



Retention of Primary Second Molars without a Permanent Successor: A Review Article

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ABSTRACT

Each deciduous tooth passes through a normal exfoliation process, but occasionally the deciduous tooth may retain its place beyond the normal time of exfoliation. Persistence of deciduous tooth may occur due to a variety of reasons. The purpose of this review article is to provide information regarding the retention of the primary second molars, the etiology of primary teeth retention and the consequences of their persistence, additionally discuss the preferences of management of the retained primary teeth. This review showed that the retention of primary teeth is an important subject that each general practitioner should notice since it could have both undesirable aesthetic and functional effects on the individual's occlusion.

Keywords: Retention, Primary second molars, Permanent successor, Deciduous tooth, Persistence

INTRODUCTION

The deciduous molar teeth spontaneously shed when three-fourths of the root length of the replacing permanent premolar formed [1,2]. When a deciduous molar persists or remains in its place beyond this point, it is considered as an over-retained tooth [3], in another word, 'persistence' is defined as the retention of primary tooth that could occur beyond the time of normal exfoliation in some cases resulted in an extended life for that primary tooth [4]. The mandibular second primary molar in cross-sectional studies was found to be the most commonly persisting tooth, followed by the maxillary primary canine, while the longest lifespan was found for mandibular primary canines and was followed by maxillary primary canines (Figure 1) [5,6]. Retention of primary teeth may occur due to a variety of reasons; the developmental absence of permanent successor is the most common reason [7].

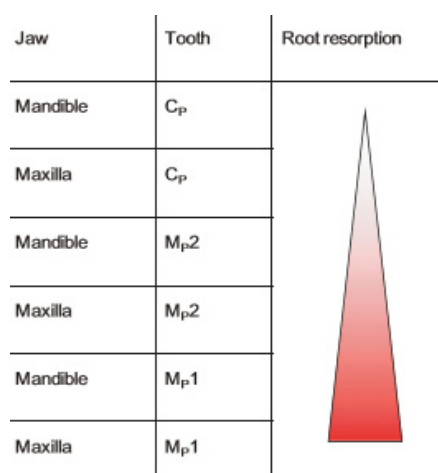


Figure 1 Relative probability of root resorption of different primary teeth when lacking a permanent successor (base of the triangle represents the highest probability, Cp: primary canine, Mp2: primary 2nd molar, Mp1: primary 1st molar) [6]

The most frequently missing permanent teeth are the mandibular second premolars (2.4-4.3%), the maxillary second premolars (1.4-1.6%), the maxillary lateral incisor in the second rank (1.6-1.8%), and the mandibular incisors (0.2-0.4%) [8]. So the primary tooth remains in place beyond the normal time of shedding when the permanent tooth failed to erupt “agenesis occurs”. Maintaining and retaining healthy primary mandibular molars has been reported to be an applicable alternative treatment [4].

Persisting the primary tooth prevents resorption of the alveolar bone, and serves as a space maintainer and may function as a semi-permanent solution which lasts into adulthood and also postpones the need for prosthetic replacement instead of the tooth [9]. So a retained primary tooth with good conditions (good crown, roots and supporting alveolar bone) could offer an adult many years of service, in such cases most of the primary teeth can continue to function [4], but beyond the benefits of retaining primary tooth, the retained primary molars carry a risk of infra-occlusion or developing progressive root resorption [9].

General dentists are in a unique position and responsibility to diagnose patients with teeth having such conditions since the early diagnosis and treatment may help to prevent future orthodontic, surgical and prosthodontic dilemmas and provide the best possible prognostic clinical options for those patients [10,11].

Etiology

Limited data are available regarding the exact reasons for the persistence or retention of primary teeth [5]. The primary mandibular second molars are the most commonly retained primary teeth. Retention or persistence of other primary teeth was relatively rare. The most common reason for primary teeth retention is the congenital absence of the permanent successor teeth, abnormal position, impaction and the late eruption of the successor's teeth. Therefore retention of the primary second molars is mostly related to the absence of permanent second premolars which are their permanent successors [5,12,13].

