

Status of retained deciduous second molars in subjects with agenesis of second premolars in relation to age



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Abstract

Background Preservation of retained deciduous second molars (DM2) can be applied to treat congenital absence of second premolars (PM2). However, the consequences of caries and progressing root resorption or infraocclusion may affect their survival.

Aim To evaluate the presence and status of retained DM2 without permanent successors in relation to age.

Method Panoramic radiographs of individuals >10 years of age with agenesis of at least one PM2 were evaluated and divided into three groups according to age. The presence and location of retained DM2, caries/restorations, infraocclusion and root resorption were investigated.

Results A total of 131 subjects with PM2 agenesis were included (mean age: 13 years 11 months). The majority were missing one or two PM2. In total, 174 retained DM2 were present (33%), and their incidence was higher in the younger age groups. Caries/restorations were found in 88 (50.6%) and infraocclusion in 21 (12%) retained DM2. The roots were resorbed mostly for 1/2 of the root length (35%).

Conclusions Long-term prognosis of retained DM2 without permanent successors seems uncertain, especially within the younger age group. In individuals older than 17 years, the prognosis for a healthy DM2 is favorable, if no distinct infraocclusion or extensive root resorption is present.

KEYWORDS deciduous dentition, molars, agenesis, young patients

preferences. The evaluation of retained deciduous second molars (DM2) is also very important, as their preservation might be considered as a possible treatment option [Bjerklin et al., 2008; Sletten et al., 2003]. The presence of advanced caries, root resorption and progressive infraocclusion of DM2 indicate poor prognosis on their long-term preservation [Bjerklin and Bennet, 2000]. The loss of retained deciduous molars usually occurs during the second or fourth decade of life [Bjerklin et al., 2008]. According to Ith Hansen and Kjær [2000], root resorption of primary teeth continues, regardless of the presence of permanent successors. The degree of root resorption may vary in different teeth. It is at its lowest in primary canines, maxillary DM2, and at its highest in maxillary first molars [Haselden et al., 2001]. The correlation between the presence of infraocclusion and root resorption in the apical area and along the entire length of the root was observed, and disturbances in bone metabolism causing pulp obliteration or ankylosis were also reported [Kurol and Magnusson, 1984; Biederman, 1968]. In patients with PM2 agenesis, the risk of progressive root resorption as a consequence of applied orthodontic force is a serious concern [Hwang et al., 2017]. Ankylosis of deciduous molars is observed four times more often in the PM2 agenesis groups compared to the general population (24.6% vs. 6–8.9%) and is reported as an important factor affecting the long-term preservation of DM2 [Hvaring et al., 2014]. Progressive infraocclusion can lead to tilting and extrusion of the neighboring teeth and therefore leads to occlusal disturbances. The progression of this process may require restoration of their occlusal surfaces and monitoring for caries development and potential loss of the said restoration. In the literature, there are not too many studies evaluating the status of persistent DM2, and most of them were performed in Scandinavian countries where the prevalence of caries is generally low [Bjerklin et al., 2008; Hvaring et al., 2014; Hvaring et al., 2019]. However, no studies have been conducted to evaluate the status of DM2 in relation to age, which is important for the estimation of their long-term preservation.

Introduction

Agenesis of second premolars (PM2) is the second most common tooth agenesis, preceded by agenesis of third molars (M3). Congenitally missing PM2 occur in about 2.5% of the general population and 51.8% of patients with other types of tooth agenesis [Dhamo et al., 2016]. This phenomenon often takes place in the mandible: from 6.9% in the general population to 85.6% in females and 83.4% in males with tooth agenesis [Lebbe et al., 2017]. It is reported more frequently in orthodontic patients compared to the general and paediatric populations [Khalaf et al., 2014; Rakhshan et al., 2016; Polder et al., 2004]. The choice of treatment in patients with PM2 agenesis depends on several factors, such as the patient's age, occlusion and profile, and the patients'

Aim

The aim of this study was to evaluate the presence and the status of retained deciduous second molars (DM2) in cases with a congenital absence of second premolars (PM2) in relation to age.

