Prevalence of Third Molar Tooth Agenesis and its Association with Hypodontia in Pediatric Population

Pediyatrik Popülasyonda Üçüncü Molar Diş Agenezisinin Prevalansı ve Hipodonti ile İlişkisi

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ABSTRACT

INTRODUCTION: This study aims to identify differences in third molar (M3) agenesis between genders and jaws and its association with other congenital tooth deficiencies.

MATERIAL and METHODS: The study included patients aged 11–13 years who visited the Dokuz Eylull University Pediatric Dentistry Clinic between December 1, 2022, and January 30, 2024, had no systemic diseases, and possessed panoramic radiographs of diagnostic quality. Congenital absence of M3 and other teeth were recorded. Data were analyzed using SPSS 24.0, and statistical evaluation was performed with the chi-square test. Significance was set at p<0.05.

RESULTS: A total of 630 patients, 325 (51.6%) females, were evaluated. Agenesis was observed in one or more M3 teeth in 136 (21.5%) patients, and 4.6% had agenesis in all M3 teeth. M3 agenesis prevalence was higher in the maxilla (11.0%) than in mandible (7.5%) (p<0.001). More females (11.9%) than males (9.6%) had one or more M3 teeth absent, but the difference was not statistically significant (p< 0.348). Hypodontia in other permanent teeth was detected in 31.3% of patients with four M3 agenesis (p<0.001).

CONCLUSION: Early detection of M3 and other tooth agenesis in children is crucial for planning future treatments for both dentists and patients.

Keywords: *Prevalence, Agenesis, Third molar, Hypodontia*

ÖZ

GİRİŞ: Bu çalışmanın amacı, üçüncü molar (M3) dişlerin agenezisinin cinsiyet ve çeneler arasındaki farklılıklarını saptamak ve diğer konjenital daimi diş eksiklikleri ile olan ilişkisini belirlemektir.

YÖNTEM ve GEREÇLER: Çalışmaya, 01.12.2022 ile 30.01.2024 tarihleri arasında, Dokuz Eylül Üniversitesi Çocuk Diş Hekimliği Kliniği'ne başvuran, herhangi bir sistemik hastalığı olmayan, uygun diagnostik kaliteye sahip panoramik radyografileri bulunan 11-13 yaş aralığındaki tüm hastalar dahil edildi. Panoramik radyografik görüntülerin incelenmesi sonrası, M3 dişlerin ve diğer dişlerin konjenital eksiklikleri kaydedildi. Verilerin analizinde SPSS 24.0 programı kullanıldı, ki-kare testiyle istatistiksel olarak değerlendirildi ve anlamlılık düzeyi p<0,05 olarak kabul edildi.

BULGULAR: 325'i (%51,6) kız olmak üzere toplamda 630 hastanın bulguları değerlendirildi. 136 (%21,5) hastanın bir veya daha fazla M3 dişinde agenezi gözlenirken, %4.6'sında tüm M3 dişlerinde agenezi olduğu saptandı. M3 diş agenezisi görülme prevalansı maksillada (%11,0) mandibulaya (%7,5) göre daha yüksek bulundu (p<0.001). Bir veya birden fazla M3 diş eksikliği kadınlarda (%11,9), erkeklere (%9,6) oranla daha yüksek gözlenmesine rağmen; fark istatistiksel olarak anlamlı bulunmadı (p<0.348). Dört adet M3 agenezisi kaydedilen hastaların %31,3'ünde diğer daimi dişlerinde de bir ya da daha fazla hipodonti tespit edildi, fark istatistiksel olarak anlamlı bulundu (p<0.001).

SONUÇ: Çocuklarda M3 diş agenezisi ve diğer konjenital diş agenezilerinin erken yaşta tespit edilmesi ileriye yönelik uygulanacak tedaviler açısından diş hekimleri ve hastalar için önem taşımaktadır.