Additionally, a protective factor exists in the periodontium of the primary teeth and prevent the root resorption under normal conditions, but this factor may undergo changes when affected by eruption of a permanent tooth, in hyper-IgE syndrome, where the primary teeth are not resorbed normally, a widened cement-like layer is observed on the roots of the primary teeth so that persistence of the primary teeth exists [14,15].

According to Kjaer, *et al.*, the agenesis of the permanent tooth could be caused by factors that are related either to the mucosal ectoderm, ectomesenchyme, or innervation [16]. Whereas, Vastardis in 2000, documented that the genetics plays an indisputable role in the occurrence of agenesis and other anomalies. He conducted a study on a large family with agenesis of all second premolars and third molars and detected a mutation in gene *MSX1* on chromosome 4p as a result of this study [17]. On the other hand, Becktor, *et al.*, suggested that the occurrence of agenesis was less likely caused by a general ectodermal factor, but more likely caused by a local factor in the region, e.g. local innervation [18].

Consequences of Retention of Primary Second Molars

Infra-Occlusion: One of the most important consequences of retention of primary second molars (without a permanent successor) is the infraocclusion. It describes a condition when the position of the tooth is inferior to an occlusal plane that means the retained primary tooth failed to maintain its normal position relative to the adjacent teeth [19]. Many terms have been used such as “arrested eruption”, half retention, buried tooth, tooth depression, disinclusion, incomplete/suppressed eruption, impaction, shortened tooth, intrusion, reimpaction, secondary retention, and re-inclusion’ [20]. However, the infraocclusion and submerged tooth are the most commonly used terms [21].

A strong association has been demonstrated between the infra-occlusion of the primary molars and agenesis of their permanent successors [22,23]. Infraocclusion of the primary tooth usually appears in the early mixed dentition with a prevalence of 8% to 14% between 6-11 years of age, the earlier it happens, the more severe the infraocclusion with the tooth which gradually becomes more in infraposition. This may result in tipping of the adjacent teeth, space loss and over-eruption of the opposing teeth, infraoccluded deciduous molars with no permanent successors showed a slowing of root resorption with age and did not shed spontaneously like infraoccluded primary teeth with permanent successors [24].

Messer and Cline in 1980, classify the infraocclusion according to its severity into mild or slight when the occlusal surface of the infraoccluded tooth was between the occlusal surface and interproximal contact of the adjacent tooth,

which was less than 2mm, moderate when the occlusal surface of infraoccluded tooth was within the occluso-gingival margins of the interproximal contact of the adjacent tooth, and severe when the occlusal surface of infraoccluded tooth was below the interproximal contact point of the adjacent tooth (Figure 2) [25-27].



Figure 2 Classification of infraocclusion (a) mild infra-occlusion [26], (b) moderate infra-occlusion [27], (c) severe infra-occlusion [27]

Generally, it is agreed that the principal etiology of infraocclusion is the ankylosis between the roots of the infraoccluded tooth and the surrounding bone. So that, the tooth involved remains in a state of static retention; while in the adjacent areas, eruption and alveolar growth continue [20]. The infraocclusion of primary molars was most frequently considered as ankylosis of these teeth [28,29].

The tooth was ankylosed when cementum or dentin fused to alveolar bone and this is considered as an abnormality that could be occurred during any time of eruption or even after occlusal contact establishment [30,31].

