

Combined surgical luxation and orthodontic traction treatment of a severely infraoccluded primary molar with deep caries: a case report and literature review



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Abstract

Background Infraocclusion refers to a tooth located below the occlusal surface compared to adjacent teeth long after it should have reached occlusion. Ankylosis is frequently associated with the infraocclusion of primary molars, but it is challenging to distinguish between the two conditions. Surgical luxation and orthodontic traction have been applied for the treatment of ankylosed, infraoccluded permanent teeth, but reports on primary molars are scarce.

Case report A 5-year-old boy presented with a severely infraoccluded primary mandibular second molar with deep caries. A partial pulpotomy was performed to treat the affected tooth when the pulp was exposed after caries removal. A combination of surgical luxation and orthodontic traction was performed for the affected tooth, and after 5 months, the tooth successfully erupted to the occlusal level. During the follow-up period of two years, no complications were observed.

Conclusions This report identified that surgical luxation, in conjunction with orthodontic traction, is effective and feasible for severely infraoccluded primary teeth. Additionally, partial pulpotomy may be an alternative for vital pulp therapy on primary teeth.

KEYWORDS Infraocclusion, Surgical luxation, Primary molar, Orthodontic traction, Deep caries.

Background

As is well documented, dental developmental anomalies affect the quantity, size, shape, mineralisation, and eruption process of teeth. Infraocclusion is a disorder that occurs during the ongoing eruption process, resulting in tooth impaction at different levels compared to adjacent teeth [Kurol, 1981; Odeh et al., 2016]. Terms such as submerged teeth, impaction, reimpaction, arrested eruption, tooth eruption failure, failure of tooth eruption, and incomplete tooth eruption are also frequently employed to describe this condition [Arhakis and Boutiou, 2016]. Infraocclusion primarily occurs in growing children. According to previous studies, the incidence of infraocclusion involving primary molars ranges from 1.3% to 38.5% [Alshaya et al., 2022; Arhakis and Boutiou, 2016; Via, 1964]. This discrepancy in incidence may be ascribed to differences in the age range and ethnicity of enrolled children [Alshaya et al., 2022]. Notably, the incidence of mandibular primary molar infraocclusion is 10 times higher than

that of primary maxillary molars, with the mandibular second primary molars being the most frequently affected tooth [Ekim and Hatibovic-Kofman, 2001]. Infraocclusion can be categorised as slight, moderate, or severe depending on the position of the occlusal surface of the infraoccluded tooth relative to adjacent teeth [Brearley and McKibben, 1973]. To date, the mechanism underlying infraocclusion remains elusive. Its diagnosis is typically made based on clinical presentation and radiographic findings. Ankylosis has been identified as a major cause of infraocclusion. It is principally diagnosed through clinical features such as the presence of infraocclusion, high percussion sound, and missing tooth mobility. Nevertheless, the aforementioned tests, such as percussion testing and mobility assessment, are not feasible for an infraoccluded tooth positioned beneath the gingiva. On periapical, panoramic radiographs, or CBCT, obliteration of the periodontal ligament in an ankylosed tooth can assist in the diagnosis of infraocclusion. Moreover, it might go undetected when the ankylosed area is small, leading to false positives [Martins et al., 2023]. However, besides ankylosis, other factors may also lead to the infraocclusion, such as disturbed local metabolism, local mechanical trauma, mechanical obstruction (supernumerary teeth, odontomas, soft tissue interference, and thumb or digit sucking), and even primary failure of eruption (PFE) [Hua et al., 2019]. Infraocclusion can manifest at an early age and may progressively worsen over time. Moreover, it may engender significant issues for young children, such as inclination of the adjacent teeth, loss of space, over-eruption of opposing teeth, decreased alveolar bone height of affected teeth, increased susceptibility to caries, ectopic eruption, impaction of successor permanent teeth, and even dislocation between the unerupted primary molar and its successor [Arhakis and Boutiou, 2016; Awad et al., 2022; Calheiros-Lobo et al., 2022; Nagayama et al., 2022]. However, there is currently no universally accepted consensus on the management of infraoccluded primary molars, posing challenges for clinicians. Various treatment methods have been proposed, including observation, restoration, extraction, orthodontic traction, and surgical luxation. The treatment modality



FIG. 1 Initial intraoral photographs.