Anahtar Kelimeler: *Prevalans, Agenezis, Üçüncü molar, Hipodonti*

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INTRODUCTION

The third molar (M3) teeth are the last molars to erupt in the oral cavity. [1] The eruption of these teeth typically begins during late adolescence (ages 14-23) and may continues into adulthood.[2] As the last permanent teeth to develop in the dentition, and due to their clinical implications in oral health and treatment planning, they have been a subject of extensive dental research.[1,2]

A comprehensive understanding of factors such as their positional variations, morphological characteristics, number, and developmental stages is crucial, as these elements can significantly influence diagnostic and therapeutic decision-making in dental practice.[2-3] Several studies have evaluated the development and calcification stages of M3 teeth in children at various ages.[4-6] Despite ethnic variations, it has been reported that crown calcification of the M3s generally initiates between the ages of 7-10 years, completed by 12-16 years.[5,7]

In studies examining congenital tooth agenesis across different populations, the prevalence of permanent tooth agenesis is typically reported with the exclusion of third molars (M3).[8] The reason for this exclusion is that the absence of M3 teeth is more commonly observed than the absence of other permanent teeth.[2] Furthermore , studies specifically focusing on M3 agenesis have shown that its prevalence varies significantly between populations, ranging from 1.9% to 40%.[1,2,7,9] In a meta-analysis conducted by Carter and Worthington[9], the global prevalence of M3 agenesis was reported to be an average of 22.6%.

There are studies that indicate a gender-based difference in M3 agenesis, as well as studies that report no such difference.[2,10-13] Alamoudi et al.[10] and Pamukcu et al.[13] have both reported that the likelihood of one or more M3 agenesis is higher in females compared to males.

Studies have indicated that genetic factors play a significant role in M3 agenesis.[14-17] Genome-wide association studies have identified several candidate genes, such as MSX1, PAX9, and AXIN2, that are involved in the development of various teeth, including the third molar.[14,15] Some researchers have reported that PAX9 gene mutations are implicated in cases of non-syndromic hypodontia and/or oligodontia, and that M3 agenesis is associated with these mutations.[16,17] Other studies suggest that mutations in the MSX1 gene, in particular, are associated with the agenesis of second premolars and third molars.[14,15] Additionally, a study on monozygotic and dizygotic twins has demonstrated that genetic factors play a significant role in M3 agenesis, with these factors strongly influencing the phenotype.[18]

While genetic predisposition plays a significant role, environmental factors such as nutrition, oral hygiene, and overall health have also been shown to influence tooth development. Additionally, craniofacial structure and tooth size have been linked to the presence or agenesis of third molars.[19]

Alamoudi et al.[10] suggested that individuals with agenesis of other permanent teeth have a higher likelihood of agenesis of all four third molars, and that the absence of other teeth may serve as an indicator for the absence of third molars. Garn et al.[20] reported that the presence of one or more M3 agenesis increases the likelihood of other permanent tooth agenesis by 13 times. Additionally, Endo et al.[21] demonstrated that as the severity of M3 agenesis increases, the frequency of hypodontia also rises.

This study aims to examine the relationship between M3 agenesis and congenital agenesis of other permanent teeth in pediatric patients, as well as the prevalence of M3 agenesis based on gender and jaw location. Additionally, by reviewing the current literature on M3 agenesis, the study seeks to contribute to the growing knowledge in pediatric dentistry and help develop effective management strategies for children affected by this condition.

MATERIAL AND METHODS

This study, designed as a retrospective cross-sectional study, included patients aged 11–13 years who visited the Dokuz Eylul University Pediatric Dentistry Clinic between December 1, 2022, and January 30, 2024, had no systemic diseases, and possessed panoramic radiographs of diagnostic quality. A total of 647 panoramic radiographs were obtained using a Planmeca Proone device, with an exposure setting of 64 kV/7mA and an exposure time of 8.9 seconds, following the manufacturer's standard protocols for pediatric imaging. Of these, 17 radiographs were excluded due to motion artifacts that impaired diagnostic quality, leaving 630 patient images available for analysis. Two pediatric dentists (GK, GB) performed repeated measurements on 25 panoramic radiographs, one week apart, which were not included in the study. This procedure standardized the methodological errors. Cohen’s Kappa scores were determined to be 0.95 and 0.85. In addition to age and gender, the congenital agenesis of permanent and M3 teeth was recorded in the patient files. Ethical approval for the study was obtained from the Dokuz Eylul University Non-Interventional Ethics Committee (Decision number: 2023/23-23).

