

**Deep submersion:
Severe phenotype of deciduous-molar infraocclusion with
biological associations**

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ABSTRACT

Objective: To evaluate the clinical manifestation of and treatment modalities for this severe phenotype of infraocclusion and to examine relationships between deep submersion and the occurrence of other dental anomalies.

Materials and Methods: The experimental sample consisted of 25 orthodontic patients with at least one deciduous molar in infraocclusion greater than 5 mm. Dental records were used to assess severity of infraocclusion, treatment modality, and presence of other dental anomalies (tooth agenesis, small maxillary lateral incisors, palatally displaced canines, and distal angulation of mandibular second premolars).

Results: The sample included 14 females and 11 males, age 7 to 14 years (mean age 10.1 years). The mean infraocclusion depth was 9 mm, with a range of 5–18 mm. The crowns of the adjacent teeth were severely tilted toward the infraoccluded tooth, space was lost in the dental arch, and the successor premolars were impacted in all cases. Treatment consisted of space regaining, surgical extraction of the deciduous molar, and space maintenance. The impacted premolar erupted spontaneously in 95% of the cases. There was a significant increase in prevalence of dental anomalies in the deep-submersion sample compared with that of reference values ($P < .001$).

Conclusions: The treatment modality used in this sample resulted in spontaneous eruption of the impacted premolar in most cases. Markers for early diagnosis of deep submersion include other dental anomalies, severe tilt of adjacent teeth, and local space loss. The increased prevalence of other dental anomalies supports a shared genetic etiology. (*Angle Orthod.* 2014;84:292–296.)

KEY WORDS: Infraocclusion; Dental anomalies; Deciduous (primary) molars; Tooth ankylosis

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INTRODUCTION

Infraocclusion is a disorder of tooth eruption observed mainly in deciduous (primary) molars. The ankylosed infraoccluded tooth is positioned below the occlusal plane in a variety of vertical discrepancies.

Deep submersion, a severe phenotype of deciduous-molar infraocclusion, is a rare phenomenon in which the vertical discrepancy between the deciduous molar and its neighboring tooth is severe, causing a challenging malocclusion for which a multidisciplinary treatment approach is often required.

Bloch-Jorgensen¹ was the first to report severe cases of “retained deciduous teeth” in one of the first radiographic studies of infraocclusion.

Currently, only two studies have examined this rare phenomenon. Winter et al.² reported on 28 cases with severe infraocclusion, including failure of eruption, and Quintero et al.³ evaluated the treatment outcome of severe infraocclusion cases, recommending early treatment.

Until recently, the etiology of infraocclusion was unclear. A familial relation,^{4–8} as well as an association with other dental anomalies,^{9–14} has been reported, suggesting a shared genetic origin. However, the severe phenotype of infraocclusion has not been studied yet in that respect. Furthermore, there are no definite guidelines for treatment of this severe anomaly.

This study was undertaken (a) to evaluate the clinical manifestation and treatment modalities for this anomaly and (b) to examine relationships between deep submersion and the occurrence of certain other dental anomalies.

MATERIALS AND METHODS

This retrospective study was approved by the Hadassah Medical Center ethics committee for clinical trials. The experimental sample included 25 orthodontic patients with at least one deciduous molar in deep submersion (more than 5 mm of vertical discrepancy); patients were from the orthodontic clinic in the Hebrew University-Hadassah School of Dental Medicine and from private clinics. The criterion for inclusion in this sample was presence of infraocclusion of a deciduous molar with over 5 mm of vertical discrepancy, as measured from the mesial marginal ridge of the permanent first molar using pretreatment plaster dental casts and panoramic radiographs.

Dental records of these patients were analyzed to assess the following parameters:

- Age and gender;
- Severity of infraocclusion;
- Treatment modality, duration, and outcome.

In addition, panoramic radiographs and dental casts were studied to determine the presence of any of the following dental anomalies:

Tooth agenesis was determined by panoramic radiographic screening for absent permanent teeth, excluding third molars. Two categories of tooth agenesis were compiled: agenesis of teeth excluding third molars and agenesis of premolars only. If younger than 10 years when initial records were established, follow-up radiographic images were obtained later to confirm the agenesis.

