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A Guideline for the Extraction of First Permanent Molars in Children

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Introduction

Children continue to present with a developing dentition affected by one or more compromised first permanent molars (FPM) with an uncertain prognosis. This places a burden of disease on each child that can lead to sensitivity and pain, complex restorations or extractions and disruption to the functional occlusion. When correctly planned, interceptive extraction of the FPM can be followed by successful eruption of the second permanent molar (SPM) to provide a suitable replacement, and ideally third molar eruption (TPM) to complete the molar dentition. However, FPM extraction can lead to poor positioning of adjacent teeth and a poor functional occlusion, requiring orthodontic management where appropriate, for definitive correction.

- » For these reasons, the elective extraction of compromised FPMs with an uncertain long-term prognosis should always be considered within the context of the patient and their underlying occlusion; and
- » FPM treatment-planning decisions should ideally be made following input from both the general dental practitioner (GDP) or paediatric dentist and a specialist orthodontist.

Development of the first permanent molar

The FPM is derived from the primary dental lamina and evidence of early formation is usually present by week 17 of gestation in the human embryo (Ooe, 1981):

- » Hard tissue formation is generally initiated in these teeth by birth and coronal development is complete by the third year of life;
- » Eruption of the FPM occurs around the age of 6-7 years;
- » Root formation is complete by the age of 9-10 years (Berkovitz et al., 2017; Nanci, 2017);
- » The timing of coronal mineralisation makes FPM teeth susceptible to chronological and systemic enamel defects, which can lead to localised hypomineralisation and/or hypoplasia (Leppaniemi et al., 2001).

Why is the FPM a particular problem?

The FPM is often one of the first permanent teeth to erupt as the child enters the mixed dentition. Combined with a degree of inaccessibility at the back of the oral cavity, this can make it susceptible to dental caries if subjected to unfavourable conditions in the young child. Whilst caries experience has continually fallen in the permanent dentition of UK children over the last forty years, the most recent data has demonstrated that around one third of UK 15 year-olds still have experience of caries into dentine in at least one of their permanent teeth (Child Dental Health Survey, 2013).

Molar-Incisor-Hypomineralisation (MIH) is a systemic condition with a poorly understood aetiology, that is increasingly being seen and characterised by demarcated and qualitative enamel defects variably affecting the FPM and permanent incisor teeth (Jalevik, 2010; Kuhnisch et al., 2012). Post-eruptive breakdown of FPM coronal enamel is common and can lead to sensitivity, increased caries risk and challenging restorative care. MIH is a significant factor in paediatric dental care and requires careful treatment planning with affected children requiring specific care pathways.

Why is planning for the FPM of poor prognosis so critical?

Enforced extraction of poor prognosis FPMs can cause disruption to the functional occlusion and impact on successful eruption of the SPM, particularly in terms of spontaneous space closure and final SPM position. Although positive associations have been found between space closure and

chronological age at extraction, angulation and developmental stage of the developing SPM and second premolar, presence of the TPM, crowding in the dental arches and skeletal relationship including retrognathic maxilla and prognathic mandible (Hallett and Burke, 1961; Dahan 1970; Plint 1970; Thilander and Skagius 1970; Thunold 1970; Crabb and Rock 1971). However, most of these associations have relied upon investigations using retrospective sample gathering, subjective measures of outcome, limited statistical analyses and incomplete reporting of results and therefore should be considered with some caution.

General principles and practical guidance

The goal of interceptive FPM extraction is to achieve successful eruption of the SPM (and TPM if present, to complete the molar dentition) and the second premolar teeth, with space closure, a lack of tooth tipping and no overeruption of the opposing molar unit.

