

To extract or not to extract? Management of infraoccluded second primary molars without successors

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Key points

Improves knowledge on how to diagnose infraoccluded primary teeth.

Demonstrates how to manage cases of early ankylosis in young patients with remaining growth potential with deciduous dental extractions.

Presents a treatment algorithm as guidance for these clinical situations.

Provides advice on when to refer patients in complex malocclusions.

Abstract

Infraocclusion is a term used to describe a tooth which has stopped its relative occlusal growth into the arch after the period of active eruption; as a result, the tooth becomes depressed below the occlusal plane. Although many aetiological mechanisms have been proposed, ankylosis is considered the primary cause of infraocclusion. Complex cases benefit from multidisciplinary management. This paper concentrates on the diagnosis and management of infraoccluded second primary molars, without permanent successors and without significant malocclusion, and provides clinicians with a treatment decision tree to aid in treatment planning.

Introduction

Infraocclusion is a term used to describe a tooth which has stopped its relative occlusal growth into the arch after the period of active eruption; as a result, it becomes depressed below the occlusal plane.^{1,2} Traditionally, the term 'submerged' was used to describe these teeth, however, numerous other terms have also been used in the literature, and some examples are listed in Box 1. The authors prefer the term infraocclusion and have used it throughout this paper.

The prevalence of infraoccluded primary molars varies between studies. Bjerklin *et al.* (1992) stated that 55% of retained primary second molars show some degree of infraocclusion.³ Kuroi (1981), in a study of 1,059 Swedish children, reported the prevalence

figure at 8.9%,⁴ however other studies have given figures between 1.3% and 38.5%.^{5,6} In all of these studies, the subjects had a mixture of permanent successor's presence or absence.

Despite the wide variation between population groups, many studies have identified a familial occurrence of infraocclusion with a significantly higher incidence between siblings.^{4,7,8,6,9} The distribution based on gender is reported to be equal.^{6,10,11} Andraesen *et al.*¹² stated that infraocclusion is most often registered at the interval of 6–11 years,^{5,6,10} but has been described in patients as young as three-years-old.^{6,13,14}

This phenomenon tends to occur bilaterally¹ with the most commonly affected teeth being the mandibular primary molars.^{4,6,10} The occurrence of infraocclusion can occur in the presence or absence of a permanent successor tooth. There are no clear guidelines to the general dental practitioner (GDP) on the management of infraoccluded primary molars when the adult premolar is absent; which, importantly, is the most common presentation of mild hypodontia, as second premolars are often developmentally absent. Clinicians can often find the decision-making challenging on whether to extract the infraoccluded teeth or to retain them. The aim of this article

is to give a brief overview of the current literature surrounding infraoccluded primary molars and to provide clinicians with an understanding of treatment options available when managing infraoccluded second primary molars with absent permanent successors.

Aetiology

Although many aetiological mechanisms have been proposed (Box 2), ankylosis is considered the main cause of infraoccluded primary molars.^{1,4,15,16} Noble *et al.* (2007) describes ankylosis of the infraerupted primary molar as one that has 'stopped its vertical movement relative to others along the occlusal plane such that marginal ridges are not at the same height as adjacent teeth'.¹⁷ This is due to failure of the periodontal ligament to separate cementum and dentine from the bone during resorption, causing fusion of the tooth to alveolar bone.¹⁰ This results in the primary tooth remaining static while the eruption of adjacent teeth continues with vertical growth and occlusal development.^{11,18} Two main theories have been proposed to explain why infraoccluded primary molars become ankylosed.

The first of these theories considers local factors as the main cause and the second is

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Box 1 Terminology used to describe infraoccluded teeth

- Ankylosis
- Impaction
- Incomplete eruption
- Infraoccluded
- Reimpaction
- Submerged
- Submergence
- Submerging
- Secondary retention

Box 2 Causes of infraocclusion identified in the literature

- Ankylosis
- Other less common causes:
 - Disturbed local metabolism
 - Gaps in the periodontal membrane
 - Local mechanical trauma
 - Local infection
 - Chemical or thermal irritation
 - Local failure of bone growth
 - Abnormal tongue pressure
 - Disturbance in interaction between normal resorption and hard tissue repair
 - Radiation

