome.

iii. Patients with high-quality panoramic radiographs.

Exclusion criteria

i. Patients with systemic diseases, genetic syndromes, ongoing orthodontic interventions, cleft lip and palate, or other congenital anomalies.

ii. Patients with previous dental visits or tooth loss due to any reason.

iii. Patients with panoramic radiographs of inadequate quality for optimal evaluation.

A total of 5000 digital panoramic radiographs obtained from January 2018 to January 2022 were selected. Among these, 3234 radiographs met the inclusion criteria, comprising 1567 females and 1667 males.

Data acquisition

All panoramic radiographs were captured using a single device (Dentsply Sirona, Orthopos SL, Germany). Congenital tooth absence, excluding third molars, was diagnosed by two calibrated experienced observers (BBA, RGKE) following an identical protocol. Intraobserver and interobserver method errors were assessed by reexamining 100 radiographs by both observers after a 2-week interval and kappa statistics were found to be higher than 0.90, indicating that all evaluations' reliability was acceptable. Any disagreements were resolved through consensus. A tooth with no crown mineralization on panoramic radiographs was classified as congenital agenesis. Demographic data, including age, gender, and details of missing teeth, were recorded in an Excel file.

Statistical analysis

IBM SPSS Statistics 22 software was employed for statistical analyses. Descriptive statistics (mean, standard deviation, frequency) and the Chi-square test and One Sample Chi-square test, were used to compare qualitative data. Significance was considered at $p<0.05$ level.

RESULTS

A total of 3234 children aged between 6 and 12 years participated in the study, with a mean age of 9.02±1.99 years. The demographic distribution of the study population is summarized in Table 1.

Table 1: Demographic distribution

		n	%
Age	6	464	14.3
	7	425	13.1
	8	476	14.7
	9	475	14.7
	10	449	13.9
	11	492	15.2
	12	453	14.0
Gender	Boy	1667	51.5
	Girl	1567	48.5
	Total	3234	100

Among these children, 63 (1.9%) had congenitally tooth agenesis, with bilateral agenesia observed in 36 cases (57.14%). Predominantly, bilateral absent teeth affected the second premolars, with only one case involving bilateral absent teeth of lateral incisors. The number of absent teeth ranged from 1 to 4, with an average of 1.8±0.9 teeth per affected child. Overall, 113 absent teeth were identified, with 41.3% of children having one absent tooth, 46% having two absent teeth, 4.8% having three absent teeth, and 7.9% having four absent teeth, as depicted in Table 2.

Table 2: Distribution of the absent teeth according to type, gender, side, and age

		n	%	p
Absent tooth	Yes	63	1.9	
	No	3171	98.1	
Number of the absent teeth (n=63)	1	26	41.3	
	2	29	46.0	
	3	3	4.8	
	4	5	7.9	
Jaw (n=113)	Right maxilla	12	10.6	0.000*
	Left maxilla	10	8.8	
	Right mandible	42	37.2	
	Left mandible	49	43.4	
Tooth type (n=113)	Maxiller second premolar	17	15.0	0.000*
	Mandibular second premolar	88	77.9	
	Maxiller lateral	5	4.4	
	Mandibular lateral	1	0.9	
	Mandibular incisors	1	0.9	
	Mandibular first premolar	1	0.9	
Age (n=113)	6	36	31.9	0.000*
	7	12	10.6	
	8	7	6.2	
	9	10	8.8	
	10	12	10.6	
	11	14	12.4	
	12	22	19.5	
Gender (n=113)	Male	58	51.3	0.778
	Female	55	48.7	

One Sample Chi-square test

**p<0.05*

Table 3: Evaluation of tooth agenesis rates categorized by age and gender

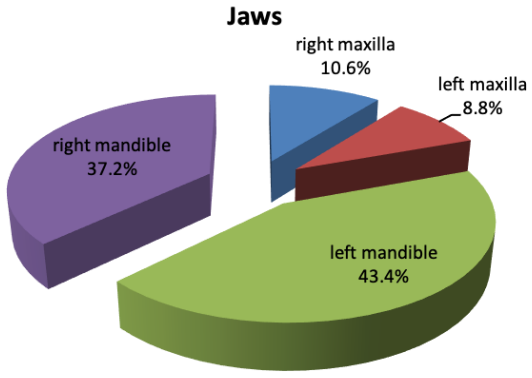
		Absent teeth		
		Exist (n=63)	**Non-exist (n=3171)**	
		n (%)	**n (%)**	**p**
Age	6	20 (4.3%)	444 (95.7%)	0.003*
	7	6 (1.4%)	419 (98.6%)	
	8	5 (1.1%)	471 (98.9%)	
	9	6 (1.3%)	469 (98.7%)	
	10	7 (1.6%)	442 (98.4%)	
	11	7 (1.4%)	485 (98.6%)	
	12	12 (2.6%)	441 (97.4%)	
Gender	Male	27 (1.6%)	1640 (98.4%)	0.163
	Female	36 (2.3%)	1531 (97.7%)	