General principles

To correctly manage compromised FPMs of uncertain prognosis multiple factors need to be considered, including those that have a wider context than occlusal issues for the patient. These include:

- » The immediate clinical symptoms related to the compromised FPM tooth or teeth;
- » An accurate diagnosis of the prognosis of the affected tooth or teeth and an appraisal of any likely future symptoms;
- » The capacity of the patient to receive complex dental care – including surgical, restorative and orthodontic treatment;
- » The availability of services;
- » The overall occlusion or malocclusion; and
- » The aspirations and values of the child and parent relating to immediate dental care and the burden of potential future care.

A child presenting with a developing dentition affected by one or more compromised FPM of poor prognosis may require their immediate enforced extraction. In cases where there is acute pathology and the child is in pain, it may not be possible to plan for ideal timing or the choice of extraction of teeth to be removed. In these cases, any future planning may have to be done once the acute phase has been managed. However, where there are no immediate needs, careful planning to encourage the best position of the developing adult teeth given the available resources and capacity of the child should be considered. This may require any compromised FPM to be restored or stabilised to allow for specialist input.

Referral to centres where combined orthodontic and paediatric services are available is encouraged to allow comprehensive treatment planning to be undertaken and should be considered the gold standard. Where this is not possible, these guidelines aim to support the clinical decisions that will need to be made by the attending clinician or clinicians.

In all cases, a detailed assessment of the prognosis of all teeth should be made with an accurate prediction of any future care needs outlined. Any restorative work undertaken on the affected teeth, including pre-operative photographs where possible, should be documented to give clear guidance for any future treatment planning.

It is understood that evidence-based decisions around prognosis are difficult to make. Any restoration is likely to fail eventually and teeth affected with MIH that appear grossly intact may have opacities that can breakdown at a later date (Neves et al., 2018).

All possible options should be communicated to the patient and or parents/guardians. Some patients may prefer to lose a tooth rather than have a lifetime burden of restorative maintenance and repair, others may choose to maintain a tooth at all costs. Discussing these options should be part of a shared decision-making process, including the opinions and values of the child, parents/guardians and dental professional. A further important consideration is the capacity of the child to undertake interceptive interventions. The treatment plan may be significantly modified if a general anaesthetic is required rather than local anaesthetic or sedation, particularly if the treatment plan is associated with multiple stages. These discussions form the basis of informed consent and are essential when providing treatment with outcomes that are often not completely predictable and rely on favourable growth and development for success.

The patient's capacity to comply with complex treatment must be recorded. Are there medical, dental, psychological, intellectual or patient-management reasons why complex treatment may not be accepted? If a child cannot cope with treatment at the time of presentation, this does not mean that they never will. A careful assessment of whether they will ever be able to, should be made with them and their guardians. Factors limiting the ability for a child to undertake complex care related to medical and intellectual capacity may be ongoing and lifelong, but those relating to quality of oral hygiene and ability to accept treatment may change over time and any assessment of capacity must include both aspects.

The developmental age of the patient may be very different to their chronological age and it essential that this is considered before choosing a treatment that relies on the eruptive pathway of the adult dentition.

Features of the occlusion, such as skeletal pattern, the presence of crowding or tooth agenesis, ectopic tooth positions, presence or absence of the TPM and assessment of SPM development and angulation will have a significant impact on treatment choice. In particular, significant mid-arch crowding may require the stabilisation of a compromised FPM to avoid further space loss; whilst conversely, hypodontia may require early extraction or restoration of compromised teeth to manage the long-term occlusal platform.

A full dental assessment must include a radiographic screen with a Dental Panoramic Tomograph (DPT) to check for the presence, position and normal formation of the full developing permanent dentition.

Predictors of successful SPM eruption following interceptive FPM removal

Radiographic evidence of a SPM within alveolar bone and early mineralisation of its bifurcation have been cited as predictors for successful eruption of this tooth following FPM extraction, particularly in the lower arch (Normando et al., 2010; Thilander et al., 1963; Thilander and Skagius, 1970; Thunold, 1970). However, this might simply reflect the developmental stage of the child rather than anything specific to SPM development. More recent research has identified a predictive relationship relating to mesio-distal angulation of the SPM and presence of the TPM in terms of favourable SPM eruption (Patel et al., 2017). These predictive factors are more pertinent following extraction of a compromised lower FPM, as favourable SPM eruption is less of a concern following extraction of a compromised upper FPM (Ay et al., 2006; Halicioglu et al., 2013; Patel et al., 2017; Williams and Hosila, 1976; Yavuz et al., 2006).

