RCS
FACULTY OF DENTAL SURGERY

A Guideline for the Extraction of First Permanent Molars in Children

An Update of the 2009 Guidelines written by MT Cobourne, A Williams and R McMullen

Martyn T. Cobourne
Professor of Orthodontics
Department of Orthodontics and Craniofacial Development
King's Dental Institute
King's College London
Floor 22, Tower Wing
London SE1 9RT

Alison Williams
Specialist in Orthodontics
SP Orthodontics Ltd
2a Barham Road
London SW20 0EU

Mike Harrison
Consultant in Paediatric Dentistry
Guy's and St Thomas' Hospital
Westminster Bridge Road
London SE1 7EH

2014

Contents

Introduction

Children can present with a developing dentition affected by one or more first permanent molars of poor prognosis, which may necessitate their enforced extraction. In the right circumstances, first permanent molar extraction can be followed by successful eruption of the second permanent molar to provide a suitable replacement, and ultimately third molar eruption to complete the molar dentition. The elective extraction of first permanent molars, with a questionable long-term prognosis, should be considered when planning enforced extraction. These treatment-planning decisions should ideally be made following input from both the general or paediatric dentist and the orthodontist, although this may not always be possible.

This guideline offers advice on the extraction of first permanent molars in the child. However, it is important to remember that in addition to the presenting clinical features a number of additional factors may influence the decision-making process. These include a child's social background, the necessity for general anesthetic to allow extraction of these teeth, the likelihood of the child co-operating with restorative or orthodontic treatment, prevention and oral hygiene practice within the family, as well as any local difficulties in accessing NHS restorative or orthodontic treatment.

Development of the first permanent molar

The first permanent molar is derived from the primary dental lamina and morphological evidence of its formation is usually present in the human embryo by week 17 of gestation[1]. Hard tissue formation has generally initiated in these teeth by birth and coronal development is complete by the third year of life. Eruption of the first permanent molars occurs around the age of 6-7 years and root formation is complete by the age of 9-10 years[2,3].

The relative timing of crown formation makes the first permanent molar susceptible to chronological enamel defects, which can lead to hypomineralisation and/or hypoplasia[4]; whilst molar-incisor hypomineralisation (MIH) is a recognized condition of unknown aetiology with a prevalence in the literature ranging from 10-30%[5,6]. The timing of first molar eruption also makes these teeth vulnerable to dental caries. Although caries experience has continually fallen in the permanent dentition of UK children over the last thirty 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[7]. Currently, the majority of first permanent molars are extracted because of dental caries[8].

First permanent molars of poor prognosis

A child presenting with a developing dentition affected by one or more first permanent molars of poor prognosis may require their enforced extraction. At this stage, some consideration should also be given toward elective extraction of the remaining first permanent molars, in the form of balancing or compensating extractions; particularly those with a compromised long-term prognosis.

Before the extraction of any teeth is prescribed, a radiographic screen should be carried out to check for the presence, position and normal formation of the developing permanent dentition. Any other primary teeth of questionable prognosis should also be considered as candidates for balancing or compensating extraction, particularly if general anaesthesia is required. It can be more difficult to justify these extractions if local anaesthesia is used for the enforced extraction of a single symptomatic tooth and cooperation for further extractions may be poor.

Balancing and compensating extractions

The practice of compensating and balancing the extraction of first permanent molars aims to preserve occlusal relationships and arch symmetry within the developing dentition. In this context:

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

A number of factors can influence whether a first permanent molar is recommended for either a balancing or compensating extraction:

- Which of the first permanent molar/s requires enforced extraction;
- The overall condition and long-term prognosis of the remaining first permanent molar/s;

- The teeth present and developmental status of the dentition (including third molars); and
- The underlying malocclusion.

As a general rule, the compensating extraction of an upper first permanent molar has been recommended when extraction of the lower first permanent molar is required[9]. This is to avoid over-eruption of an unopposed upper first permanent molar, which can prevent desirable mesial movement associated with the erupting lower second permanent molar and other occlusal interferences. There is, however, little formal data in the literature to verify these claims. Current evidence would suggest that the risk of upper first permanent molar over-eruption as a consequence of lower first permanent molar extraction is small[10,11]. However, all available data that addresses this issue directly is based on retrospective cohort studies, often with very small sub-samples[9-11]. A randomised controlled trial has been registered, which aims to investigate clinical effectiveness and quality of life associated with and without compensating extraction of upper first permanent molars in conjunction with the enforced extraction of lower first permanent molars[12].