Material and methods

The research material consisted of panoramic radiographs selected from the database of the Department of Orthodontics of the Medical University of Warsaw, a private orthodontic practice and a radiology center in Warsaw, Poland. The inclusion criteria were agenesis of at least one PM2. PM2 was diagnosed as missing when there was no visible mineralisation of PM2 tooth germ in the DM2 region on the panoramic radiograph, and a previous extraction of PM2 was not confirmed in dental files. The minimum age of patients who qualified for the study was 10 years. Exclusion criteria included patients with dentofacial deformities, patients with oligodontia (excluding M3) and poor-quality panoramic radiographs. The patients were divided into three groups according to age: 10–13 years, 14–17 years and 18–22 years. The study group was examined for the presence and location of retained DM2, the degree of their root resorption, the presence of fillings/dental caries and infraocclusion. The degree of root resorption and infraocclusion were determined according to Bjerklin and Bennett [2000] (Figs. 1,2). The study was approved by the Bioethics Committee of the Warsaw Medical University (No: AKBE/80/17). Root resorption of DM2 was graded from 1 to 6 (Figure 1):

- Grade 1. Roots without resorption;
 - Grade 2. Roots resorbed for $\frac{1}{4}$ of the root length;
 - Grade 3) Roots resorbed for $\frac{1}{2}$ of the root length;
 - Grade 4. Roots resorbed for $\frac{3}{4}$ of the root length;
 - Grade 5) Roots completely resorbed;
 - Grade 6) Missing tooth.
- The infraocclusion was diagnosed as a marked distance

from the occlusal line to the occlusal surface of a retained deciduous molar ($>2\text{mm}$), on a scale of 0 to 1 with 1 referring to present infraocclusion and 0 to its absence (Figure 2) [Bjerklin and Bennett, 2000]. The presence of caries and restorations was assessed as: 1- presence of caries/restoration and 0 - healthy deciduous molar

Results

The study group consisted of 131 subjects, 82 females (62.6%) and 49 males (37.4%) aged 10–22 years. The mean age was 13 years and 11 months (median: 13.14 years, standard deviation: 2.73 years). Fifty-eight participants (44%) were older than 14 years of age. The study group included 53 orthodontic patients (40.5%), while the other 78 participants (59.5%) were classified as the general population.

In the majority of patients, agenesis of one or two PM2 (80%) was diagnosed, and it was more frequent in the mandible than in the maxilla. Most often, bilateral agenesis of PM2 in the mandible was observed. Agenesis of all PM2s was observed three times more frequently in the group of females than in males, and the ratio was 3:1. Agenesis of two PM2 mostly occurred in females, and in males mostly one PM2 was missing. The detailed results are presented in Table 1.

Retained deciduous molars

In the study group, 174 DM2 were present (111 in females, 63 in males), which indicate the presence of a deciduous molar in 33% agenesis sites. Thirty-six of the retained DM2 (20.7%) were located in the maxilla, and 138 (79%) in the mandible. In females, 111 DM2 were retained, of which 31 were in the maxilla (28%) and 80 were in the mandible (72%). In males, 63 persistent DM2 were found, of which 5 were in the maxilla (8%) and 58 in the mandible (92%).

In all age groups, the majority of the DM2 were retained in the mandible (Table 2). The highest number of DM2 was present in the youngest group (10–13 years). In this group, 107 retained DM2 were present, which included 28 in the

Gender / Number of missing PM2	1	2	3	4
Females	30 (36.6%)	31 (37.8%)	9 (11%)	12 (14.6%)
Males	23 (46.9%)	21 (42.9%)	1 (2%)	4 (8.2%)
All	53 (40.5%)	52 (39.7%)	10 (7.6%)	16 (12.2%)

TABLE 1 Distribution of congenitally absent second premolars (PM2) according to gender and number of missing premolars.

Tooth	10–13 years			14–17 years			18–22 years			10–22 years		
	All	Females	Males	All	Females	Males	All	Females	Males	All	Females	Males
55/65	28	25	3	8/	6	2	0	0	0	36/	31	5
75/85	79	49	30	45	22	23	15	9	6	138	80	58
Total	107	74	33	53	28	25	15	9	6	174	111	63

TABLE 2 Presence of retained deciduous second molars (DM2) according to the age group and gender.

Restoration /caries	10-13 years	14-17 years	18-22 years	10-22 years
55/65	15	5	0	20
75/85	35	25	8	68
Total	50/57%	30/34%	8/9%	88/100%

TABLE 3 Presence of restoration or caries in retained deciduous second molars (DM2) according to the age group.