Microdontia of maxillary lateral incisors was identified by direct observation. This category of anomaly included peg shape, conical phenotype, and small maxillary lateral, defined as having an equal or smaller maximum mesiodistal crown diameter compared to that of its opposing mandibular lateral incisor.¹⁵

Palatally displaced canine anomaly (PDC) was diagnosed based on initial radiographic records if the subject was at least 10 years old at that time.^{16,17} If younger at that time, follow-up radiographic images

were obtained later to confirm the presence of clear-cut PDC.

Mandibular second-premolar distal angulation anomaly (MnP2-DA) was defined as the mandibular second premolar forming a distal angle with the mandibular plane of less than 75°. The choice of this threshold was based on the results of previous studies that introduced this positional anomaly.^{18–22} The method for measuring MnP2-DA was previously described by Shalish et al.¹⁸

Statistical analysis included descriptive statistics and a chi-square test for goodness of fit that was used to compare the frequencies of dental anomalies within this sample with previously published reference values in the general population.

RESULTS

The sample included 25 orthodontic patients, 14 females and 11 males, age 7 to 14 years (mean age 10.1 years) who had at least one severe infraoccluded deciduous molar. The mean infraocclusion depth was 9 mm, with a range of 5–18 mm.

The rank order of occurrence of deep submersion according to the location of affected deciduous molars was recorded. The left mandibular deciduous second molar was the most frequently severely infraoccluded tooth, with 52% (13 patients) of the cases having this condition. The left maxillary deciduous second molar was next, with 40% (10 patients) of the cases affected, followed by the right mandibular deciduous second molar, with 32% (8 patients), and the right maxillary deciduous second molar, with 16% (4 patients) of the cases affected. The least frequent site for deciduous-tooth deep submersion was the deciduous first molar: two patients (8%) had deep submersion of the left maxillary deciduous first molar, and only one patient (4%) had severe infraocclusion of the left mandibular or the right maxillary deciduous first molar. Five patients (20% of the cases) had multiple teeth with deep submersion (three of them included deciduous first molars). In all cases, the crowns of the adjacent teeth were severely inclined toward the submerged tooth, and space was lost in the dental arch (Figure 1).

Twenty patients had successor premolars, whereas five patients were congenitally missing the premolars. All the successor premolars of the deeply submerged deciduous molars were impacted. The orthodontic treatment consisted of:

- Space regaining using a removable plate (18 patients; 72% of the cases) or fixed appliances (seven patients; 28% of the cases),
- Surgical extraction of the obstructing deciduous molar (in all cases),



Figure 1. Panoramic radiograph of a female patient, age 8 years, with deep submersion of the mandibular right deciduous second molar, demonstrating tilt of adjacent teeth and space loss in the arch.

- Insertion of a space maintainer immediately after the extraction (in all cases),
- Follow-up every 3–6 months during the transition period from the mixed to the permanent dentition.

In 19 out of 20 patients (95% of the cases) the impacted premolar, underlying the formerly deeply submerged tooth, erupted spontaneously during the follow-up period (Figure 2a–e). The mean time required for eruption was 2 years, with a range of 1.5–3 years. In one case, the second premolar remained impacted and required surgical exposure.

Table 1 shows prevalence of five dental anomalies occurring in the deep-submersion sample compared with reference sample occurrences. In our study group, there was a fivefold higher prevalence rate of agenesis of permanent teeth, excluding third molars, compared to reference values in the general population. The prevalence rate of premolar agenesis was also increased in the sample. Small maxillary lateral incisors were six times more prevalent in the deep-submersion sample compared with reference values. PDC anomaly was seen approximately 12 times more frequently in the deep-submersion sample than in the reference values. MnP2-DA anomaly averaged over five times the relative frequency noted in the reference sample.

The observed greater prevalence of anomalies in subjects with deep submersion compared with published reference values was significant statistically at the $P < .001$ level (Table 1).