When the enforced extraction of a lower first permanent molar is required, some consideration should be given toward compensating extraction of the upper first permanent molar if this tooth is likely to remain unopposed for a significant length of time. The routine compensating extraction of a sound lower first permanent molar, in conjunction with enforced extraction of the upper first permanent molar, is not recommended.

The balancing extraction of sound first permanent molars has been recommended to preserve arch symmetry[13,14]. Retrospective cohort studies have suggested that unilateral first molar extraction can be associated with the development of both skeletal and dental arch asymmetries[15,16]. Evidence from similar study designs suggests that the dental centreline in either arch is unlikely to be affected[10,11].

Routine balancing extraction of a sound first permanent molar to preserve a dental centreline is not recommended.

Treatment planning goals

Ideally, first permanent molar extractions should be followed by successful eruption of the second permanent molars to replace them and ultimately, the third molars. However, achieving this can be complicated by a number of factors:

- Timing of first permanent molar extraction can influence the subsequent eruptive position of the second permanent molar, particularly in the lower arch; and
- Third permanent molar development cannot always be confirmed at the time extraction decisions have to be made.

In addition, consideration also needs to be given to the consequences of first permanent molar extraction within the context of the developing occlusion, particularly in the presence of an underlying malocclusion.

In many cases, at least one first permanent molar may require enforced extraction because of its poor condition and unfavourable long-term prognosis. At this stage, a decision should also be made regarding the need for elective extraction of any other teeth. This decision will be influenced primarily by their condition and the underlying occlusion. Before any extraction decisions are made, good quality radiographs are required to show the presence, condition and developmental stage of all teeth in the dentition. If any teeth in the permanent dentition are absent or in a poor eruptive position, this can significantly affect the decision-making process. Ideally, an orthodontic opinion should be obtained, preferably from the orthodontist responsible for future treatment, whenever this is practically possible.

- In the absence of a definitive opinion and if the use of local anaesthetic is practical, enforced extraction should be carried out and advice sought regarding further elective extractions; and
- If a general anaesthetic is the only option, advice on elective extractions should be obtained beforehand if at all possible, to prevent the risk of multiple anaesthetics.

Ideal timing of first permanent molar extraction

In the upper arch, an unerupted second permanent molar will generally achieve a good occlusal position following extraction of the first permanent molar; however, in the lower arch occlusal outcome can be more variable and less predictable[17-21].

The timing of first permanent molar extraction in the lower arch is more important for successful eruption of the second permanent molar. The most favourable chronological age range is 8-10 years, after eruption of the lateral incisors but before eruption of the second permanent molar and/or second premolar[20,21]. Traditionally, it has been suggested that second permanent molar development as a predictor for successful eruption of these teeth requires that they are still within bone and demonstrating radiographic evidence of calcification in the root bifurcation to produce the best occlusal position. However, the response of the second permanent molar is variable and acceptable positions are also possible in association with extraction at earlier or later stages of development[18].

If the first permanent molar is extracted before the age of 8 years, there is often no radiographic evidence of third molar development. In addition, in the lower arch:

- The second premolar can drift distally into the extraction space, tip and rotate[21,22]; and
- The labial segments can retrocline with an accompanying increase in the overbite[21-24].

If the first permanent molar is extracted during the later stages of second permanent molar eruption, there is more risk that this tooth may tip mesially and rotate, producing spacing and poor occlusal contacts[19-21,25]. In addition, the erupted second premolar can migrate distally.

There is some retrospective evidence that first permanent molar extraction can accelerate the development and eruption of the third molar in both the upper and lower jaws[26-29].

Extraction of a first permanent molar is rarely the extraction of choice. However, favourable spontaneous development of the dentition and space closure can be expected in many cases[10,11,18]. It is also possible to achieve good results using fixed appliances and appropriate mechanics, although treatment times tend to be increased[30,31]. It is not advisable to extract a healthy premolar for orthodontic purposes if the first permanent molar in the same quadrant is heavily restored.

