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ORIGINAL ARTICLE

Comparison of the dental anomaly frequency in patients with and without mandibular second premolar agenesis

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Abstract *Background/purpose:* There is remarkably little information in the literature comparing the prevalence of dental anomalies associated with mandibular second premolar (MP2) agenesis with control groups. The aim of the present study was to investigate the frequency of dental anomalies associated with agenesis of the MP2, and to compare the results with control groups.
Materials and methods: A total of 4812 panoramic radiographs (also called orthopantograms, OPGs) and dental casts were used to assess the presence of MP2 agenesis and 245 patients (age range: 11–18 years) with MP2 agenesis were included in the study. OPGs and dental casts were used to assess the presence of the following dental anomalies: (1) tooth agenesis excluding third molars; (2) third molar agenesis; (3) supernumerary teeth; (4) taurodontism of permanent teeth; and (5) microdontia of maxillary lateral incisors.
Results: The prevalence of MP2 agenesis was found to be 5.1% (245/4812) with no statistical sex difference ($P = 0.209$). The prevalence of tooth agenesis excluding the third molars ($P < 0.05$), third molar agenesis ($P < 0.05$), taurodontism ($P < 0.001$), and microdontia of maxillary lateral incisors ($P < 0.05$) were significantly greater in patients with agenesis of MP2.
Conclusion: Tooth agenesis, microdontia of maxillary lateral incisor, and taurodontism are frequently associated with agenesis of MP2 as compared with a well matched control group and different populations.
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Introduction

Hypodontia, which is a common dental anomaly, can causes poor aesthetics, functional problems, and some oral health problems, such as food packing. Genetics play a fundamental role in the etiology of the condition.[1] Several studies have suggested that around half of the relatives of children with hypodontia presented with tooth agenesis and identified a mutation in gene *MSX1* on chromosome 4p in families with agenesis of all second premolars and third molars.[2,3] Several studies have been published of the prevalence of hypodontia in general[4–7] and in pediatric populations in particular.[8–10]

The data for hypodontia, excluding the third molar, in both sexes combined, varies from 0.3% in the Israeli population[11] to 11.3% in the Irish population.[12] This anomaly was found to be more commonly present in orthodontic populations.[13–16] The mandibular second premolar (MP2) is clearly the most frequently absent tooth excluding third molar agenesis,[8–10,17] followed by the maxillary lateral incisor and the maxillary second premolar. The reported prevalence of agenesis of the MP2 ranges from 1.55% to 2.41%.[15,17]

Tooth agenesis is often associated with other dental anomalies, such as taurodontism, microdontia, and delayed dental development.[18–20] These dental anomalies commonly appear together in the same patient; one possible explanation is that a single genetic defect causes a series of different phenotypic expressions. Celikoglu et al[21] found that patients with third molar agenesis had an increased prevalence of agenesis of other permanent teeth, microdontia of the maxillary lateral incisors, and total dental anomalies. Previous studies[22,23] have reported a high degree of association in the occurrence of agenesis of premolars, microdontia of maxillary lateral incisors, and enamel hypoplasia and infraocclusion of deciduous molars, suggesting that these anomalies present a common genetic etiology.

Although recent studies[21,24–26] have reported associations between tooth agenesis and some other dental anomalies, to our knowledge, no study has compared the frequency of dental anomalies between the patients with and without MP2 agenesis. Thus, there is remarkably little information in the literature comparing the prevalence of other dental anomalies associated with MP2 agenesis with the prevalence of those anomalies in general populations and in control groups without MP2 agenesis.

The aim of this study was, therefore, to investigate the frequency of associated dental anomalies such as hypodontia, supernumerary teeth, taurodontism, and microdontia in children with agenesis of the MP2, and to compare the results with the published data in different populations and normal case controls including patients without MP2 agenesis.

Materials and methods

The clinical records [case histories and panoramic radiographs or orthopantograms (OPGs)] of the patients referred to the Departments of Pediatric Dentistry and Orthodontics, Erciyes and Karadeniz Technical Universities were used to determine agenesis of MP2. If an accurate diagnosis of the agenesis could not be made from these records, the patient was excluded from the study (2 patients). All patients in this study were Caucasian and were free from developmental anomalies such as a cleft lip or palate, Down's syndrome, or ectodermic dysplasia. To reduce radiographic misinterpretation, teeth with blurred images (3 images) were not included in the study. Finally, the data of 4812 patients were included in the study.

A total of 245 children and adolescents with agenesis of MP2, between 11 and 18 years of age, were included in the study. For every patient with hypodontia, a case-control individual matching for sex and age to within 0.5 years was randomly selected from the archive of the department (Table 1). OPGs and dental casts were used to assess the presence of the following dental anomalies: (1) tooth agenesis excluding third molars; (2) third molar agenesis; (3) supernumerary teeth; (4) taurodontism of permanent teeth; and (5) microdontia of maxillary lateral incisors.