DISCUSSION

This study was undertaken to test whether deep submersion was a severe phenotype of dental anomaly patterns that likely have shared genetic origins, and to examine the clinical manifestation of

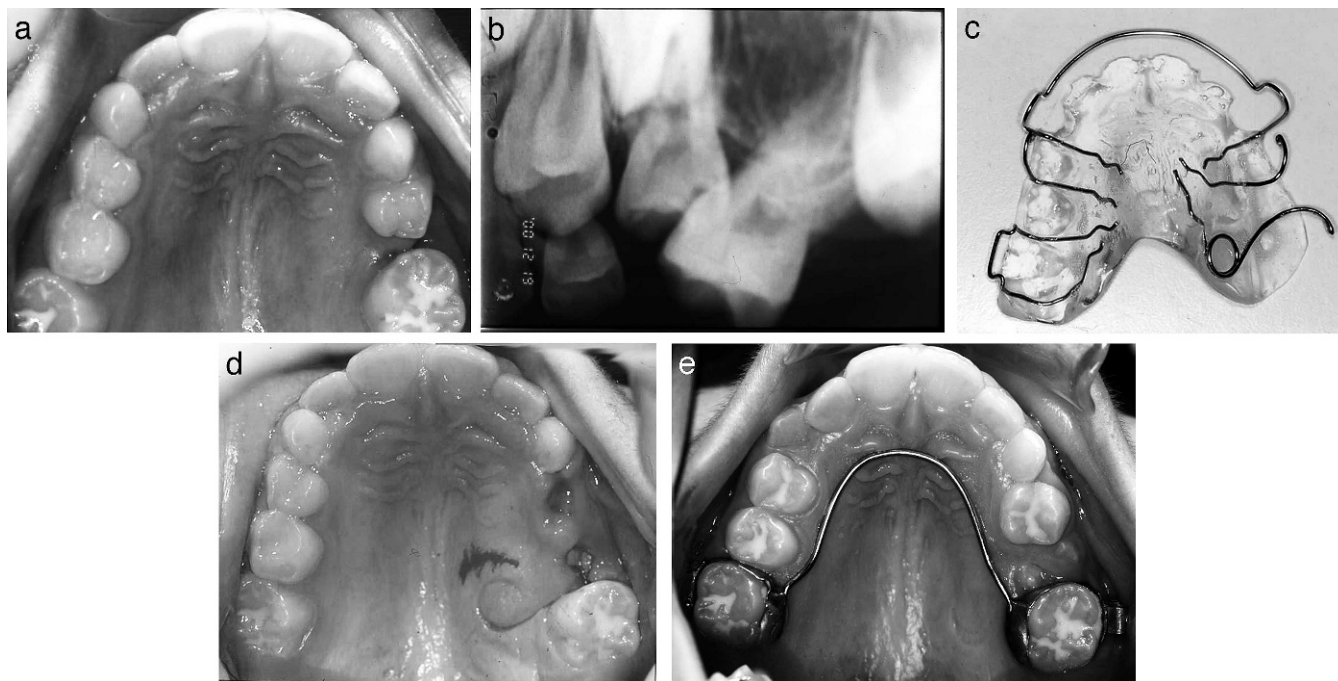


Figure 2. (a) Occlusal clinical view of a female patient, age 8 years, with deep submersion of the maxillary left deciduous second molar. (b) Periapical radiographic film showing severe tilting of adjacent teeth and impaction of the maxillary left second premolar. (c) Removable appliance used for opening space by distalization of the maxillary left first molar. (d) Occlusal clinical view after distalization. (e) Occlusal clinical view 2.5 years after surgical extraction of the maxillary left deciduous second molar and space maintenance with a palatal arch. The permanent successor erupted spontaneously in the dental arch. The patient was treated by one of the authors (SC). Reproduced with permission from *Treatment of Impacted Teeth* (by Becker A; Oxford: Wiley Blackwell Publishers; 2012).