Early diagnosis, proper treatment, and thorough follow-ups are very important in the case of ankylosis of primary teeth [32]. Diagnosis of ankylosis cannot be made merely by the observation or notification of a small step in the occlusal plane between the primary and the adjacent permanent molar. This is because that the crown of the primary molar is naturally shorter than that of an adjacent permanent tooth. Clinically, tapping on the ankylosed tooth produce an abnormal percussive ‘cracked tea-cup’ sound and this is a clinical indicator of ankylosis [33-35]. Andersson, et al., in 1984 and Ne, et al., in 1999, indicated that percussion on the ankylosed tooth is not necessarily a reliable indicator, since at least 20% of a root surface may have to be ankylosed before a definite metallic tone is elicited [36,37]. A lack of tooth mobility is also unreliable because more than 10% of a root surface may be ankylosed before tooth mobility is affected [6]. Ankylosis could be radiographically evaluated by using periapical radiograph which could clarify the lack of a well-defined periodontal ligament and lamina dura space, a depression in the marginal bone surrounding the infraoccluded tooth and the fusion of the root with bone which often occurs in an isolated area, often at the furcation area [33,38]. According to Kokich, the most reliable indicator of ankylosis in a mildly infraocclusion is the presence of a vertical step in the interproximal bone around the infraoccluded primary molar [39] (Figure 3).

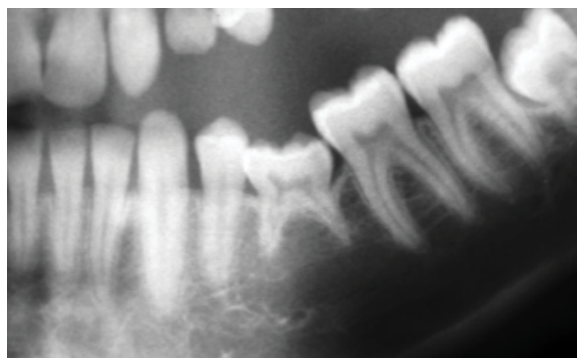


Figure 3 Lower left second primary molar showing signs of early infra-occlusion. An early reliable indicator of ankylosis is the presence of an angular alveolar defect between an ankylosed tooth and the adjacent teeth with normal eruptive mechanisms [6]

The ankylosis mechanism is unknown but it is probably thought to be due to the developmental disturbances in the periodontium, and changes in the distribution of epithelial rests of Malassez in the periodontium [40].

Additionally, ankylosis may be the after effect of an injury to periodontium causing repercussions in regenerative

procedures, however, the disappearance or the evanescence of the periodontal ligament that follows the root resorption in primary teeth was supported by the local metabolism theory. The disturbances in local metabolism lead to the obliteration of the periodontal ligament first and result in the close contact of the bone to the tooth structure allowing union [41].

Inheritance plays a role in increasing the incidence of infraocclusion among siblings [21,42], studies have shown that 1.3-8.9% of kids may have infraoccluded teeth with an equal occurrence in males and females since the gender has no significant relation with infraocclusion. However, this proportion is reported to be between 18.1- 44% in the siblings of those children [9,43].

In 1992 Bjerklin, *et al.*, found a reciprocal connection between infraocclusion of the primary molars and aplasia of the premolars [22]. Baccetti in 1998 reported that child with infraoccluded primary molar could frequently develop infraocclusion of other teeth and other dental anomalies such as peg-shaped lateral incisor and palatal displacement of maxillary canines [23]. Some studies also reported that the ankylosis of primary molars could be associated with various anomalies in permanent dentition, like taurodontism of the first permanent molar, the ectopic eruption of canine, aplasia of second molars, tipping and increased susceptibility to caries and periodontal disease of the adjacent teeth [40,44,45].

On the other hand, the infraoccluded or infraerupted tooth could result in an insufficient development of adequate width and height of the supporting bone, this could complicate the future dental treatment including placement of a dental implant and orthodontic treatment [24]. In addition to that, the insufficient bone may result in dehiscence, periodontal pocketing and root exposure of the adjacent teeth which also could complicate other dental treatment [46].

Root Resorption: The process of primary teeth exfoliation and permanent teeth eruption was thought to be correlated and considered as a programmed process [47]. The root of each tooth is usually protected from root resorption by the presence of a narrow PDL (Periodontal ligament) cells layer which is mainly composed of fibroblast, cementoblast and collagen fibers [48].