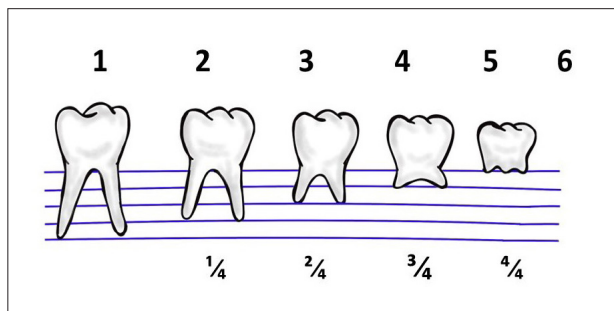


FIG. 1 Stages of root resorption according to Bjerklin and Bennett [2000]

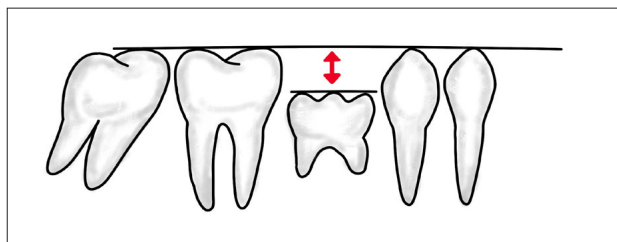


FIG. 2 Assessment of infraocclusion according to Bjerklin and Bennett [2000]

maxilla (26%) and 79 (74%) in the mandible. In the older group (14–17 years old), 53 DM2 were present: 8 in the maxilla (15%) and 45 (85%) in the mandible. In the oldest age group (18–22 years) no deciduous teeth were present in the maxilla, while 15 DM2 were present in the mandible.

Caries/restorations

The presence of caries/restorations in the study group was observed in 88 retained DM2 (50.6%), which included 20 maxillary DM2 and 68 mandibular DM2. The results are shown in Table 3. In females, the presence of caries/restorations was found in 57 of the retained DM2 (51.4%), of which 20 were in the maxilla and 37 were in the mandible. In males, the presence of caries/restoration was found in 31 retained mandibular DM2 (49.2%), while none of the maxillary teeth were affected. The presence of caries/restorations was similar in all age groups.

Infraocclusion

In the study group, the presence of marked infraocclusion was found in 21 retained DM2 (12%), of which 2 were in the maxilla and 19 were in the mandible. In the maxilla, infraocclusion of DM2 was recorded once, while in the mandible infraocclusion of DM2 was recorded 10 times and 9 times, respectively. In the youngest age group (10–13 years), the infraocclusion of DM2 occurred in 9.3% of the sample, while in the older group (14–17 years) this figure increased to

Tooth	10-13 years	14-17 years	18-22 years	10-22 years
55/65	2	0	0	2
75/85	8	11	0	19
Total	10/48%	11/52%	0/0%	21/100%

TABLE 4 Presence of distinct infraocclusion in retained deciduous second molars (DM2) according to the age group and gender.

20.7%. In the oldest group (18–22 years old) no infraocclusion was found. The detailed results are presented in Table 4.

Root resorption

In the study group, the roots were most frequently resorbed for ½ of the root length (grade 3), which was seen in 35% of teeth. Grade 4 was recorded in 24% and grade 2 in 22.4% of all DM2. The least frequent were grade 1 (7%) and grade 5 (11.5%). The degree of root resorption of retained DM2 is shown separately for each tooth in Tables 5–8 according to age and gender.

Discussion

The prognosis of retained DM2 in patients with P2 agenesis seems to be uncertain, as 67% of them were found to be missing in the study sample. Their absence was increasing in relation to the age of the subject, however in the oldest group (18–22 years), the status of the retained DM2 was reasonably good. Therefore, if a retained DM2 without a permanent successor is healthy after 17 years of age, without advanced root resorption, it has a good chance of functioning for many years. On the other hand, the prognosis of retained DM2 in children before the growth spurt is difficult to predict, and depends on the progression of root resorption, infraocclusion and possible consequences of caries. According to Ith-Hansen et al. [2000], persistence of DM2 in subjects with a congenital absence of one or two PM2, and with no morphological deviations in the permanent dentition, is an acceptable, semi-permanent solution for the patient. The retrospective studies by Bjerklin and Bennett [2000] and Haselden et al. [2001] confirmed the favourable long-term survival of these teeth in older subjects with PM2 agenesis, but the generally low prevalence of caries in Scandinavia could have influenced their findings. Half of the retained DM2 included in the present study had caries/restorations, and it is possible that some of the missing DM2 were lost because of caries. The present sample included the highest number of cases with PM2 agenesis in relation to other studies, however, the study included cross-sectional assessment of individuals with PM2 agenesis, and the cause of the DM2 loss was generally not known.