Guidelines for elective first permanent molar extraction

A number of general guidelines on treatment planning first permanent molar extraction cases for a number of malocclusions are available[13,31-33]. As a general rule, if in doubt, get the patient out of pain, try and maintain the teeth and refer for a specialist orthodontic opinion.

Class I cases

Class I cases with minimal crowding

Aim for extraction at the optimal time for eruption of the second permanent molars into a good occlusal position.

- Do not balance unilateral first permanent molar extraction in either the upper or lower jaws with healthy first permanent molars;
- If the lower first permanent molar is to be lost, compensating extraction of the upper first permanent molar can be considered if this tooth is likely to be unopposed for a significant length of time;
- If the upper first permanent molar is to be lost, do not compensate with extraction of the lower first permanent molar if it is healthy.

Class I cases with moderate crowding

In the presence of moderate crowding in the buccal segments, extract at the optimal time to allow eruption of second permanent molars into a good occlusal position, which should also provide some relief of crowding.

- If the buccal segment crowding is bilateral, consider balancing extraction of the contralateral first permanent molar to provide suitable relief, if there is any question regarding the long-term prognosis for this tooth;
- Compensating extraction of upper first permanent molars can be considered to relieve premolar crowding.

In the presence of crowding in the labial segments, little spontaneous relief is provided by first permanent molar extraction.

- First permanent molar extractions can be delayed until the second permanent molars have erupted and then the extraction space used for alignment with fixed appliances.
- Alternatively, first permanent molars can be extracted at the optimum time and the crowding treated once in the permanent dentition. If premolar extractions are likely to be required at this stage, the third permanent molars should be present.

Class II cases

The extraction of first permanent molars in class II cases can be more difficult to plan, particularly with regard to the timing of upper first permanent molar extraction. The main complicating factors often involve the upper arch because of the need for space to correct the incisor relationship.

Class II cases with minimal crowding

Lower first permanent molar extraction should be carried out at the ideal time for successful eruption of the second permanent molar and control of the second premolar.

In the upper arch, space will often be required to correct the incisor relationship:

- If the upper first permanent molars require immediate extraction:
    - Orthodontic treatment may be instituted to correct the incisor relationship. A functional appliance or removable appliance and headgear can be used to correct the buccal segment relationship, followed by fixed appliances if required;
    - Alternatively, after extraction of the upper first permanent molars, the second permanent molars can be allowed to erupt and the incisor relationship corrected once this has taken place. Correction of the malocclusion at this stage can involve any of the methods described above. In addition, if there is radiographic evidence of third molar development, then further space for incisor correction could be created by the loss of two upper premolar teeth;
- If the upper first permanent molars can be temporised or restored, then their extraction can be delayed until the second permanent molars have erupted. The extraction space can then be used to correct the malocclusion with fixed appliances. If the upper first permanent molars are to be left unopposed for any length of time, a simple removable appliance may be required to prevent their over-eruption, whilst waiting for the second permanent molars to erupt. Alternatively, a functional appliance can be used immediately to correct the incisor relationship prior to extraction of the first molars and fixed appliances;
- If the upper first permanent molars are sound, then all of the options described above can apply. Their elective extraction should ideally be carried out when there is evidence of third molars radiographically. The class II relationship can then be managed as for immediate extraction of upper first molars with a poor prognosis. Alternatively, these teeth can be left and if there is no sign of upper third molar development, an appliance to prevent the over-eruption of sound upper first molars should be considered and the malocclusion managed following eruption of the second molars.

The introduction of temporary anchorage devices (TADs) has provided an additional source of anchorage for the correction of a class II incisor relationship following the extraction of upper first permanent molars, particularly when extracted after eruption of the upper second permanent molars.

The maintenance of overbite correction can be very challenging in class II division 2 cases requiring prolonged space closure following extraction of first permanent molars after second permanent molar eruption. There is some retrospective evidence that first permanent molar extraction can be associated with incisor uprighting and an increase in the overbite[21-24].

Class II case with crowding.