Degeneration of the PDL cells layer precedes root resorption and mainly the removal of collagen fibers of the PDL cells layer is considered the main step in the initiation of root resorption process [49]. According to Lee, *et al.*, it is thought that the erupting pressure from the permanent teeth induces differentiation of hemopoietic cells into osteoclasts, which resorb the roots of primary teeth [50]. So in normal condition and during the development of dentition, the roots of primary teeth undergo a gradual resorption in accordance with the eruption of their permanent successors [51]. But surprisingly the primary tooth root resorption could also be monitored even when the permanent successor's tooth bud is congenitally missing [52]. The differences in the PDL between the permanent and primary teeth may explain in some parts the increased susceptibility of the root resorption of the primary teeth [53], since the root resorption occurs when there is shifting in balance between the factors that stimulate the secretion of collagenase and the factors that inhibit the resorptive process toward the root resorption, the PDL cells from the primary teeth produce more collagenase than the resorptive process inhibitors as compared to the permanent teeth PDL cells [47,53].

The forces are applied to the primary teeth as the face grows and the muscles of mastication enlarge become heavier than the primary teeth can bear, these forces weaken the PDL of the primary tooth and may cause PDL necrosis, which may lead to the damage of the PDL layer and losing the root protective layer and root resorption will take place [54,55].

Mechanical trauma is another etiology for root resorption of primary teeth, especially during the mixed dentition stage when there is abnormal occlusion as the permanent tooth in one arch occluding with the primary tooth in another arch. On the other hand, the root resorption of the primary tooth could be significantly delayed when the primary tooth is protected from the occlusal forces [47,56]. Some studies reported that the rate of resorption of primary tooth root may vary among individuals and also diminishes with age since the resorption didn't progress up to 16 years after the age of normal exfoliation [24,57]. The shortest time any tooth could remain in the same stage of root resorption was 2 years and 0 months and the longest time was 8 years and 9 months [52].

According to Bjerklin and Bennett, root resorption could be assessed or judged subjectively and scored on a six-point scale of severity, in which the mesial and distal roots divided into quarters [58] (Figure 4).

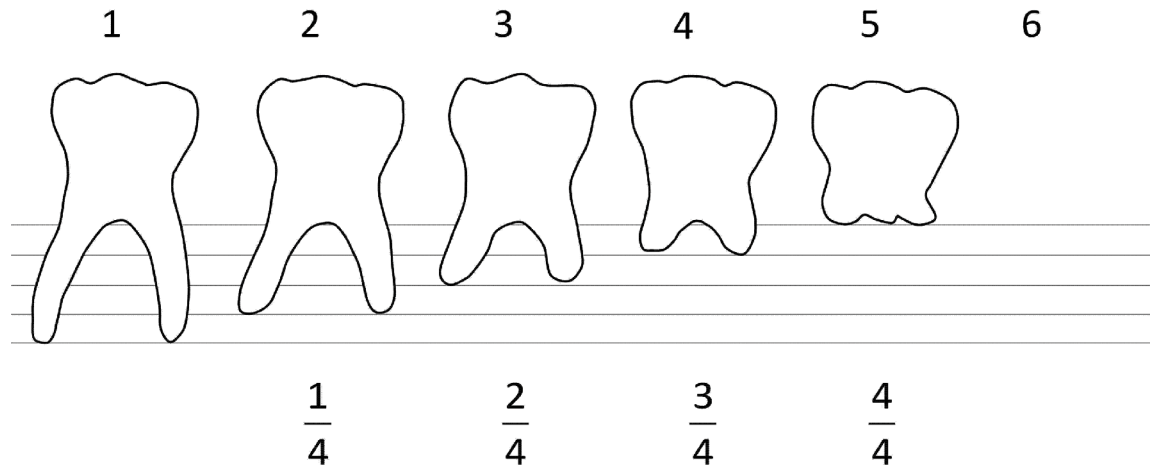


Figure 4 The different resorption stages, measuring quarters of each root. Level 1: no resorption, level 2: one-quarter resorbed, level 3: half of the root resorbed, level 4: three-quarter resorbed, level 5: complete root resorption, level 6: shedding of the tooth [58]

In some children, root resorption seemed to occur concurrently with the eruption of the adjacent permanent teeth and discontinue when these teeth had erupted [52] (Figure 5).