Chi-square test

**p<0.05*

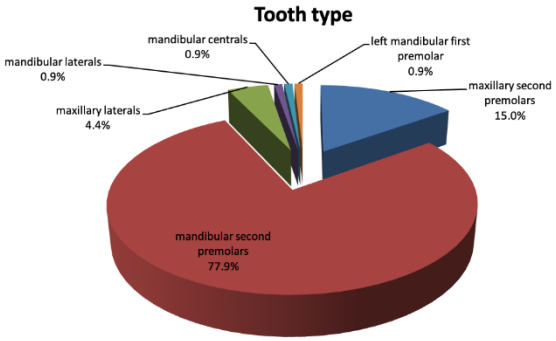
The distribution of absent teeth by jaw is illustrated in Figure 1. Statistical analysis revealed no significant difference in the prevalence of absent teeth among different age groups (p=0.003; p<0.05, Table 3). However, the prevalence of absent teeth in the 6-year-old group (4.3%) was significantly higher than in other age groups. No significant variation in absent teeth prevalence was observed among the remaining age groups. Additionally, the prevalence of absent teeth did not significantly differ between genders, with rates of 1.6% in boys and 2.3% in girls (p>0.05, Table 3).

Figure 1: The distribution of absent teeth by jaw



The prevalence of absent teeth was significantly higher in the right and left mandibular jaws compared to the right and left maxillary jaws (p<0.05). Mandibular second premolars were the most commonly absent teeth, with a statistically significant difference observed (p<0.05). Furthermore, the agenesis rate of maxillary second molars, the second most commonly absent teeth, was significantly higher than other teeth types (p<0.05). The distribution of absent teeth according to tooth type is presented in Figure 2. No instances of oligodontia were identified in the panoramic radiographs analyzed.

Figure 2: The distribution of absent teeth according to tooth type



DISCUSSION

This study conducted an extensive review of patient radiographs at a hospital in Antalya, known for its substantial pediatric patient volume. While the sample size constituted a modest fraction of the Turkish population, it encompassed a significant number of pediatric cases (totaling 3234) and ascertained the prevalence of tooth agenesis

exclusively through the analysis of radiographic images and patient medical histories. To the best of our knowledge, this study represents the first investigation of congenital tooth agenesis among pediatric patients conducted in Antalya Province.

The etiology of congenitally teeth agenesis remains a topic of debate, with various factors potentially contributing to this anomaly. Infections, traumas, early exposure to chemotherapy or radiotherapy, cleft lip-palate, ectodermal dysplasia, Down syndrome, low birth weight, advanced maternal age, multiple births, and infections such as rubella, osteomyelitis, and candidiasis are among the factors speculated to play a role in tooth agenesis.[5] The multifactorial nature of this anomaly likely explains the variation in its prevalence reported in the literature.[10]

Altuğ-Ataç et al.[21] reported hypodontia as the most prevalent dental anomaly in Turkish orthodontic patients. Similarly, studies in Turkey have reported varying prevalence rates of hypodontia, ranging from 2.63% to 7.95%, and oligodontia, ranging from 0.07% to 0.71%.[22] In the present study, the prevalence of hypodontia was 1.9%, indicating discrepancies among studies assessing congenital tooth deficiency. Methodological differences, such as the inclusion or exclusion of third molars, sample size, selection criteria, and age range, may contribute to these variations.

Considering that the mean age of third molar calcification is reported to be 9.5 years,[6] we excluded third molars from our study to prevent overestimation. Notably, the prevalence of missing teeth was significantly higher in the 6-year-old group compared to other age groups ($p<0.05$). This finding aligns with the onset of permanent tooth germ calcification around 3 years of age, with mineralization completed by age 6.[6,17,23] However, some cases have reported delayed mandibular second premolar development, suggesting that inclusion of children aged 7 years and older may be more appropriate for detecting missing teeth,[24] which could be a limitation of our study.