Statistical Analysis

The statistical analysis of the data was performed using SPSS 24.0 software (SPSS Inc., Chicago, IL, USA). Descriptive statistics, including percentage distribution, mean (±) values, and standard deviation, were calculated. The analysis of categorical variables was conducted using the Chi-square test and Fisher's exact test. Inter-observer agreement was assessed using

Cohen's Kappa analysis. A p-value of <0.05 was considered statistically significant.

RESULTS

The clinical and radiographic (panoramic) findings of 630 patients, including 325 females (51.6%) and 305 males (48.4%), with ages ranging from 11 to 13 years (mean age: 12.13 ± 0.78), were analyzed. Among the patients whose panoramic radiographs were examined, 78.5% had all M3 teeth present, while 21.6% (136 patients) exhibited agenesis of one or more M3 teeth. Agenesis of all M3 teeth was identified in 4.6% (29 patients) of the cases. The prevalence of agenesis in one or two M3 teeth was found to be 7.1%, while agenesis in three M3 teeth was observed in 2.7% of the patients (Table 1).

Table 1: Status of Third Molar Teeth in Patients

Third Molar(M3) Teeth	N (%)
Agenesis of a Single M3 Tooth	45 (%7,1)
Agenesis of Two M3 Teeth	45 (%7,1)
Agenesis of Three M3 Teeth	17 (% 2,7)
Agenesis of Four M3 Teeth	29 (% 4,6)
All M3 Teeth Present	494 (%78,5)
TOTAL	630 (%100)

* M3: Third molar

The most common M3 tooth agenesis was observed in the upper right M3 (15.1%), followed by the upper left M3 (13.2%), lower left M3 (10.2%), and lower right M3 (9.2%) (Table 2). The prevalence of M3 tooth agenesis in the maxilla was found to be higher than in the mandible, with the difference being statistically significant ($p < 0.001$) (Table 3).

Table 2: Agenesis of Third Molar (M3) Teeth in Patients

Agenesis of Third Molar (M3) Teeth	N (%)
Maxillary right M3 (18)	95 (%15,1)
Maxillary left M3 (28)	83 (%13,2)
Mandibular left M3 (38)	64 (%10,2)
Mandibular right M3 (48)	58 (%9,2)
Maxillary M3(18-28)	69 (%11)
Mandibular M3 (38-48)	47 (%7,5)
Upper right-lower right side (18-48)	35 (%5,6)
Upper left-lower left side (28-38)	40 (%6,3)
TOTAL	630 (%100)

* M3: Third molar

Table 3: Status of Third Molar (M3) Teeth in the Maxilla and Mandible

Third Molar (M3) Teeth	Present (N %)	Absent (N %)	P
Maxillary M3 (18-28)	561(%89,0)	69 (%11,0)	0.000*
Mandibular M3 (38-48)	583 (%92,5)	47 (%7,5)	

Chi-square test, *p<0.001

No statistically significant difference was found between gender and the prevalence of M3 tooth agenesis or congenital tooth agenesis (hypodontia) in other teeth. M3 tooth agenesis was slightly more common in females (11.9%) than in males (9.7%) ($p = 0.348$) (Table 4).

Table 4: Distribution of Third Molar Teeth (M3) by Gender and Prevalence of Hypodontia in Other Teeth

Gender	Female (N %)		Male (N %)		P
	Present	Absent	Present	Absent	
M3 Tooth Agenesis (One or More)	75(%11,9)	250(%39,6)	61(%9,7)	244(38,7)	0.348
Upper right M3 (18)	276 (%43,8)	49 (%7,8)	259 (%41,1)	46(%7,3)	0.999
Upper left M3 (28)	280 (%44,4)	45 (%7,1)	267 (%42,4)	38 (%6,0)	0.607
Lower left M3 (38)	293 (%46,5)	32 (%5,1)	273 (%43,3)	32 (%5,1)	0.789
Lower right M3 (48)	299 (%47,5)	26 (%4,1)	273 (%43,3)	32 (%5,1)	0.280
Maxillary M3 (18-28)	290 (%46,0)	35 (%5,6)	271 (%43,0)	34 (%5,4)	0.879
Mandibular M3 (38-48)	305 (%48,4)	20 (%3,2)	278 (%44,1)	27(%4,3)	0.198
Upper right- Lower right M3 (18-48)	310 (%49,2)	15 (%2,4)	285 (%45,2)	20 (%3,2)	0.288
Upper left- Lowe left M3 (28-38)	306 (%48,6)	19 (%3,0)	284 (%45,1)	21 (%3,3)	0.593
Agenesis of Four M3 Teeth	12 (%1,9)	313(%49,7)	17 (%2,7)	288 (%45,7)	0.260
Agenesis of Three M3 Teeth	10 (%1,6)	315 (%50)	7 (%1,1)	298 (%47,3)	0.545
Agenesis of Two M3 Teeth	24 (%3,8)	301(%47,8)	21 (%3,3)	284 (%45,1)	0.808
Agenesis of a Single M3 Tooth	29 (%4,6)	296(%47,0)	16 (%2,5)	289 (%45,9)	0.073
Hypodontia in Other Permanent Teeth	18 (% 2,9)	307(%48,7)	14(%2,2)	291(% 46,2)	0.588