The critical age of 14 years was considered to be the point of confirmation of the absence of third molars.[27,28] This criterion was used to restrict the sample for evaluation of third molar agenesis to only those with diagnostic records from 14 years of age onwards. A third molar was classified as missing when there was no evidence in the records that it had been extracted and when there was no sign of mineralization of the third molar tooth crown on the OPGs.[21] The maxillary lateral incisor was considered as presenting microdontia when the maximum mesiodistal crown diameter was smaller than the same dimension of the opposing mandibular lateral incisor in the same patient. Permanent mandibular first molars were employed for assessment of taurodontism in this study, because it has been established that these teeth are minimally distorted on the OPGs. To assess taurodontism, the crown body and root lengths of both permanent mandibular first molars in every patient were measured, using the method of Seow and Lai.[29] Supernumerary tooth was defined as the existence of an excessive number of teeth relative to the normal dental formula (32 in the permanent dentition).[30]

All radiographs were reviewed and discussed by the panel in a negatoscope for the presence of MP2 agenesis and associated dental anomalies. The data were analyzed with Pearson Chi-square test and the prevalence of MP2 agenesis in the study sample was compared with control group and published data.[2,20,30–32] The Statistical Package

Table 1 Demographics of children with mandibular second premolar agenesis (MP2) and the control groups.

Individual groups	Sex[a]	*N*	Age (yr)	
			Mean ± SD	Range
Children with agenesis of MP2	Girls	136	13.7 ± 2.66	11.3–17.9
	Boys	109	12.3 ± 1.35	11.0–17.5
Control groups	Girls	136	13.5 ± 2.59	11.1–17.7
	Boys	109	12.5 ± 1.42	11.0–17.6

N = number; SD = standard deviation.
[a] No statistically significant difference in the distribution of MP2 agenesis between sexes.

Table 2 Prevalence of tooth agenesis and associated dental anomalies in patients with mandibular second premolar (MP2) agenesis, comparison with published data and control group.

Dental anomaly	Our data	Published data		Control group	P	
					SG-GP	SG-CG
Tooth agenesis (excluding third molars)	12.6% (31/245)	5.0% (53/1064)	Grahnen (1956)[2]	2.8% (7/245)	0.000	0.000
Third molar agenesis	42.4% (43/101)	17.3 (61/351)	Celikoglu et al (2010)[32]	20.8% (21/101)	0.000	0.001
Supernumerary teeth	1.6% (4/245)	1.2% (42/3491)	Celikoglu et al (2010)[30]	1.6% (4/245)	NS	NS
Taurodontism	17.1% (42/245)	5.6% (67/1200)	Shifman and Chanannel (1978)[20]	6.1% (15/245)	0.000	0.000
Small maxillary lateral incisor	9.8% (24/245)	4.7% (47/1000)	Baccetti (1998)[31]	4.4% (11/245)	0.002	0.021

NS = not significant; SG-GP = comparison of study group and general population; SG-CG = comparison of study group and control group.

for Social Sciences (version 11.5; SPSS Inc, Chicago, IL, USA) was used and the significance level was $P < 0.05$. To determine errors in the method, approximately 10% of the individuals with or without agenesis of MP2 were selected at random and reevaluated by another author 3 weeks after the initial survey. The agreement between the two readings was 100% confirming the reproducibility and reliability of the assessments.

Results

Of the 4812 individuals (2483 females, 2329 males) examined, 245 patients (136 females, 109 males) were found to have MP2 agenesis (Table 1). Therefore, the prevalence of MP2 agenesis in our sample was 5.1% (5.4% for females and 4.6% for males). The difference between the sexes was not statistically significant ($x^2 = 1.58$; $P = 0.209$).

Bilateral agenesis of MP2 occurred in 106 individuals (43.2%) and unilateral agenesis in 139 patients (56.8%). Of those presenting with unilateral agenesis of the MP2, 67 (48.2%) were on the right side and 72 (51.8%) on the left side. No sex difference was observed in the side-to-side distribution of MP2 agenesis ($P > 0.05$).

The prevalence rates of dental anomalies associated with MP2 agenesis in the present study were compared with several references in the general population and control group (Table 2). The prevalence of tooth agenesis excluding the third molar ($P < 0.05$), third molar agenesis ($P < 0.05$), taurodontism ($P < 0.001$), and microdontia of the maxillary lateral incisors ($P < 0.05$) were significantly more common in this study sample than in the published data of general populations and control groups. There was, however, no statistically significant difference in the prevalence of supernumerary teeth in our sample as compared with the published data of general populations and control groups ($P > 0.05$). Taurodontism was more commonly found in the maxilla (27/42) than in the mandible (15/42). The most taurodont molar teeth were found to be maxillary second molars, followed by mandibular second molars, maxillary first molars, and mandibular first molars. A supernumerary tooth was observed in four patients: one had a mesiodens, and the other three had supernumerary mandibular premolars.

Discussion

We investigated the prevalence of MP2 agenesis in a large population and found that approximately 5% of our patients had one or more MP2 agenesis. The prevalence of MP2 agenesis in this study was higher than the data (MP2 agenesis; 2.91–3.22%) reported by Polder et al,[17] who investigated the prevalence of tooth agenesis from 33 studies published to determine the frequency of tooth agenesis in different populations. It is impossible to determine the contributions made by ethnic or other factors because of the differences in the methods of sampling and examination.[8]

Consistent with previous studies, we found a higher prevalence of MP2 agenesis in females.[17,33–35] In addition, the occurrence of unilateral agenesis was more frequently observed (56.8%); when one second premolar was missing, it was likely to be on the right side, in agreement with the systematic review of Polder et al.[17] The authors stated that unilateral agenesis of MP2 was calculated as 52.3–56.5% (95% CI). These demographic data might be affected by the distribution of the males and females included in the studies and racial differences of the populations studied.