The influence of gender on congenital tooth agenesia remains uncertain. While some studies suggest a higher prevalence in females, attributed to smaller jaw structures, others report no significant gender-based differences.[6,25,26] In their extensive investigation, Aktan et al. explored dental agenesis across six distinct regions of Turkey, noting a greater prevalence of congenitally teeth agenesis among females compared to males in five of these regions.[27] In the present study, although the incidence of teeth agenesia was higher among girls (2.3%) compared to boys (1.6%), no statistically significant difference was observed between genders ($p>0.05$). This outcome aligns with numerous prior publications on the subject.[9,16,28,29]

In accordance with prior investigations, the majority of patients exhibited one (41.3%) or two (46%) absent teeth, with a maximum of four (7.9%) absent teeth observed, and no instances of oligodontia were identified.[9,10,30] Our study findings indicated a higher prevalence of bilateral agenesis compared to unilateral agenesis across all tooth types. Polder et al.[10] reported that upper lateral teeth were the most commonly bilaterally absent teeth, whereas unilateral tooth absence predominantly affected lower second premolars. Similarly, some studies documented upper lateral incisors as the most commonly bilaterally absent teeth.[21,31] However, in alignment with the findings of Gkantidis et al.[29] our study identified second premolar teeth as the most frequent bilateral absent teeth (57.14%). Upon examination of the inter-jaw relationship, no statistically significant disparity was noted between the right and left arches in the present investigation ($p>0.05$). Conversely, a

statistically significant discrepancy was observed in the incidence of absent teeth between the mandibula and maxilla ($p<0.05$), consistent with findings from previous studies.[28,32]

In accordance with a general trend, when few teeth are absent, they tend to be those situated more distally within each dental group.[6,9,33] The findings of this study align with this pattern. A statistically significant discrepancy in the prevalence of absent teeth among different tooth types was observed ($p<0.001$; $p<0.05$), with mandibular second premolars exhibiting the highest prevalence compared to other teeth ($p<0.05$). Consistent with numerous investigations into congenital tooth agenesis, lower second premolars emerged as the most commonly absent teeth, consistent with our findings.[11,16,21,34] However, our study revealed maxillary second premolars as the second most frequently absent teeth, contrasting with findings from diverse populations such as Japanese, Brazilian, Iranian, Venezuelan, and Portuguese studies, where maxillary lateral incisors were reported as the second most commonly absent teeth.[9,28,35,36] Conversely, Rolling S. et al.[30] reported a predominance of mandibular second premolars, maxillary second premolars, and maxillary lateral incisors as the most commonly absent teeth in Danish schoolchildren, a pattern consistent with our study. These findings suggest that ethnicity may influence both the prevalence and type of congenital tooth agenesis, consistent with existing literature.[21,37]

Advancements in imaging and diagnostic techniques have led to an elevated detection rate of absent teeth in recent years, consequently resulting in a more frequent encounter of these anomalies by dentists.[5] Sogukpinar et al.[12] highlighted insufficiencies in the training of Turkish dentists concerning congenital permanent tooth agenesis, stressing the necessity for enhanced theoretical and practical education in this domain.

In cases of permanent tooth agenesis, a comprehensive approach to management during the primary dentition phase is essential to mitigate the potential long-term effects on oral health. Early diagnosis and monitoring through regular dental check-ups and radiographs allow for the timely identification of agenesis and enable the development of tailored interventions that address the specific needs of each patient. The maintenance of space for future teeth, whether through the use of space maintainers or serial extractions, is critical in preserving dental arch integrity and preventing malocclusion. Preservation of primary teeth through conservative care, including preventive restorations, plays a vital role in maintaining function and aesthetics in the absence of permanent successors. Moreover, early orthodontic planning, incorporating both evaluation and the use of appliances to guide tooth eruption, is crucial in optimizing alignment and occlusion outcomes. Prosthetic planning, initiated during early stages, ensures the preservation of bone and soft tissue, which are indispensable for successful future restorative treatments. Additionally, educating patients and parents on proper oral hygiene practices and dietary habits, combined with addressing psychosocial concerns through aesthetic interventions and counseling, is fundamental in supporting the child's overall well-being and self-esteem. Implementing these preventive strategies not only facilitates the management of permanent tooth agenesis but also enhances the likelihood of achieving favorable functional and aesthetic results as the child matures.[5]

CONCLUSION

The prevalence of congenitally permanent teeth agenesis was determined to be 1.9% with a notably higher incidence observed

in the mandibular region compared to the maxillary region. Mandibular second premolars represented the most frequently absent teeth followed by second premolars. This study underscores the significance of congenitally tooth agenesis in pediatric dentistry due to its common occurrence, which can lead to aesthetic and functional challenges, necessitating costly and intricate interventions. Hence, prompt diagnosis of tooth agenesis is imperative to mitigate potential complications, thereby potentially reducing treatment expenses and alleviating psychosocial impacts.

Ethical Approval

The ethics approval for this study was received from the Non-Pharmaceutical and Non-Medical Device Ethics Committee of the Clinical Research Ethics Committee of University of Health Sciences Antalya Training and Research Hospital (17.02.2022-4/8).

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Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: BBA, Data collection and processing: BBA, RGKE, Analysis and interpretation: MB, Literature review: BBA, RGKE, MB, Writing: BBA, RGKE, MB.

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