Chi-square test, *p<0.001

In our study, hypodontia (one or more missing teeth) was detected in 5.1% (32) of the 630 patients. Among patients with agenesis of all four M3 teeth, 31.3% (10 patients) demonstrated hypodontia in one or more permanent teeth, and this difference was statistically significant (p<0.001). In the 10 patients with agenesis of all four M3 teeth, congenital agenesis was observed in a total of 20 teeth, including eight maxillary laterals, five mandibular second premolars, and seven maxillary second molars. No statistically significant difference was found between patients with agenesis of one, two, or three M3 teeth and the occurrence of hypodontia in permanent teeth (p=0.840, p=0.615, p=0.203, respectively) (Table 5).

Table 5: Presence of Tooth Agenesis (Hypodontia) in Patients with M3 Tooth Agenesis

	Hypodontia		P
	Present (N %)	Absent (N %)	
Agenesis of Four M3 Teeth	10 (%1,6)	19(%3,0)	0.000*
Agenesis of Three M3 Teeth	2 (%0,3)	15 (%2,4)	0.203
Agenesis of Two M3 Teeth	3(%0,5)	42(%6,7)	0.615
Agenesis of a Single M3 Tooth	2 (%0,3)	43 (%6,8)	0.840

Chi-square test, *p<0.001

DISCUSSION

In this study, panoramic radiographs of children aged 11–13 years, who had no systemic diseases, were examined, and the relationship between M3 tooth agenesis and hypodontia in other permanent teeth was assessed. It has been suggested that genetic, epigenetic, and environmental factors play a significant role in the development of permanent tooth agenesis, with these factors interacting with each other.[2,22] Among permanent teeth, agenesis is most commonly observed in M3 teeth (5.3%–56.0%).[9-15] The agenesis of these teeth can be associated with a syndrome, but it can also occur without any specific underlying cause.[2,9-15]

In our study, the prevalence of one or more M3 agenesis was found to be 21.5% (136 patients), while the prevalence of hypodontia in permanent teeth was 5.1% (32 patients). In a study by Karaca and Çapan[7], conducted on 1460 children within a similar age group, the prevalence of one or more M3 tooth agenesis was reported to be 35.6%. Atay et al.[12,] in their study of 1471 patients, found the prevalence of M3 tooth agenesis to be 10.3%, while the prevalence of hypodontia in other permanent teeth was 2.7%. These differences may be attributed to variations in sample size and the genetic diversity of the populations studied. Specifically, the broader population examined in the study by Karaca and Çapan[7] may have contributed to the higher prevalence of agenesis observed.

In a study conducted by Sujon et al.[23] on 5923 patients in Malaysia, the prevalence of M3 tooth agenesis was found to be 38.4%, while the prevalence of hypodontia in other permanent teeth was 3.1%. In our study, consistent with the findings of previous researchers, we detected hypodontia in other permanent teeth in 31.3% of patients with agenesis of all four M3 teeth, and this difference was statistically significant. This suggests that the early diagnosis of M3 agenesis in pediatric patients not only helps identify the absence of these teeth but also aids in the detection of potential agenesis in other permanent teeth. In clinical practice, it is crucial to conduct thorough radiographic and clinical evaluations to assess the absence of other teeth in children with M3 agenesis.