Previous studies [16,19,21,24,36–41] have shown that tooth agenesis may be related to other dental anomalies, such as microdontia or the development of peg-shaped incisors, taurodontism, transposition, supernumerary teeth, ectopic eruption, and retained primary teeth. However, the examination of agenesis of MP2 and the associated dental anomalies was limited in the literature. A unique study investigating the associated dental anomalies with premolar agenesis was published by Garib et al.[25] However, the patients included in their study had both maxillary and MP2 agenesis giving uncertain information about the association with MP2 agenesis and other dental anomalies. In addition, they compared their findings with reference values of published data but not with a well matched control group of patients without tooth agenesis and representing the same characteristic features.

The most commonly observed dental anomaly associated with the agenesis of MP2 was found to be agenesis of the third molar, with a prevalence of 42.4%. In agreement with our study, Garib et al[25] found that the missing tooth was usually the third molar with a frequency of 48.1%. In the

1960s, Garn and Lewis[28] observed that patients with third molar agenesis presented an increased prevalence of other missing permanent teeth. The prevalence of agenesis of permanent teeth in the group with third molar agenesis was 13 times higher than the prevalence of agenesis in the control group. Celikoglu et al[21] found that the prevalence of agenesis of permanent teeth in the group with third molar agenesis was 12 times higher than in the control group. Garib et al[25] reported that 21% of the patients with agenesis of maxillary and MP2 agenesis had other permanent teeth missing, excluding the third molar, a four-fold increase in prevalence compared with the general population. In accordance with this, we found approximately two-fold and five-fold of other tooth agenesis excluding third molar increases compared with the general population and control group, respectively.

Data regarding supernumerary teeth in our sample were not statistically different from the published data[30] and the control group. This suggests that these anomalies have different or independent etiological factors. This is conceivable, considering that hypodontia is a hypoplastic dental anomaly, whereas hyperdontia is a hyperplastic anomaly. These results corroborate the findings of Baccetti,[23] Garib et al,[25] and Celikoglu et al,[21] who did not find higher frequencies of supernumerary teeth in samples with agenesis of the second premolar and third molars.

Another important finding in this study was the higher percentage of taurodontism in patients with the MP2 agenesis, compared with the general population and control group. To date, we have found no published study examining MP2 agenesis and associated taurodontism, even after conducting a bibliographic search in Medline using PubMed and the key words/phrases "taurodontism", "hypodontia", "agenesis," "second premolar agenesis", "dental anomalies", and "prevalence of dental anomalies". Therefore, it is difficult to make a true comparison between our findings and those of other clinicians. Only a few studies in the literature have addressed the increased occurrence of taurodontism with tooth agenesis.[19,29] In accordance with our results, Kan et al[19] and Seow et al[29] found a strong association between hypodontia and taurodontism in nonsyndromic children.

Compared to the general population and the control group, the patients with agenesis of MP2 presented a significantly higher prevalence of microdontia of the maxillary lateral incisors. The results showed that 9.8% (24/245) of the patients with MP2 agenesis also presented reduced size of maxillary lateral incisors. These results corroborate previous studies[21,41,42] and suggest that agenesis and microdontia are different manifestations of the same genetic defect, since these phenotypes are frequently associated. Celikoglu et al[21] observed a general reduction in tooth size in patients with third molar agenesis. Brook[42] analyzed families of patients with dental anomalies and observed that agenesis and microdontia often occur concomitantly. In addition, Baccetti[23] and Garib et al[25] found that 20% and 18% of patients with tooth agenesis had small-size maxillary lateral incisors, respectively. These variations in the data may provide part of the explanation for variations between ethnic groups and the specialty of the patients included to our study (only MP2 agenesis present).

Patients who are missing permanent teeth may suffer from a reduced ability to chew, inarticulate pronunciation, an unfavorable appearance and oral health problems, such as food packing.[8,43] The treatment of children with tooth agenesis represents an interdisciplinary challenge for pedodontics and orthodontics. When anterior teeth are missing, aesthetic features of treatment become more important. Therefore, the clinical implications of patterns of associated dental anomalies are important, since early detection of a single dental anomaly (such as the emergence of a conical maxillary lateral incisor, supernumerary tooth, or radiographic evidence of second premolar agenesis) may call the attention of professionals to the possible development of other associated anomalies in the same patient or in the family, allowing timely preventive, prosthetic, and orthodontic intervention in children and young people.

In conclusion, there is a strong association between agenesis of the MP2 and agenesis of other permanent teeth, as well as increased likelihood of other tooth anomalies, such as microdontia of the permanent maxillary lateral incisor and taurodontism of other molars. There is, however, no association between MP2 and supernumerary teeth.

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