Loss of Deciduous Teeth – Is Timing Important to the GDP?

Abstract: On a daily basis, GDPs encounter patients with prematurely lost deciduous teeth or, conversely, deciduous teeth retained well past their accepted exfoliation date. The timing of deciduous tooth loss impacts on many aspects of the developing occlusion. The aim of the article is both to describe this impact and also to set out guidelines which should assist the general dental practitioner in the decision of when to lose deciduous teeth.

Clinical Relevance: The timing of deciduous tooth loss is an important concept which, when outside the normal pattern, may have adverse or beneficial side-effects that general dental practitioners should fully understand.

The normal eruptive sequence

Eruption can be defined as ‘the biological process that follows the formation of the dental crown and is essentially penetration of the covering oral mucosa by any part of a single tooth’. The time of eruption of both the deciduous and permanent dentitions occur over a wide age range and are affected by endocrine, genetic and dysmorphic factors. Environmental factors such as ethnic origin, socio-economic group, climate and fluoride concentration can also have an effect.

Variation in eruption times is commonplace, however, significant variation from the norm should be appreciated and investigated. Dental practitioners should also be able to identify patients with an unusual eruptive sequence and take appropriate action.

The typical sequence of eruption differs between the upper and lower arches: the lower teeth generally erupting before their upper counterparts, with the exception of the premolars. There are also differences between the sexes, with girls’ teeth erupting in the same sequence but sometimes up to 12–18 months earlier than boys.

Eruption of the permanent dentition is often described as occurring in three phases:
- First permanent molars and incisors;
- The remaining deciduous teeth are exfoliated and replaced with permanent successors and the second permanent molars erupt;
- Third molars erupt.

Chronology tables of the development and eruption dates of the human dentition are available. These can be referred to by the practitioner when assessing patients for potential orthodontic problems.

The classic sequence of permanent tooth eruption in the upper arch is:
- First molar, central incisor, lateral incisor, first premolar, canine, second premolar, second molar and third molar.

In the lower arch the sequence is:
- Central incisor, first molar, lateral incisor, canine, first premolar, second premolar, second molar and third molar.

Delayed eruption of permanent teeth can be caused by many factors but retained deciduous teeth, which may or may not be ankylosed, are often the cause. Teeth may also show delayed eruption due to other physical obstructions such as supernumerary teeth, scar tissue and other soft tissue impediments. Systemic conditions, such as amelogenesis imperfecta and Down’s syndrome, have also...
been implicated and delayed eruption, whatever the cause, can cause challenges when orthodontic treatment planning.  

Early loss of deciduous teeth  
Early loss of deciduous molar teeth is mainly attributed to caries, whereas deciduous central incisors are principally lost due to trauma and deciduous lateral incisors and canines are lost early due to premature root resorption.  
Early loss of deciduous teeth is likely to have some effect upon the developing dentition. As a general rule, there is space loss in the area with a concomitant reduction in space available for permanent successors. Other adverse effects include tipping of the adjacent teeth, and crowding and subsequent impaction of the unerupted permanent teeth. An increased need for orthodontic treatment has been demonstrated in those who have prematurely lost deciduous teeth. Arch length is generally lost due to mesial movement of the first permanent molars, but has also been shown to occur by distal drift of anterior teeth in the case of early loss of deciduous canines where teeth adjacent to extraction sites are moving in both directions towards the extraction space.  

Lower deciduous canines have, in the past, been suggested for extraction to relieve lower permanent incisor crowding. Reports have, however, shown this to cause slight mesial drift of the buccal segments, a general decrease in the arch length, retrusion of the incisors, an increase in overbite and an increase of crowding within the arch. Lower deciduous canine extraction is therefore rarely recommended by contemporary orthodontists.  

Premature loss of the deciduous molars has also been shown to influence the occlusion and space within the arch. Space loss occurs more in the maxilla than the mandible. In cases where there is little crowding, the effect of tooth loss is minimal. However, where there is significant crowding, loss of the second primary molar leads to greater space loss than the first primary molar. If the second primary molar is lost prior to the eruption of the first permanent molar, then the entire space for the second premolar can be completely lost. Generally, the later the deciduous tooth loss, the smaller is the overall space loss. Extractions carried out after the age of ten years have been shown to cause little overall space loss, owing to the fact that the first permanent molars have established their position in the oral cavity.  

Whilst extracting a deciduous tooth close (within 6 months) to the eruption time of the permanent successor will almost always hasten its appearance, extracting a deciduous tooth very early will have the opposite effect. It is more difficult for a permanent successor to erupt through the mature scarred mucosa or compact bone which can result from early loss of a deciduous predecessor.  