Box 3 Clinical findings associated with infraoccluded molars

- Tipping of adjacent teeth (Fig. 2)
- Apically positioned gingival margins
- Lateral open bite
- Supraeruption of opposing teeth (Fig. 3)
- High pitch sound on percussion
- Incomplete alveolar process development (Fig. 4)
- Increase caries³⁰
- Periodontal disease susceptibility^{15,27}
- Lack of normal mesial drift
- Significant deviation in midline shift towards the affected side⁴⁰

based on genetic factors, although, to date, no genes have been identified. Biederman suggested that ankylosis may be due to a change in metabolism caused by local disturbances in the periodontal ligament.¹⁹ Bone turnover is a complex process involving the close interaction of osteoclasts and osteoblasts along with periodontal ligament cells.²⁰ Studies have identified that disturbances in this process could also cause tooth ankylosis.²⁰

The second theory based on genetic factors is well supported. A study of monozygotic twins, and another study assessing the prevalence of infraoccluded teeth in different races, have shown evidence of a genetic aetiology and familial occurrence of infraoccluded teeth.¹⁸ It has been suggested that ‘infraocclusion and other dental anomalies including those of shape, texture, number, and eruption may all represent microsymptoms of an inheritable disturbance because of a general disruption of the tooth developmental structures.’¹⁸

Although these theories do have evidence to support them within the literature, the exact cause of ankylosis of primary molars remains unknown. Other reported, but less common causes of infraocclusion in the literature are listed in Box 2. For teeth with permanent successors, the ankylosed condition of the primary tooth usually, but not always, disappears concurrently with the physiological resorption process, which is delayed, indicating that ankylosis is usually a transient phenomenon.²¹ However, there are cases where deciduous molars with a permanent successor remain ankylosed.²²

Clinical features

Developmental anomalies are often identified by the GDP during routine examination²¹ and infraocclusion of primary teeth is one such condition that is usually diagnosed on clinical examination. As the name signifies, typically, the infraoccluded tooth appears depressed

below the occlusal plane at varying levels of severity (Fig. 1).^{4,6,10}

Other clinical findings that can be associated with infraoccluded teeth are listed in Box 3 (which includes references to Figure 2, Figure 3 and Figure 4). Tipping of adjacent teeth is often noted, owing to the tension in the transeptal fibres between the infraoccluded and non-infraoccluded teeth, as the infraoccluded tooth sinks below the occlusal plane.²³ A high-pitched percussive tone has been described due to the ankylosis of the tooth to the surrounding bone, but this is a largely a subjective measure as it only occurs when at least 20% of the root surface is ankylosed.²¹ Other clinical features include: an apical position of the gingival margin; overeruption of opposing teeth; lateral open bites; and incomplete alveolar process development.²⁴ Root resorption detected radiographically without expected increase in mobility may occur, which suggests ankyloses of the tooth.¹ A loss of mobility with infraoccluded teeth occurs when more than 10% of the root becomes ankylosed.²¹

Use of radiography in management of infraoccluded primary molars

The presence of a non-mobile primary molar with a pronounced degree of physiological root resorption may be a sign of ankylosis and warrants further investigation. The use of radiographs enables the clinician to identify if there is a successor present; in addition, radiographs facilitate the diagnosis of dental pathology including caries and root resorption. Periapical radiographs may show periodontal ligament space obliteration which is an indicator of ankylosis and differences in occlusal heights can also be seen. Other features that can be seen radiographically



Fig. 1 Severe infraocclusion of 65 and 75. The teeth are significantly depressed below occlusal plane almost to gingival level

include oblique interproximal bone levels 'bone notching', that slope down towards the infraoccluded tooth (Fig. 5).

However, conventional radiographs only offer a two-dimensional view of the infraoccluded tooth and, given that ankylosis is microscopic,²⁵ it is unsurprising that radiographic interpretation is limited. Some histological studies including Raghoobar *et al.*²¹ and Henderson²⁶ have reported that most ankylosed molars had osteoid tissue deposited in the furcation area. Thornton *et al.*²⁷ and Krakowiak¹⁰ found that teeth without successors showed ankylosis in the vicinity of the apex. However, despite these conclusions, radiographic presentation is of limited value to the majority of clinicians.