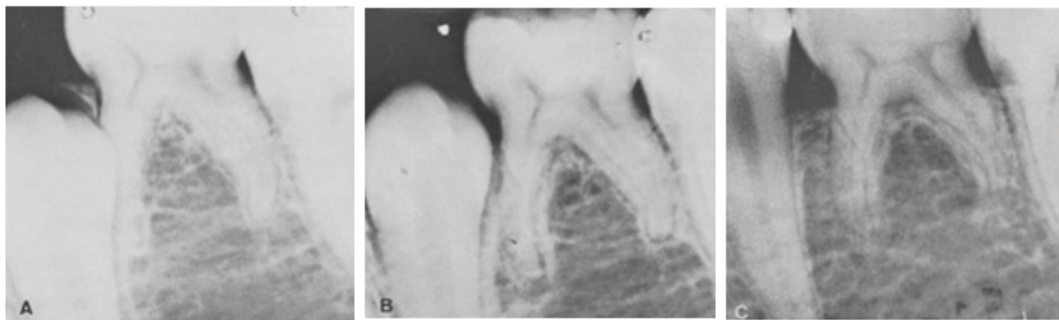


Figure 5 Root resorption of the mesial root in the mandibular left deciduous second molar concomitant with the eruption of the first premolar in one boy. A: Age 13 years and 4 months. B: Age 14 years and 4 months. C: Age 20 years and 4 months. About the same degree of root resorption as observed at the age of 14 years and 4 months [52]

It is also obvious that the number of missing permanent teeth is a factor that influences the resorption pattern in the primary dentition, which means there is a resistance to root resorption of primary molars in individuals with agenesis of only one premolar [57,59]. Additionally, if the root resorption of primary molars occurs, the alveolar bone gradually replaces the resorbing roots which will help in the maintenance of bone volume and may simplify later restorative treatment [6].

Some of the studies that have discussed the subject retention and ankylosis of primary teeth were shown below in Table 1.

Table 1 Some of the studies that have discussed the subject retention and ankylosis of primary teeth

The study	The sample	Conclusion
Agensis of mandibular second premolars with retained primary molars. A longitudinal radiographic study of 99 subjects from 12 years of age to adulthood. (Bjerklin K et al, 2008) [13].	The sample composed of the radiographs of 99 subjects 37 males and 62 females	They found that only 7 of the 99 primary molars were lost due to extensive root resorption, infraocclusion, or caries. In more than 90% of patients, long-term survival may be expected with retained primary molars with agenesis of mandibular second premolars.

Can persistence of primary molars be predicted in subjects with multiple tooth agenesis? (Kjær I et al, 2008) [59].	The sample consisted of dental pantomograph from 105 children (51 males and 54 females).	They concluded that the primary molars are not expected to have a long-term persistence.
Root resorption of primary teeth without permanent successors. (Lee JE et al, 2009) [50].	The sample collected from the patients that visited the pediatric department at Yonsei University Dental Hospital-Korea	They concluded that the primary lateral incisor, primary canine and primary molars without permanent successors showed abnormal root resorption and root resorption of primary teeth occurs due to inflammation, occlusal forces, weakness of periodontium...etc.
The prognosis of retained primary molars without successors: infra-occlusion, root resorption, and restorations in 111 patients. (Hvaring Ch, et al, 2014) [9].	The sample was composed of 188 persisting primary mandibular second molars in 111 subjects, 48 males, and 63 females	They concluded that the infra-occlusion was estimated to be a more critical factor for the prognosis of retained primary molars than root resorption
Root resorption in retained primary teeth without successors among Sulaimani Adult Population. (Rashid ZJ, et al, 2016) [60].	The sample was 2232 students of Sulaimani University including 1064 males and 1168 females.	They concluded that the primary maxillary canine was the most frequently retained deciduous teeth, followed by the mandibular 2 nd primary molar on both sides. The level 1 root resorption is the most frequent followed by level 2, 3, 4 respectively