Table 1. Comparison of Prevalence Rates of Dental Anomalies in the Deep Submersion Sample and in the General Population Using Chi-Square Test, $n = 25$

Dental Anomaly	Deep Submersion Prevalence Rate	Reference Sample	Chi-Square (P Value)
Agenesis (excluding M3)	24% (6/25)	5% (53/1064) (Grahnen 1956) ²³	17.24 (<.001)
Agenesis of P2	24% (6/25)	5.8% (58/1000) (Baccetti 1998) ¹¹	13.80 (<.001)
Small MxI2	32% (8/25)	4.7% (47/1000) (Baccetti 1998) ¹¹	35.79 (<.001)
Palatally displaced canines	20% (5/25)	1.7% (25/1450) (Dachi 1961) ²⁴	41.19 (<.001)
Distal angulation of MnP2 (MnP2-DA)	60% (15/25)	13.1% (13/99) (Shalish 2010) ¹⁴	25.08 (<.001)

this severe phenotype as well as the recommended treatment protocol.

Our results demonstrate a clear and statistically significant increase in prevalence of dental anomalies among subjects with deep submersion, compared with their reported prevalence in the general population.^{11,14,23,24} The increased prevalence found in this study was greater than the one found in a previous study among subjects with mild, moderate, and severe infraocclusion,¹⁴ suggesting that deep submersion is indeed a severe phenotype of deciduous-molar infraocclusion with biological associations.

Koyoumdjisky-Kaye and Steigman²⁵ found ethnic variability in the prevalence of submerged primary molars and higher prevalence in the Kurds in comparison to North American children, augmenting the assumption that genetic predisposition may play a role in infraocclusion.

Our study is in agreement with earlier studies by Baccetti^{11,12} and Shalish et al.¹⁴ that found an association between infraocclusion and other dental anomalies, suggesting a common genetic etiology and a dental anomaly pattern, as described by Peck.²⁶

Clinically, we found that the mandibular deciduous second molar was the most frequently severely infraoccluded tooth, similar to the findings of Quintero et al.,³ while Winter et al.² found the maxillary deciduous second molar to be the tooth most often presenting this extreme phenotype. The difference might be related to the different populations examined.

The clinical manifestation observed in our study included severe tilting of the crowns of the two adjacent teeth toward the affected tooth, with impaction of the premolar. The crown tilt caused loss of space in the dental arch, while the space between the roots remained unchanged. Such a tilt might increase the risk for caries and periodontal disease.

While the protocol of Quintero et al.³ for space maintenance and extraction of the severely infraoccluded tooth resulted in spontaneous eruption of the successor in 82.6% of the cases, our treatment protocol was successful in 95% of the cases and prevented the need for orthodontic traction of the mechanically impacted premolar. Space opening followed by a surgical extraction of the infraoccluded

deciduous tooth was required at a young age, as well as an extended follow-up with a space maintainer.

When the developing successor premolar is in its early stages of development, clinicians may fear that extraction of the severely infraoccluded deciduous molar could injure the bud of the premolar. Mínguez-Martínez et al.²⁷ examined 200 children with supernumerary teeth and found no displacements of neighboring buds after extraction of the supernumerary teeth in the primary dentition. Likewise, we did not observe damage to the developing bud in our sample's patients.

In the majority of the cases, space opening was achieved using a removable plate, since only tipping of the adjacent teeth was indicated.

Space regaining was also performed in the five hypodontia cases in order to allow access for the removal of the ankylosed tooth, to correct the malocclusion (severe tilt of the molar, midline shift, molar relations), and to enable prosthetic treatment in the future.

Early diagnosis of these developing severe cases of infraocclusion is important. Compensating inclination of contiguous teeth and concomitant presence of other dental anomalies (tooth agenesis, microdontia of maxillary lateral incisors, PDC, and MnP2-DA) can serve as markers for deep submersion. Another indicator is a "missing" (gingivally embedded) deciduous molar with no history of an early extraction.

Interceptive treatment, including timely extraction of the infraoccluded deciduous molar and fabrication of a space maintainer, is recommended.

CONCLUSIONS

- In cases of deep submersion, space opening followed by the removal of the severely infraoccluded deciduous tooth and space maintenance commonly result in spontaneous eruption of the impacted premolar.
- Markers for early diagnosis of deep submersion include other dental anomalies, severe tilt of adjacent teeth, and local space loss.
- Statistically significant associations of severe infraocclusion with the occurrence of other dental anomalies support a hypothesis favoring shared causal genetic factors.

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