Cone beam computer tomography (CBCT) scans have shown that there is obliteration of the periodontal ligament in cases of ankylosis.²⁸ CBCT is also useful in managing complex cases requiring the surgical removal of infraoccluded teeth, as it enables the surgeons to identify and localise the anatomical structures such as the inferior dental nerve.²⁴ However, CBCT should only be used in selective cases where the benefit outweighs the risks associated with this technique.

Classification

There are numerous classification systems in the literature. Two most frequently used are Kjaer *et al.* (2008), where primary molar eruption is classified according to the distance from the occlusal level of the primary molars to the adjacent teeth in millimetres.¹² The other frequently used classification is by Brearley *et al.* (1973), as shown in Table 1.⁶ For the purpose of this article, the authors have chosen to use the Brearley classification.

Prognosis of infraoccluded molars

Studies have shown that ankylosed mandibular and maxillary second primary molars have a better prognosis than ankylosed first primary molars.²⁹ Due to the increased incidence of permanent second molar absence, there is more available literature regarding their longevity. Bjerklin *et al.* (2000) analysed 41 subjects longitudinally, from age 11 years into adulthood, who had all retained lower second primary molars, of which 55% had some degree of infraocclusion.²⁹ Out of 59 teeth in 41 subjects, only seven retained primary second molars were lost, of which none were lost after



Fig. 2 Tipping of 24 distally adjacent to infraoccluded 65



Fig. 3 Overeruption of tooth 15 against infraoccluded 85



Fig. 4 a) Occlusal view shows a horizontal bony defect; b) right side buccal view shows a vertical defect in the same patient

the age of 20.³⁰ This suggests that if primary molars are retained past the age of 20, then the prognosis is good and other studies have drawn a similar conclusion.²⁹

As previously stated, decision making around infraoccluded primary molars can be complex and confusing. The next part of this paper provides a simplified summary of the literature and a flow chart to aid clinicians in treatment planning cases of infraoccluded primary molars with missing permanent successors.

Treatment planning

Management of infraoccluded teeth is influenced by several factors such as timing of diagnosis, age of the patient, type and degree of malocclusion, the degree of ankylosis and whether there is a permanent successor present. Management of pathology-free ankylosed primary second molars with a

missing permanent successor in a child without any significant malocclusion depends on the timing of diagnosis. Mildly ankylosed teeth, diagnosed before the child's pubertal growth spurt, should be monitored biannually to ensure that the ankylosis is not getting worse. If the ankylosis worsens over time or is diagnosed as severe at the time of diagnosis, the clinicians should consider extracting the tooth, ideally before the child's growth spurt. This is done in order to avoid a significant vertical bone defect.³¹ This will prevent greater challenges in future management of these cases where continued infraocclusion results in a lack of alveolar bone development.

Pathology-free mildly ankylosed primary molar teeth with missing underlying permanent successor that are diagnosed after the child's growth spurt could be retained. Progression of infraocclusion is shown to be slower in children aged 15–17-years-old with a mean increase of 0.5 mm per year.³² However,



Fig. 5 Orthopantomogram showing 3 quadrants of infraoccluded teeth with evidence of ankylosis at the apex, lack of alveolar development and bone notching in between the deciduous mandibular right second molar and the first permanent molar

it is important to retain the integrity of the occlusal table. The infraoccluded primary molar could be built up to the correct occlusal plane with direct composite or with an indirect restoration like a ceramic or composite onlay. An onlay may be more suitable to build up to the occlusal table and establish a contact point with the adjacent first premolar.³³ The primary molars could also benefit from placement of a preformed metal crown (PMC); which prevents tipping of the adjacent teeth, restores the occlusion to the correct height and prevents overeruption of the opposing teeth.³⁴ Clinicians must be careful when selecting the size of the PMC, as PMCs have the risk of being

oversized and this may compromise the leeway space.³⁴ These treatment strategies also act as alveolar ridge maintainers in children, should this tooth need to be extracted and restored in the future with a fixed/removable prosthesis.³⁴