Management of Retained Primary Second Molar without a Permanent Successor

Clinically, it is proven that there are no accurate predictors for the permanence of the primary teeth without a permanent successor [57,61]. Preservation or maintenance of primary teeth is important especially in cases of severe hypodontia, as they could play a functional role for a substantial period of time [9].

In some cases, they are maintained well till adulthood whereas in other cases they may exfoliate much faster [47]. However, it has been observed that if a primary molar remains in the dental arch up to 20 years of age with no significant root resorption it has then a favorable prognosis for long-term existence [58].

Retention or persistence of primary molars without permanent successor cases should be approached with special caution, since the aplasia can aggravate the progression of infra-occlusion of primary molars, the patient's age, the developmental condition and the occlusal status of the affected tooth are the factors that should be considered in the therapeutic decision [62,24]. There are a number of treatment modalities in case of agenesis of mandibular second premolars; the first one is that the primary molar may be left *in situ* or extracted, in some cases the maxillary premolars and the contralateral premolar are also extracted, with spontaneous space closure or closure with a fixed orthodontic appliance. The second modality is that the maxillary third molar may be autotransplanted, whereas implant-supported prosthetic replacement or a tooth-supported bridge and pontic could be the third option [13].

In addition to the previously mentioned treatment options, Lygidakis, et al., in 2009 and Parisay, et al., in 2013 proposed surgical luxation as a treatment approach aiming to break the root ankylosis sites, allowing the tooth to continue in its eruption, this method is being used for permanent molar ankylosis successfully and is considered as a safe and effective approach for the treatment of the infra-occluded primary molars except in those that having shorter and more fragile roots [63,64].

Lygidakis, et al., in 2015 proposed a more conservative approach by building of primary molars without a permanent successor in order to increase the tooth height and to re-establish the normal occlusion by using PMC (performed metal crown). This clinical approach enables the dental clinician to create an aesthetic crown in one appointment easily and using materials and instruments that are available in clinical practice without the need for a laboratory work [65].

Orthodontically, an ideal Class I molar relationship would not be possible because of the distal position of the deciduous second molar in addition to its larger size compared to the replacing premolar, building the deciduous second molar or ceramic onlay may be a beneficial restorative option to build up or to retain the occlusal surface and establish a suitable contact with the first premolar (Figure 6) [66]. Another way to obtain better occlusal relationship is to reduce the distal aspect of the primary second molar; this will allow the permanent first molar to move mesially, the exposed dentine could be protected with the flowable composite material (Figure 7) [6].



Figure 6 (a and b) Missing mandibular second premolars with ankylosed and infra-occluded deciduous second molars in a distal malposition; (c to e) a ceramic onlay to close the residual mesial space [3]



Figure 7 Patient with primary second molar that reduced distally to obtain better occlusal relationship [7]

CONCLUSION

The retention of primary teeth is an important subject that each general practitioner should notice since it could have both undesirable aesthetic and functional effects on the individual's occlusion. Inheritance may play a role in increasing the incidence of infra-occlusion or ankylosis among siblings, additionally, the primary tooth root resorption could be monitored even when the permanent successor's tooth bud is congenitally missing. There are many options for management of the retained primary tooth that should be considered to preserve the primary tooth for a substantial period of time especially in severe cases of hypodontia.

DECLARATIONS

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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