In the presence of crowding, space requirements will be greater. In the lower arch, space will be required for crowding relief, whilst in the upper arch there will be an increased demand on space available for correction of the incisor relationship.

- If the third molars are present radiographically, lower first permanent molars can be extracted at the optimum time to allow second permanent molar eruption and then premolars extracted at a later stage for the correction of crowding. In these cases, fixed appliances will usually be required;
- Alternatively, first permanent molars can be extracted after second permanent molar eruption and the space used directly for the correction of crowding with fixed appliances;
- Balancing and compensating extraction of lower first permanent molars are not generally required.

Because space requirements in the upper arch can be significant, upper first permanent molars should be temporised or restored if at all possible and the child referred to a specialist orthodontist. If the upper first permanent molar is unopposed and at risk of over-erupting, if the third molars are present radiographically, then extraction of the upper first permanent molar may be indicated. The patient should be counselled that additional premolar extractions in the upper arch may be required in the future to create sufficient space for crowding relief and incisor correction.

Class III cases

Class III cases are often difficult to manage and ideally require the opinion of a specialist orthodontist before any first permanent molars are extracted. As a general rule, balancing and compensating extractions are not recommended in class III cases. A tendency toward increased residual spacing of the second permanent molar has been described in the lower arch of class III cases following first permanent molar extraction[18].

Levels of Evidence

1++	High quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias
1+	Well-conducted meta-analyses, systematic reviews, or RCTs with a low risk of bias
1-	Meta-analyses, systematic reviews, or RCTs with a high risk of bias
2++	High quality systematic reviews of case control or cohort or studies High quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal
2+	Well-conducted case control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal
2-	Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal
3	Non-analytic studies, e.g. case reports, case series
4	Expert opinion

Grades of Recommendations

A	At least one meta-analysis, systematic review, or RCT rated as 1++, and directly applicable to the target population; *or* A body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results
B	A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results; *or* Extrapolated evidence from studies rated as 1++ or 1+
C	A body of evidence including studies rated as 2+, directly applicable to the target population and demonstrating overall consistency of results; *or* Extrapolated evidence from studies rated as 2++
D	Evidence level 3 or 4; *or* Extrapolated evidence from studies rated as 2+

SIGN 50 A Guideline Developer's Handbook
http://www.sign.ac.uk/guidelines/fulltext/50/index.html

References

1. Ooe T. Human *Tooth and Dental Arch Development.* Ishiyaku Publishers Inc; 1981.

2. Berkovitz BKB, Holland GR, Moxham BJ. *Oral Anatomy, Embryology and Histology.* 4th edn. Mosby International Ltd, Edinburgh; 2009.

3. Ten Cate AR. *Oral Anatomy: development, structure and function.* Mosby-Year Book Inc, St Louis, Missouri; 2015.

4. Leppaniemi A, Lukinmaa PL, Alaluusua S. Nonfluoride hypomineralizations in the permanent first molars and their impact on the treatment need. *Caries Res* 2001; **35(1):** 36-40.

5. Jalevik B. Prevalence and Diagnosis of Molar-Incisor- Hypomineralisation (MIH): A systematic review. *Eur Arch Paediatr Dent* 2010; **11(2):** 59-64.

6. Kuhnisch J, Heitmuller D, Thiering E *et al.* Proportion and extent of manifestation of molar-incisor-hypomineralizations according to different phenotypes. *J Public Health Dent* 2012.

7. Pitts NB, Chestnutt IG, Evans D *et al.* The dentinal caries experience of children in the United Kingdom, 2003. *Br Dent J* 2006; **200(6):** 313-320.

8. Albadri S, Zaitoun H, McDonnell ST *et al.* Extraction of first permanent molar teeth: results from three dental hospitals. *Br Dent J* 2007; **203(7):** E14; discussion 408-409.

9. Holm U. Problems of compensative extraction in cases with loss of permanent molars. Rep Congr Eur Orthod Soc. 1970: 409-427.

10. Jalevik B, Moller M. Evaluation of spontaneous space closure and development of permanent dentition after extraction of hypomineralized permanent first molars. *Int J Paediatr Dent* 2007; **17**: 328-335.