Thought should therefore be given to retaining deciduous teeth wherever possible if the permanent teeth are not going to erupt within the next 12 months or, alternatively, to space maintenance following early loss of deciduous teeth if it is thought that space loss might adversely impact upon the development of the permanent dentition.  

Table 1. The chronology of development of the deciduous dentition.  

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<thead>
<tr>
<th>Tooth</th>
<th>Eruption</th>
<th>Root completion</th>
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<tbody>
<tr>
<td>Maxillary central incisor</td>
<td>7.5 months</td>
<td>1.5 years</td>
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<tr>
<td>Maxillary lateral incisor</td>
<td>9 months</td>
<td>2 years</td>
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<tr>
<td>Maxillary first molar</td>
<td>18 months</td>
<td>3.25 years</td>
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<tr>
<td>Maxillary second molar</td>
<td>24 months</td>
<td>3 years</td>
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<tr>
<td>Mandibular central incisor</td>
<td>6 months</td>
<td>1.5 years</td>
</tr>
<tr>
<td>Mandibular lateral incisor</td>
<td>7 months</td>
<td>1.5 years</td>
</tr>
<tr>
<td>Mandibular canine</td>
<td>16 months</td>
<td>3.25 years</td>
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<tr>
<td>Mandibular first molar</td>
<td>12 months</td>
<td>2.25 years</td>
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<tr>
<td>Mandibular second molar</td>
<td>20 months</td>
<td>3 years</td>
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<tr>
<td>Maxillary central incisor</td>
<td>7−8 years</td>
<td>10 years</td>
</tr>
<tr>
<td>Maxillary lateral incisor</td>
<td>8−9 years</td>
<td>11 years</td>
</tr>
<tr>
<td>Maxillary first premolar</td>
<td>10−11 years</td>
<td>12−13 years</td>
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<tr>
<td>Maxillary second premolar</td>
<td>10−12 years</td>
<td>12−14 years</td>
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<tr>
<td>Maxillary first molar</td>
<td>6−7 years</td>
<td>9−10 years</td>
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<tr>
<td>Maxillary second molar</td>
<td>12−13 years</td>
<td>14−16 years</td>
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<tr>
<td>Maxillary third molar</td>
<td>17−21 years</td>
<td>18−25 years</td>
</tr>
<tr>
<td>Mandibular central incisor</td>
<td>6 years</td>
<td>9 years</td>
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<tr>
<td>Mandibular lateral incisor</td>
<td>7−8 years</td>
<td>10 years</td>
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<tr>
<td>Mandibular canine</td>
<td>9−10 years</td>
<td>12−14 years</td>
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<tr>
<td>Mandibular first premolar</td>
<td>10−12 years</td>
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<td>14−15 years</td>
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<tr>
<td>Mandibular third molar</td>
<td>17−21 years</td>
<td>18−25 years</td>
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Table 2. The chronology of the development of the permanent dentition.
Balancing and compensating deciduous tooth extractions

Balancing extractions can be defined as ‘the extraction of a tooth from the other side of a dental arch from which a tooth is to be or has been either extracted or prematurely exfoliated’. Balancing extractions are considered in order to maintain the symmetry of the dental arch and to prevent shifting of the dental midline. The idea of carrying out balanced extraction originally came from a clinical observation of centre line shift following unilateral extraction and, secondly, from the concept of ‘serial extraction’, which is discussed later. It is widely observed that the extraction of primary canines will cause a centre line shift.1 Avramaki and Stephens12 found centre line shifts to be greater in a non-balanced extraction group when compared to a balanced extraction group. If any shift of the centre line whatsoever is undesirable, then balancing deciduous canine loss is probably worth considering.

Balanced extractions theoretically encourage the drift of teeth to be symmetrical, however, the practice of balancing extractions is itself controversial and scientific evidence for its clinical benefit, sadly lacking. An alternative to balancing an extraction would be the use of space maintenance to prevent undesirable drifting of teeth adjacent to the site of tooth loss. The justification for balancing primary molar extractions is, however, much less clear cut. Mills13 claimed that the effect of the loss of a primary molar on one side was not as important as first thought. The effects of unilateral extraction of a primary molar on the centre line are probably minimal. If a significant centre line shift occurs, however, then a balancing extraction can be considered but only after assessing all the other aspects of the malocclusion.11

Overall, there is a lack of good scientific evidence to support balancing extractions but clinical evidence does suggest that balancing is necessary for primary canines.12