In patients with agenesis of all four M3 teeth, we found that the most commonly absent permanent teeth were the maxillary lateral incisors, followed by the maxillary second molars and mandibular second premolars. Similarly, previous studies have reported that maxillary lateral incisor agenesis is more frequently observed in patients with agenesis of all four M3 teeth.[1,24] Scheiwiller et al.[24] found that the prevalence of hypodontia in other permanent teeth was 2.5 times higher in individuals with agenesis of one or more M3 teeth compared to those without M3 agenesis.

In our study, although the prevalence of M3 tooth agenesis was higher in females (11.9%) compared to males (9.6%), no statistically significant difference was observed. This may suggest that gender differences in younger age groups might not yet be pronounced, or that the sample size was insufficient to detect such a difference. The literature includes studies reporting no gender differences in M3 agenesis,[2] a higher prevalence in females[9,10] or equal prevalence in both genders.[25]

In our study, the prevalence of one or more M3 tooth agenesis was found to be 21.5%, with agenesis observed in one or two teeth at rates of 7.1%, three teeth at 2.7%, and four teeth at 4.6% (1 = 2 > 4 > 3). In their meta-analysis, Carter and Worthington[9] reported that agenesis of one or two M3 teeth is more common, while the prevalence of agenesis in three or four teeth is lower. Atay et al.[12] found the prevalence of M3 agenesis in four teeth to be 4.3%, which is very similar to our finding of 4.6%. Endo et al.[21] indicated that the highest prevalence of M3 agenesis occurred in two teeth, while the lowest was in three teeth (2 > 1 > 4 > 3), whereas Sujon et al.[23]

reported the highest prevalence in one M3 tooth and the lowest in three M3 teeth (1 > 2 > 4 > 3). As in many studies [9, 14, 21, 23, 24], M3 agenesis in our study was most rarely observed in three teeth.

In our study, the prevalence of M3 agenesis was found to be higher in the maxilla than in the mandible. Similar findings have been reported in studies conducted both in our country [2,7,12,13] and internationally [9,23,24], where the rate of M3 agenesis is also higher in the maxilla compared to the mandible. Possible explanations for this include developmental differences between the maxilla and mandible, as well as genetic factors.

When examining M3 tooth agenesis on the right and left sides of the jaws, it was found that the highest prevalence occurred in the upper right jaw (15.1%), followed by the upper left jaw (13.2%), lower left jaw (10.2%), and lowest in the lower right jaw (9.2%). However, the difference was not statistically significant. Sujon et al.[23] reported no significant difference between the right and left sides of the jaws, with the highest frequency of M3 agenesis found in the upper right jaw and the lowest in the lower left jaw.

Since this study uses a retrospective and cross-sectional design, the data obtained only provide a snapshot of the population included. Therefore, the long-term effects of third molar (M3) agenesis or its impact on dental development in later years could not be assessed. Additionally, the role of genetic factors was not thoroughly examined in our study, as no genetic analysis was performed.

Future studies should involve broader age groups and diverse ethnic populations to explore how third molar (M3) agenesis varies with age and genetic factors. Additionally, the potential connections between M3 agenesis, temporomandibular joint disorders, occlusal issues, and jaw irregularities should be examined through more detailed clinical and genetic research. Genome-wide association studies could help identify genetic markers linked to M3 agenesis, providing a deeper understanding of this condition. Finally, longitudinal studies should investigate how M3 agenesis affects oral health in the long term.

CONCLUSION

In our study, hypodontia was detected in approximately one-third of patients with agenesis of all four M3 teeth. This finding suggests that M3 agenesis may not be limited to the third molars but could also be associated with the agenesis of other permanent teeth. Early diagnosis of M3 agenesis and associated hypodontia in pediatric dentistry is crucial for comprehensive oral care and treatment planning.

Early evaluations should be conducted in individuals with M3 agenesis to assess potential spaces that may require prosthetic, implant, or orthodontic interventions in the future. Furthermore, monitoring temporomandibular joint disorders and occlusal issues in these patients may help facilitate the implementation of preventive treatment strategies.

Finally, considering the potential genetic predisposition of M3 agenesis, it is important to examine family members, as this may facilitate the early diagnosis of similar deficiencies. Our study highlights that identifying the relationships between M3 agenesis and other permanent tooth agenesis can contribute to patient diagnosis and treatment, as well as improve oral health outcomes.

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