FIG. 2 Initial panoramic radiograph.

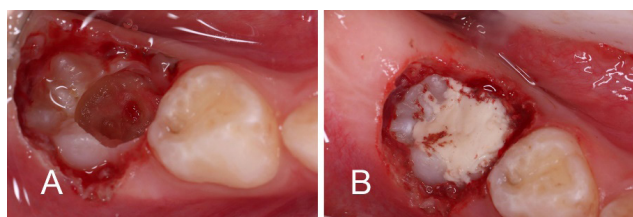


FIG. 3 Intraoral photographs during the procedure conducted under nitrous oxide/oxygen sedation.

A. A partial pulpotomy was performed when caries removal resulted in pulp exposure.

B. The cavity was filled with glass ionomer after pulp capping with iRoot BP plus.

is based on the patient's age, the condition of successor permanent teeth, the type of infraocclusion, and the degree of tilting of adjacent teeth [Ekim and Hatibovic-Kofman, 2001]. To date, surgical luxation and orthodontic traction have been widely used in the treatment of ankylosed permanent teeth, but there is a paucity of studies on treatment for infraoccluded primary molars [Chong and Mah, 2023]. This report reviewed the case of a 5-year-old boy with a severely infraoccluded and carious primary mandibular second molar. The tooth erupted successfully shortly following the combination of surgical luxation and orthodontic treatment. No complications were noted during the 2-year follow-up period.

Case presentation

A 5-year-10-month-old boy was referred to our hospital, with a lack of eruption of his right mandibular posterior tooth for the past 3 years as the chief complaint. His past medical history and physical examination findings were unremarkable. The mother reported having no history of illness or complications and did not take medications during pregnancy. Clinical intraoral examination revealed that the mandibular right second primary molar had not erupted (Fig. 1). Of note, tooth 84 was marginally shifted distally. A blind pouch was noted at the distal side of tooth 84, wherein the crown of the mandibular second primary molar could be detected. In addition, multiple carious lesions were observed in the maxillary teeth of the patient. Panoramic radiograph displayed an unerupted mandibular right second primary molar with deep caries (Fig. 2). According to the radiographic examination, tooth 85 did not exhibit periapical radiolucency, and the distal tooth root appeared to be ankylosed. Consequently, agenesis of the mandibular right and left second premolar was suspected. Tooth 85 was diagnosed with severe infraocclusion and deep caries, and congenital agenesis of tooth germs of 35 and 45 was considered. Gingival excision and caries treatment for tooth 85 were performed. Using nitrous oxide/oxygen sedation and local anesthesia, the overlying gingival tissue of tooth 85 was excised. After completely removing the decay, the pulp was exposed and was vital. Partial pulpotomy was performed and the exposed pulp was capped with iRoot BP plus