There is often a restorative challenge in replacing lower second deciduous molars, as the mesiodistal width of the tooth is greater than a premolar width. Some clinicians advocate interproximal reduction (IPR). This is carried out using either hand files, rotary files or discs, and over a few appointments removes up to 2.5 mm of interproximal width. This procedure must be undertaken with caution, as the relatively large pulp horns

place the primary teeth at a risk of pulpal inflammation and could stimulate premature root resorption and sensitivity.³⁴ In addition, the discing of primary molars may alter contact point height, which leads to food packing and increases caries risk. However, there is a lack of long-term studies on retained second primary molars that have been reduced with IPR,³⁴ therefore it should be used with caution in selected cases.

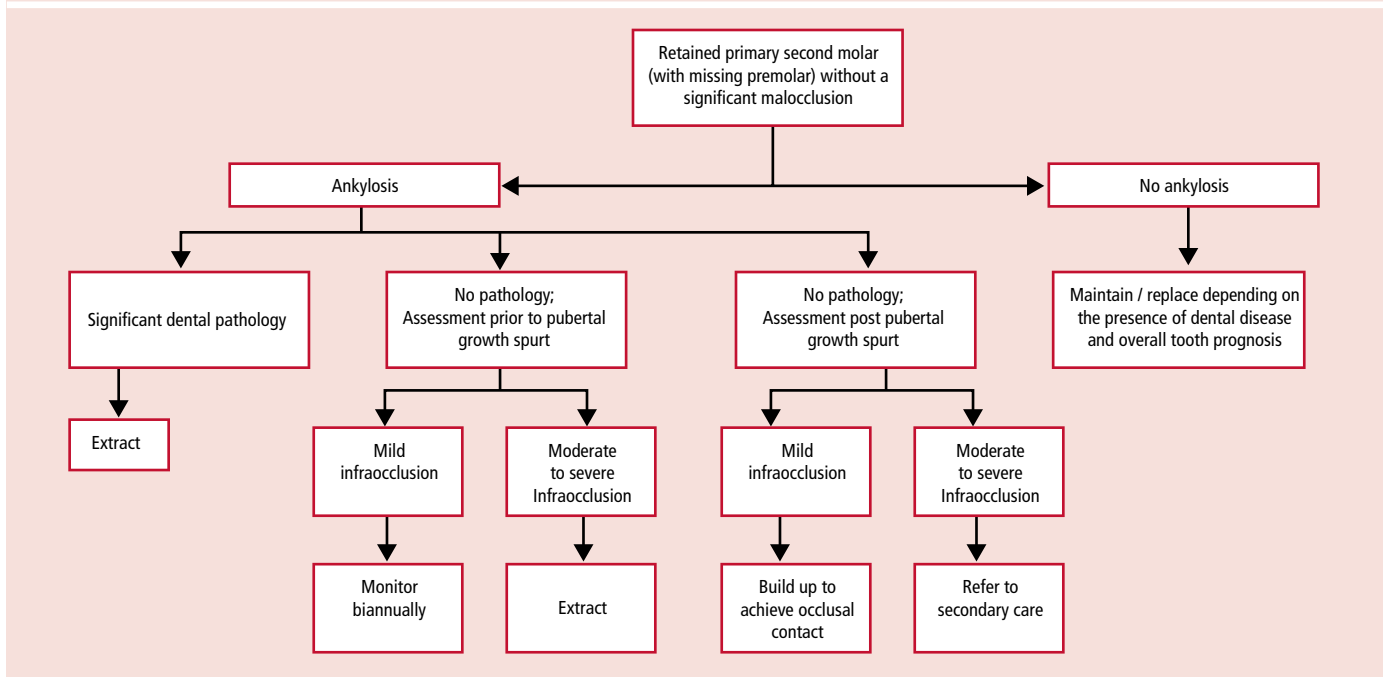
Pathology-free severely ankylosed primary molars with missing underlying permanent successor that are diagnosed after the pubertal growth spurt often need to be referred to secondary care services. Guidance can be sought from an orthodontist regarding the timing of extraction of the infraoccluded primary molar and if orthodontic space closure would be possible.³⁴ Early removal of the infraoccluded molars is often required and facilitates efficient tooth movements.