Most of the participants were missing one or two PM2 (40.5% and 39% respectively) and no clear gender predisposition was present. However, absence of more than 2 PM2 was higher in the female group (35.6%) than in the male group (10.2%).

Root resorption

Root resorption of persistent DM2 in the study group was found to a moderate degree. The most common was grade 3, which occurred in one-third of the examined teeth. A study by Bjerklin et al. [2008] confirmed that during the observation

Root resorption stage	10-13 years		14-17 years			18–22 years	
	Tooth 55/65	Tooth 75/85	Tooth 55/65	Tooth 75/85	Tooth 55/65	Tooth 75/85	
1	5/18%	5/6%	0	1/2%	0	1/7%	
2	7/25%	18/23%	1/12,5%	11/24%	0	2/13%	
3	6/21%	33/42%	4/50%	14/31%	0	5/33%	
4	10/36%	17/21,5	0	13/29%	0	2/13%	
5	0	6/7,5	3/37,5%	6/13%	0	5/33%	
Total number/%	28/100%	79/100%	8/100%	45/100%	0	15/100%	

TABLE 5 Stage of root resorption in retained deciduous second molars (DM2) in relation to age.

period, in almost half of the persistent DM2, the degree of root resorption had not been changed. Only seven DM2 (7%) were lost due to root resorption, caries or progressive infraocclusion. In another study by the same authors, it was concluded that in adult patients (over 20 years old) persistent DM2 without their permanent successor had a good long-term prognosis [Bjerklin and Bennett, 2000]. A slow course of root resorption was observed, and infraocclusion was found in 55% of the teeth. The evaluation of root resorption revealed that in the group of patients aged 10–13 years, grade 1 (no resorption) was found in 9.3% of the study group. This result is slightly lower than the findings of Bjerklin and Bennett [2000], where no root resorption was assessed in 11.9–16.9% of mesial and distal roots of deciduous teeth. The results of the current study confirm the occurrence of root resorption above ½ root length in 67.3% of DM2 in patients aged 10–13 years, 75.5% of DM2 in the 14–17 age group and 80% DM2 in patients aged 18–22 years. The obtained results indicate the progression of root resorption in older patients and potentially unfavorable prognoses. Similar results were found in the study by Nordquist et al. [2005], in which 89 different persistent deciduous teeth were evaluated. Positive correlation between root resorption and the age of patients was found.

Caries

Sletten et al. [2003] evaluated the degree of root resorption, the presence of fillings and the survival rate of DM2 in twenty cases with PM2 agenesis. The loss of four (25%) DM2 was reported: three molars were lost due to caries and one due to periodontitis, but none of the deciduous molars were lost due to root resorption. The survival rate of DM2 was 86% in the observation period of 12 years. In patients older than 40 years, retaining healthy DM2 was concluded to be a viable treatment alternative for prosthetic rehabilitation in cases of premolar tooth agenesis. However, the results of the present study indicate that about half of the DM2 had fillings or carious lesions in the majority of patients younger than 20 years, which might adversely influence their long-term prognosis.

Hvaring et al. [2014] studied a group of 111 retained primary molars without successors and reported that 78.4% of them had no restorations. The presence of fillings was not considered a significant factor affecting the prognosis of deciduous molars. It should be noted that the prevalence of caries in Poland is much higher than in Scandinavia. This is undoubtedly an important factor in the prognosis of retained DM2. The latest cross-sectional studies performed in Poland in 2016 in the group of 5- and 7-year-old children showed that caries

were detected in 76.9% of 5-year-old and 89.4% of 7-year-old examined children [Olczak-Kowalczyk et al., 2017]. The incidence of caries in deciduous teeth was 55.6% in children aged 18–36 months [Grzesiak and Kaczmarek, 2006]. In our sample, the presence of caries/restorations was found in 88 DM2 (50.6%). The material of the study was collected in the capital city where dental care and awareness of oral hygiene is presumably higher than in the countryside.