11. Mejare I, Bergman E, Grindefjord M. Hypomineralized molars and incisors of unknown origin: treatment outcome at age 18 years. *Int J Paediatr Dent* 2005; **15(1)**: 20-28.

12. Innes N, Borrie F, Bearn D *et al.* Should I eXtract Every Six dental trial (SIXES): study protocol for a randomized controlled trial. *Trials* 2013 Feb 27;14:59. http://www.trialsjournal.com/content/14/1/59

13. Ong DC, Bleakley JE. Compromised first permanent molars: an orthodontic perspective. *Aust Dent J* 2010; **55**: 2-14; quiz 105.

14. Williams JK, Gowans AJ. Hypomineralised first permanent molars and the orthodontist. *Eur J Paediatr Dent 2003*; **4:** 129-132.

15. Caglaroglu M, Kilic N, Erdem A. Effects of early unilateral first molar extraction on skeletal asymmetry. *Am J Orthod Dentofacial Orthop* 2008; **134:** 270-275.

16. Telli AE, Aytan S. [Changes in the dental arch due to obligatory early extraction of first permanent molars]. *Turk Ortodonti Derg* 1989 Apr; **2(1)**: 138-143.

17. Plint DA. The effect on the occlusion of the loss of one or more first permanent molars. Rep Congr Eur Orthod Soc. 1970: 329-336.

18. Teo TK, Ashley PF, Parekh S *et al.* The evaluation of spontaneous space closure after the extraction of first permanent molars. *Eur Arch Paediatr Dent* 2013; **14(4):** 207-212.

19. Thilander B, Jakobsson SO, Skagius S. Orthodontic sequelae of extraction of permanent first molars. *Skand Dent J* 1963; **71:** 380.

20. Thilander B, Skagius S. Orthodontic sequelae of extraction of permanent first molars. A longitudinal study. Rep Congr Eur Orthod Soc. 1970: 429-442.

21. Thunold K. Early loss of the first molars 25 years after. Rep Congr Eur Orthod Soc. 1970: 349-365.

22. Hallett GEM and Burke PH. Symmetrical extraction of first permanent molars. Factors

controlling results in the lower arch. *Trans Eur Orthod Soc* 1961. 238-253.

23. Abu Aihaija ES McSheny PF and Richardson A. (2000) A cephalometric study of the effect of extraction of lower first permanent molars. J Clin Pediatr Dent. 24, 195-198.

24. Richardson A. Spontaneous changes in the incisor relationship following extraction of lower first permanent molars. *Br J Orthod* 1979; **6:** 85-90.

25. Normando AD, Maia FA, Ursi WJ *et al.* Dentoalveolar changes after unilateral extractions of mandibular first molars and their influence on third molar development and position. *World J Orthod* 2010; **11(1)**: 55-60.

26. Halicioglu K, Toptas O, Akkas I *et al.* Permanent first molar extraction in adolescents and young adults and its effect on the development of third molar. *Clin Oral Investig* 2013.

27. Williams R, Hosila FJ. The effect of different extraction sites upon incisor retraction. *Am J Orthod* 1976; **69(4):** 388-410.

28. Yavuz I, Baydas B, Ikbal A *et al.* Effects of early loss of permanent first molars on the development of third molars. *Am J Orthod Dentofacial Orthop* 2006; **130(5):** 634-638.

29. Ay S, Agar U, Bicakci AA *et al.* Changes in mandibular third molar angle and position after unilateral mandibular first molar extraction. *Am J Orthod Dentofacial Orthop* 2006; **129(1):** 36-41.

30. Jacobs C, Jacobs-Muller C, Luley C, *et al.* Orthodontic space closure after first molar extraction without skeletal anchorage. *J Orofac Orthop* 2011; **72(1):** 51-60.

31. Sandler PJ, Atkinson R, Murray AM. For four sixes. *Am J Orthod Dentofacial Orthop* 2000; **117(4):** 418-434.

32. Gill DS, Lee RT, Tredwin CJ. Treatment planning for the loss of first permanent molars. *Dent Update* 2001. **28(6):** 304-308.

33. Mackie IC, Blinkhorn AS, Davies PHJ. The extraction of permanent molars during the mixed dentition period - a guide to treatment planning. *J Paed Dent* 1989; **5:** 85-92.