(Innovative BioCeramix, Vancouver, BC, Canada) (Fig. 3A). Due to blood exudation, the defect was filled with glass ionomer cement and scheduled to be replaced with composite resin following successful tooth eruptions (Fig. 3B). During the operation, the unerupted tooth 85 was immobile in the alveolar fossa, indicative of ankylosis. Consequently, surgical luxation was then performed, and the tooth was gently mobilised with suitable extraction forceps in both the buccolingual direction and anteroposteriorly using a spear-pointed elevator [Skolnick, 1980]. After a week, the gingiva had effectively healed, and the occlusal surface was sequentially etched with 37% phosphoric acid (Bisco Inc., Schaumburg, IL, USA) for 60 s, rinsed, and dried. A lingual button was then bonded to the occlusal surface. Next, a lingual arch with a hook was fabricated and cemented into the mandibular arch, and elastics were placed between the hook and the lingual button (Fig. 4). Additionally, the absence of tooth germs 35 and 45 was monitored. If the tooth germs do not develop, implant restoration or systemic orthodontic treatment may be necessitated in adulthood. After 2 months, tooth 85 partially erupted and was distinguished as being only 2 mm inferior to tooth 84. Radiographic image corroborated the eruption of tooth 85, whilst the height of the surrounding alveolar bone remained unaltered (Fig. 5). Considering that intramaxillary traction might not produce any further effect, the lingual arch appliance was removed, and tooth 85 was scheduled for a follow-up examination in 1 month to assess spontaneous re-eruption. However, due to the COVID-19 pandemic, the second follow-up appointment was postponed. 5 months later, the patient returned for a follow-up visit due to the shedding of filling materials in the affected tooth. According to the parent, the defect in tooth 85 was temporarily filled with zinc oxide at a local dental clinic. Intraoral examination showed adequate eruption of tooth 85 at the occlusal level. Radiographically, the height of the surrounding alveolar bone was increased, while the tooth germ of 45 became unexpectedly visible and reached Nolla stage 2 (Fig. 6A). Nevertheless, the development of tooth 45 was markedly delayed compared with other second premolars. Under the isolation with a rubber dam, zinc oxide was removed, and a hard tissue barrier approximating the pulp could be detected (Fig. 6B). Then, tooth



FIG. 4 Intermaxillary traction using a lingual arch with a hook and a lingual button bonded to the occlusal surface.

85 was capped with iRoot BP plus (Innovative BioCeramix, Vancouver, BC, Canada) on the newly formed hard tissue and filled with composite resin (Shofu, Kyoto, Japan) (Fig. 6C). While a preformed metal crown was recommended, the child did not cooperate. Thus, the placement of the performed metal crown was postponed to a later visit (Fig. 7). At 2-year follow-up, no evidence of abnormalities was detected in the oral examination (Fig. 8). The panoramic radiograph depicted that tooth germ 45 had attained Nolla stage 3, and the root of tooth 85 had no abnormal resorption (Fig. 9). Nonetheless, the tooth germ of 35 was still not detected.

Discussion

At present, the management of infraoccluded primary molars remains controversial, and several treatment approaches have been proposed. Treatment plans should be formulated after a comprehensive analysis that takes into account factors such as patient age, infraocclusion severity, timing of onset, timing of diagnosis, presence of successors, and the condition of adjacent teeth. The degree of difficulty in the treatment of infraoccluded primary molars is related to the time of onset and the timing of diagnosis. Late cessation of eruption may result in slightly infraoccluded teeth. Hence, the treatment objectives are to increase tooth height and re-establish occlusion or adopt a wait-and-see approach [Ekim and Hatibovic-Kofman, 2001; Patano et al., 2023]. On the other hand, if infraocclusion occurs early, the treatment aim is contingent upon the timing of diagnosis. The treatment objective of patients with early-onset and early diagnosis is to mitigate the risk of complications [Oh et al., 2020], whereas cases with an early onset and a late diagnosis always manifest as severe infraocclusion with a high risk of occlusal complications. Consequently, early diagnosis is key to preventing complications. It is essential to consult the appropriate specialists, including orthodontists, prosthodontics,

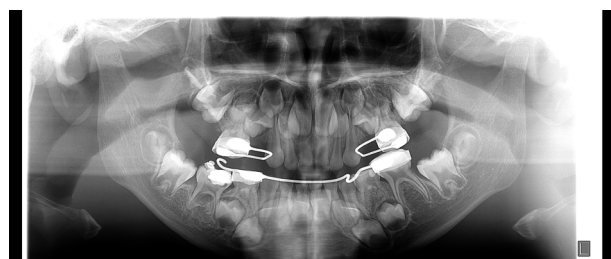


FIG. 5 Panoramic radiograph at the 2-month follow-up.