Extraction of the compromised FPM when the SPM is developing (between the ages of 8-10 years) appears to cause less disruption to the occlusion. If this window is not met and the lower FPM is

extracted before the age of 8 years, or during the later stages of SPM eruption, the SPM and second premolar can drift into the extraction space, tip, rotate and produce spacing in the dental arch with poor occlusal contacts (Normando et al., 2010; Thilander et al., 1963; Thilander and Skagius, 1970; Thunold, 1970).

TPM development is usually evident radiographically by 8 years of age, but it can demonstrate wide variation and be delayed significantly. This is unfortunate because treatment planning often needs to be undertaken before the presence or absence of the TPM can be confirmed. If a TPM is present and FPM interceptive extraction is carried out at the optimal time or the patient is able to undergo orthodontic treatment, there is every expectation that the child will ultimately have two molars in each quadrant in good occlusion; and therefore, in these circumstances, it is much more acceptable to extract a compromised FPM with an uncertain prognosis.

Where there is no evidence of a TPM, the decision to restore or extract the affected FPM is more complex. Extraction of the FPM will potentially leave the child with only one molar unit in the affected quadrant, leading to a reduced posterior occlusion and possibly unopposed teeth, if TPM are present in the opposing quadrant. This situation requires a much more detailed conversation between patient, dentist and orthodontist.

Should we provide balancing and compensating extractions?

- » A compensating extraction is the removal of a FPM from the opposing quadrant; and
- » A balancing extraction is the removal of a FPM from the opposite side of the same dental arch.

Compensating extraction of a sound upper FPM has been recommended when extraction of the lower FPM is required (Holm, 1970). This is to avoid over-eruption of an unopposed upper FPM, which can prevent desirable mesial movement of the erupting lower SPM, thus impeding space closure and potentially inducing other occlusal interferences. There is little evidence to verify these claims and what evidence is available is based on retrospective cohort studies, often with very small samples (Holm, 1970; Jalevik and Moller, 2007; Mejare et al., 2005). Current evidence would suggest that the risk of upper FPM over-eruption as a consequence of lower FPM extraction is small (Jalevik and Moller, 2007; Mejare et al., 2005).

Recommendation: When the enforced extraction of a lower FPM is required the compensating extraction of a sound upper FPM should not be routinely carried out unless there is a clear occlusal requirement or likelihood of the upper FPM being unopposed for a significant period of time.

The balancing extraction of sound FPMs has been recommended to preserve arch symmetry (Ong and Bleakley, 2010; Williams and Gowans, 2003). Retrospective cohort studies have suggested that unilateral FPM extraction can be associated with the development of both skeletal and dental arch asymmetries (Caglaroglu et al., 2008; Telli and Aytan, 1989). Evidence from similar study designs suggests that the dental centreline in either arch is unlikely to be affected (Jalevik and Moller, 2007; Mejare et al., 2005).

Recommendation: Routine balancing extraction of a sound FPM to preserve a dental centreline is not recommended unless part of a comprehensive orthodontic treatment plan.

General principles of management: upper arch

In the upper arch, an unerupted SPM will generally achieve a good occlusal position following extraction of the compromised FPM (Patel et al., 2017). The upper SPM can be expected to drift mesially into contact with the second premolar.