More than half of the retained DM2 in the oldest age group in the present study had restorations, which indicates marked differences in the susceptibility to develop caries between the Scandinavian and other populations. Caries incidence and oral hygiene are important factors for prognosis of retained DM2 in cases with PM2 agenesis.

Infraocclusion

Infraocclusion of retained deciduous teeth is an important factor for their long-term survival [Hvaring et al., 2014]. Kokich [2005] recommended extraction of ankylosed DM2 because of possible disturbances in vertical development of the alveolar process, which could lead to complications during future implantation procedures. On the other hand, the width of the alveolar process, which is a determining factor regarding the insertion of a dental implant, is well preserved even in excessively ankylosed teeth. According to Thilander et al. [2001] extraction is only recommended in cases with severe infraocclusion.

In the study by Hvaring et al., infraocclusion was found in 43.6% of persistent DM2, while advanced infraocclusion in almost twenty percent (18.8%) [Hvaring et al., 2014]. Also, a positive correlation between the degree of root resorption and the range of infraocclusion was demonstrated. No correlation was observed between the patient's gender and the occurrence of infraocclusion. However, there was a weak correlation between root resorption, infraocclusion and the patient's age. The authors included patients with oligodontia, and there was an average of 8.4% agenesis of teeth per patient, which could possibly influence the discrepancies in the results. In the present study, the infraocclusion of persistent DM2 was reported less frequently (12.1%). However, only a distinct infraocclusion was recorded, which may underestimate the true number if it were to be followed longitudinally.

Garib et al. [2014] found a positive correlation between the age of patients and the presence of infraocclusion of DM2 in the population of orthodontic patients from Brazil. Infraocclusion rate in the group of 10–15-year-olds was 24%, in the group of 15–20-year-olds was 27%, while in the group

of 20–30-year-olds was 45%. In the present study, the rates were lower, in the 10–13 age group 9.3%, while in the older group (14–17 years) it was 20.7%. In the oldest group, 18–22 years old, no infraocclusion was found. According to Garib et al. [2014] a positive correlation between the presence of infraocclusion and root resorption was found. Despite the significant occurrence of root resorption, the DM2 continued to function and could be retained in the oral cavity. The results of the present study confirm the increased percentage of DM2 with infraocclusion in relation to the age. Patients aged 18–22 years did not exhibit infraocclusion, but this was the least numerous group, and therefore the results should be interpreted with caution. Bjerklin and Bennett [2000] reported that infraocclusion of DM2 at the age of 19 years is in the range of 0.5 up to 4.5 mm at molars without a permanent successor. Rune and Sarnäs [1984] evaluated 123 retained DM2 for the presence of root resorption and infraocclusion. Root resorption led to the loss of 26% of DM2 in the maxilla, and 5% in the mandible were removed because of infraocclusion. Also, there was no observed difference in root resorption between the genders, and no correlation with dental caries or infraocclusion was found. The rate of severe root resorption was significantly higher compared to the present study.

Limitations

An epidemiological screening to evaluate the presence and survival of DM2 in cases with PM2 hypodontia in Poland would be advisable. The current study included orthodontic patients in whom premolar agenesis was more prevalent compared to the general population. Also, a longitudinal observation of retained DM2 in patients with PM2 agenesis can provide valuable information on the occurrence of infraocclusion and root resorption in relation to age and skeletal maturation as well as the consequence of caries in these teeth. However, the choice of other treatment options, for example autotransplantation of developing premolars, is time-related, and therefore it is practically impossible to conduct randomised trials on the effectiveness of different treatment options in patients with PM2 agenesis.

Conclusions

1. PM2 agenesis occurred three times more frequently in the mandible than in the maxilla. Retained DM2 were present in approximately one-third of all PM2 agenesis sites, and their prevalence was higher in younger age groups.
2. Half of DM2 at the PM2 agenesis sites had caries or restorations, therefore their prognosis was uncertain, especially for younger individuals. Progressing root resorption and progressing infraocclusion were also common.
3. In older patients, the prognosis for a healthy, retained DM2 without a permanent successor is favorable, if no distinct infraocclusion or extensive root resorption is present.

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