and implantologists. Noteworthy, whether the presence of a permanent successor or not influences the decision-making of treatments [Savoldi et al., 2021]. The treatment objective of infraoccluded primary molars with successors is to facilitate successful eruption of the successor, particularly in cases with severe impaction [Ng et al., 2022; Tayab et al., 2023]. To ensure the successful eruption of the successor, it is important to conduct space maintenance, preventing the inclination of adjacent teeth or supra-eruption of the antagonist [Garcovich et al., 2019]. In cases where the successor tooth is absent, the potential treatment options for severe infraocclusion may involve tooth extraction with either space closure or space retention. During the initial examination, the panoramic radiograph revealed severe infraocclusion of tooth 85 and the absence of tooth 35, while the presence of tooth 45 remained uncertain. Taking into account the patient's ability to comply with the complex and lengthy treatment process, tooth extraction could be an option. However, in consideration of the difficulties in maintaining the free-end space and the prevailing belief that a well-preserved primary tooth serves as an effective natural space maintainer, an alternative approach could involve preserving the primary tooth. The decision to preserve primary tooth was ultimately influenced by the perceived advantages of this method and the strong parental preference for tooth preservation. The parents were fully informed about the potential obstacles and demonstrated a steadfast commitment to ensuring compliance throughout the treatment process. Interestingly, a subsequent periapical radiograph taken 5 months later showed the presence of successor tooth 45 indicating clinicians should consider the possibility of delayed tooth development, meticulously examine the radiographs, and conduct CBCT examination to confirm the presence of early tooth germs. However, the development of tooth 45 was significantly delayed compared with other normal permanent premolar germs. This condition is likely related to the abnormal eruption of tooth 85, which is consistent with the findings from other reports [Nagayama et al., 2022; Nanduri et al., 2018]. During the excision of the covering gingival tissue, tooth 85 was immobile in the alveolar fossa, strongly suggesting the presence of ankylosis. Articles focusing on therapies introducing the combined surgical luxation and orthodontic traction treatment for ankylosed primary molars are scarce [Chong and Mah, 2023; Geiger and Bronsky, 1994; Smith et al., 2012]. Skolnick et al. reported that surgical luxation of primary teeth might accelerate normal tooth absorption [Skolnick, 1980]. In 2013, Parisay et al. reported the first case of luxating an infraoccluded primary molar, wherein they attempted luxation twice due to the initial procedure's lack of success [Parisay et al., 2013]. It is also the only documented case about surgical luxation of primary teeth so far, according to our comprehensive review of the available literature written in English [Parisay et al., 2013]. Regarding orthodontic traction, the duration generally ranges between 8 and 18 months [Han et al., 2009; Motokawa et al., 1990]. Herein, the combination of orthodontic traction and surgical luxation resulted in the successful eruption of the affected mandibular primary second molar within 2-months, highlighting the effectiveness of this therapy. The shortened treatment time and traction duration enhance the feasibility and practicality of preserving a severely infraoccluded primary molar. Meanwhile, the primary mandibular second molar successfully erupted to the occlusal level, which not only eliminated the need for extraction and the application of maintainers but also played an important role in inducing the eruption of the distal permanent first molar in the right direction. Notwithstanding, this treatment method may not be indicated for all patients with infraoccluded primary molars; it offers an additional treatment option for the



FIG. 6 Periapical radiograph and intraoral photographs at the 5-month follow-up. **A.** Periapical radiograph depicted the position of the alveolar crest (arrow) and the tooth germ 45 (sharp triangle). **B.** Intraoral photograph displayed a newly formed hard tissue (arrow) after the removal of temporary materials. **C.** The temporary restoration was replaced by composite resin.



FIG. 7 Intraoral photograph after placement of a preformed metal crown.