If there is crowding in the upper arch or if space will be required for correction of a class II incisor relationship, consideration should be given towards temporisation of the compromised FPM until the SPM erupts, allowing placement of a palatal arch on the erupted SPMs to prevent their mesial movement and maintain the FPM spaces. If this is not feasible or the patient is unsuitable for appliance wear or there is a need for urgent care under general anaesthetic, then a decision will need to be made in terms of space requirements. In particular, the position of the upper canines and the need for interceptive extraction of any other teeth that might be required at the time of FPM removal. With patients who cannot tolerate complex treatment, it may be preferable to plan and manage as many presenting issues as possible to avoid repeat general anaesthesia. In cases where there is no TPM, assessment of FPM prognosis is even more critical for those patients who are not suitable for orthodontic care to maximise the chances of a good posterior occlusion.

For patients who can access specialist orthodontic care, the introduction of TADs and innovative fixed anchorage techniques has made the effects of space loss due to early extraction of the upper FPMs much less significant and these patients can be managed with fixed appliances

General principles of management: lower arch

In the lower arch, occlusal outcomes are more variable and less predictable and the timing of FPM extraction is more critical to ensure successful eruption of the SPM (Plint, 1970; Teo et al., 2013; Thilander et al., 1963; Thilander and Skagius, 1970; Thunold, 1970). However, space requirements are often less demanding, depending upon the underlying malocclusion.

Classically, radiographic evidence of early mineralisation in the SPM bifurcation has been regarded as the best predictor for successful eruption of these teeth following FPM extraction (Normando et al., 2010; Thilander et al., 1963; Thilander and Skagius, 1970; Thunold, 1970). However, recent work suggests that whilst there may be a relationship between age and root development and successful eruption of the SPM, the angulation of the SPM and presence of the TPM at the time of FPM extraction may be more important in predicting a favourable erupted occlusal position and angulation (Patel et al., 2017; Teo et al., 2013).

If a TPM is present, there is every expectation that the child will have two erupted molars in each quadrant and therefore extraction of a compromised FPM of uncertain prognosis is much more acceptable. There is also evidence that interceptive extraction of a FPM can improve the position of the TPM in both the upper and lower jaws (Ay et al., 2006; Halicioglu et al., 2013; Williams and Hosila, 1976; Yavuz et al., 2006), further supporting removal in those cases with an uncertain prognosis.

Ideal timing of FPM extraction – important information to consider

This guidance should not be used if:

- » The SPM is erupted – if it is, there is no advantage to an interceptive approach because a SPM in occlusion will not migrate mesially;
- » Access to a recent DPT to assess SPM development and position, and the presence or absence of TPMs is not available; or
- » There are acute symptoms such as pain, swelling or infection and the affected compromised FPM or FPMs cannot be temporised.

It is important that each case is evaluated independently and not simply on the basis of age or malocclusion. The following information should be recorded:

- » The immediate clinical symptoms related to the compromised FPM;
- » An accurate diagnosis of the prognosis of the affected teeth and an options appraisal of any likely future symptoms (this should be sought from the referrer, the patient and by assessment on clinic);
- » The capacity of the patient to receive complex dental care should be assessed following discussion with the patient, guardians and by the patient's own general dental practitioner or paediatric dentist whenever possible;
- » The availability of services – the location, availability and financial burden in seeking services should be assessed;
- » The overall occlusion or malocclusion – a detailed dental and orthodontic assessment should be made; and
- » The aspirations and values of the child and parent relating to dental care and the burden of future care – a comprehensive discussion outlining the options available and the commitment involved should be explored.

Once this information has been recorded, the best option for the patient should be formulated with alternatives tailored to their individual needs and capacity along with reference to the services available to them. Once this has been done, a full shared-care discussion should be had with the patient and parent/guardians and the best practical approach agreed. At each stage following this and after each intervention, this process should be reviewed to consider any changes in capacity or wish and to reflect on the outcome of the development of the dentition.

It is important to remember that interceptive extraction in the developing dentition is a dynamic intervention that requires professional supervision and careful review. It is best undertaken through a specialised team with the full complement of specialties and, ideally, care should not be considered a one-off intervention.

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