A majority of severely infraoccluded teeth need to be surgically extracted, which may necessitate the use of general anaesthesia in anxious children. Concerns involved with extraction of severely ankylosed primary second molars is the potential alveolar bone loss, which could be critical if the future management plan includes an implant-supported prosthesis.³⁵ Ostler *et al.* and Kokich *et al.* showed that 25% of the bucco-lingual width would be lost in the first three years, post-extraction of mandibular second primary molars.^{35,36} Potentially, ridge preservation techniques could be considered to maintain soft and hard tissue volume. Sandor *et al.* (1993) described a technique to place coral granules in the primary second molar extraction site,³⁷ which had a 93.5% success rate in preserving the alveolar process and meant that implants were placed without the need for bone grafting.³⁷ An alternative ridge preservation technique described by Smalley involves decoronating the crown of the primary second molar, leaving the roots within the alveolus.³⁸ This technique is used for ankylosed primary molars where a traumatic surgical extraction would be required, resulting in significant bone loss. The decoronation technique helps to preserve the bone until an implant can be placed in the future.³⁸

When assessing the patient orthodontically, lower incisor position can influence the treatment plan and the decision to extract or maintain the retained primary molars. If the lower incisors are at the correct angulation, then space closure should be avoided as

Table 1 A simple classification of infraocclusion with respective clinical examples and radiographs			
Degree of Infraocclusion	Clinical features	Example	Radiograph
None	No infraocclusion present between the occlusal level and the interproximal contact point of the premolar		
Mild	Infraocclusion between the occlusal level and the interproximal contact point of the premolar		
Moderate	Infraocclusion at the interproximal contact point of the premolar (note tooth in image shown is restored with onlay)		
Severe	Infraocclusion below the interproximal contact point of the premolar (note that the adjacent tooth in this image is a canine)		

Fig. 6 A treatment algorithm for cases of infraoccluded primary second molars without permanent second premolar successors and without significant malocclusion



excessive retroclination can be detrimental to the patient's profile. In addition, patients with minimal crowding, deep overbites, reduced anterior face height and flat mandibular plane angles are often treated with a non-extraction approach.³⁴ In patients with these non-extraction characteristics, providing the roots of the mandibular second molars are favourable with mild or no infraocclusion present, then these teeth should be retained and maintained with a fixed prosthesis such as a ceramic onlay or full coverage crown. However, if the ankylosis is severe then extraction and space maintenance or closure may be indicated.³⁴

In patients where the space left by the extraction of the infraoccluded second molar would be too large to be closed orthodontically, then extraction of the infraoccluded molar followed by implant placement is a long-term treatment option to consider. The benefits of an implant-retained prosthesis having a reliable long-term solution needs to be weighed against the longer treatment times, surgical operation, higher treatment fees and ongoing costs for patients.³⁴

If the space is not adequate for restorative or implant rehabilitation, then orthodontists can place temporary anchorage devices to help protract posterior teeth to avoid lower incisor retroclination and eliminate the need for restorative replacement.³⁹ Excessive lower incisor retraction would compromise facial aesthetics in these cases.³⁴

There is lack of clear guidance and information to enable GDPs to manage cases of infraocclusion of primary molars in practice, taking account of the aforementioned scenarios. The authors propose a treatment tree (Fig. 6) that can aid in treatment planning cases of infraoccluded primary molars without permanent successors and without any associated significant malocclusion. The decision tree cannot be fully evidence-based, given the small volume of research in this area, and so it is based on the authors' experience. Complex cases of infraocclusion with or without significant malocclusions would benefit from a multidisciplinary specialist input, and referral to orthodontics, restorative and paediatric dentistry would be prudent.

Conclusion

Early diagnosis of an infraoccluded molar is essential to avoid common problems associated with this clinical scenario. The treatment modalities depend on a number of factors including age of the patient, presence of a permanent successor, the time of diagnosis in relation to a patient's growth spurt, and the malocclusion present. Complex cases would benefit from multidisciplinary input; however, in a majority of simple cases, the given decision tree which is based on the authors' experience would aid clinicians in formulating a suitable treatment plan.

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