FIG. 8 Intraoral photographs at the 2-year follow-up.

management of severely infraoccluded primary molars, especially when parents prefer a more conservative approach over tooth extraction and when the child is apprehensive about surgery. Furthermore, in cases without signs of eruption after this combination treatment, the possibility of an issue with the eruption mechanism of the teeth should be considered, commonly referred to as primary failure of eruption (PFE) [Smith et al., 2012]. This holds significant clinical importance in the early detection of PFE. One of the prevalent complications of infraoccluded primary molars is their susceptibility to caries [Hua et al., 2019]. In this case, the presence of the blind pouch facilitated the development of deep caries. A prior study reported a case of filling up a carious primary molar with severe infraocclusion and successfully repositioning it [Parisay et al., 2013]. However, reports on preserving a severely infraoccluded primary molar with decay reaching the pulp are limited. According to the guidelines of the American Academy of Pediatric Dentistry, pulpotomy is recommended for primary teeth when carious dentin excavation results in pulp exposure [Dhar et al., 2017]. Partial pulpotomy refers to the removal of 2–3 mm of pulpal tissues underneath the exposure site [Jassal et al., 2023]. It is associated with benefits such as the preservation of crown pulp, reduced operation time, and easier restoration compared to traditional cervical pulpotomy [Careddu and Duncan, 2021]. Indeed, partial pulpotomy has been established as a safe and effective treatment for permanent teeth with vital crown pulp [Albaiti et al., 2022; Jassal et al., 2023]. However, there is a paucity of high-quality randomised controlled trials on partial pulpotomy in caries-derived primary teeth [Boutsiouki et al., 2021]. International guidelines recommend partial pulpotomy for carious exposures in young permanent teeth but not in primary teeth, likely attributable to the limited evidence in primary teeth and the superior blood supply of young permanent teeth [Wassel et al., 2023]. A randomised controlled trial undertaken by Nematollahi et al. identified no significant difference between partial pulpotomy with MTA (mineral trioxide aggregate) and formocresol pulpotomy in mandibular second primary molars [Nematollahi et al., 2018]. In paediatric dental treatment, the duration of time spent in the chair is significantly associated with their behaviour, which in turn influences treatment outcomes [Govindaraju et al., 2021]. In this case, due to the patient's uncooperative behaviour, a partial pulpotomy was performed to minimise the operating time. After 24 months of follow-up, there was no evidence of sensitivity, pain, swelling, or any other complications, and radiographic examination showed no signs of pathological root resorption (Fig. 8, 9). This report outlines the case of a 5-year-old boy with severe infraocclusion of a primary molar, which was successfully treated to erupt into proper occlusion via surgical luxation and orthodontic traction.

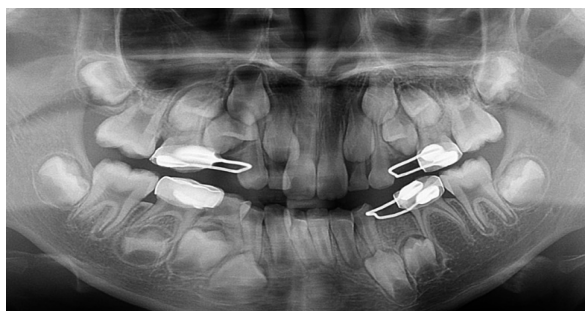


FIG. 9 Panoramic radiograph at the 2-year follow-up.

Partial pulpotomy was performed to treat deep caries with vital pulp exposure. The findings in this report signal that surgical luxation along with orthodontic traction is feasible in patients with primary dentition, including those with carious primary teeth. Overall, our findings lay a theoretical reference for the management of severely infraoccluded primary molars. Partial pulpotomy may serve as an alternative vital pulp therapy option for primary teeth with carious pulp exposure. Nevertheless, its efficacy and safety warrant further investigations.

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