Compensating extractions (ie removing a tooth from the opposing arch, in addition to the tooth that is planned for extraction or has been prematurely lost) aims to minimize occlusal interferences following tooth loss. When there is no other indication for tooth removal, compensating is even more difficult to justify than balancing extractions as it involves the removal of a healthy tooth from an intact arch and is therefore almost never appropriate.15

‘Serial extraction’

The ‘serial extraction’ concept was first suggested in 1929. This term is used to describe a sequence of three phases of planned extractions, with the aim of optimizing the available space in the dental arch and minimizing the malocclusion. It is based upon the idea that, at the mixed dentition stage, it is possible for the practitioner to predict whether the natural spontaneous increase in arch size and inter canine width will be sufficient to accommodate all the permanent teeth in correct alignment.16 Originally, the technique was proposed as a preliminary treatment prior to appliance therapy and, in some cases, it was thought to give acceptable results alone, avoiding the need for active appliances.1

The extraction sequence proposed begins in the early mixed dentition (about 8 years of age), starting with the extraction of the primary canines just at the time the lateral incisors begin to erupt, to provide space for the anterior teeth to align and to relocate potential crowding further back in the arch. The first primary molars are then extracted (at about 9 years) to encourage the eruption of the first premolars ahead of the permanent canines. The erupted first premolars are then removed, in turn, prior to eruption of the permanent canines.17

It has been suggested that the technique should only be considered in the absence of any skeletal discrepancy, where there is a decrease in arch length, a normal overbite, a Class I malocclusion and when all teeth in the arch are present and in good position.17 The procedure is also contraindicated if a diastema is present between the central and lateral incisors, or if there is a deep bite present, as extraction of teeth could lead to a worsening of either of these two situations.

The main disadvantage of serial extraction is the need to have up to 12 otherwise healthy deciduous teeth extracted under anaesthetic and on several episodes. This is a traumatic introduction to dentistry with an unpredictable outcome and, in contemporary practice, is rarely indicated.

Retained deciduous teeth

Deciduous teeth are retained for many reasons, including:

- Malposition or absence of a permanent successor;
- Ankylosis;
- Delayed root resorption; or
- Supernumary teeth obstructing the path of eruption.

Whenever a retained deciduous tooth is observed beyond its expected period of exfoliation, the clinician should ascertain whether the permanent successor is present and in a reasonable position.

The problems associated with retaining deciduous teeth are that, if eruption of the permanent tooth is significantly delayed, a much more severe malocclusion can result, or more complex orthodontic treatment may be required.

If a second premolar is congenitally missing, retaining a deciduous molar will prevent attainment of optimal Class I occlusion as this tooth has a larger mesio-distal width than its successor and may prevent eruption of the first premolar. In order to achieve a perfect Class I molar relationship, the second deciduous molar width should be reduced by interproximal stripping. Another limiting factor is that deciduous tooth roots are significantly divergent, which can prevent the adjacent teeth being moved closer than their divergent roots allow.18

Retained deciduous teeth may become ankylosed and infra-occluded. Infra-occlusion is defined as ‘the cessation of eruption without a physical barrier or ectopic position of the tooth at some point after emergence’.19 Infra-occluded teeth remain stationary while the surrounding dentition and alveolus continue to develop vertically. Infra-occlusion is more common in the mandible than maxilla and most commonly affects the second deciduous molar.19 The earlier the infra-occlusion begins, the more severe it can become and a clue to infra-occlusion is when the interproximal bone level dips down towards the ‘submerging tooth’.

Infra-occlusion can result in the following:

- Tipping of adjacent teeth;
- Overeruption of opposing teeth;
- Space loss;
- Delayed eruption of permanent successors;
- Ectopic eruption of successors;
- Disturbed root development; and
A more complicated extraction. It is therefore wise at least to consider extracting any infra-occluded tooth as soon as the phenomenon is noticed, but bear in mind the work of Bjerklin and Bennett demonstrating that a significant proportion of retained second deciduous molars can last the patients into their 50s. If infra-occluded or ankylosed teeth are to be extracted, the loss of alveolar bone should be kept to a minimum as this can complicate further restorative or orthodontic treatment. Extraction should therefore be carried out when infra-occlusion is first diagnosed, allowing the alveolar bone after extraction to grow with the adjacent teeth, resulting in a less severe bone defect.

There are some other situations where retained deciduous teeth should be considered for extraction:
- The permanent successor is not erupting or is erupting into an ectopic position;
- When the deciduous tooth is preventing eruption of the adjacent teeth;
- If there is no sign of root resorption, 6 months after normal exfoliation of the same tooth on the opposite side of the arch, with no overriding reason to keep the retained deciduous tooth;
- There is severe tipping of adjacent teeth and the need to regain space;
- Other reasons such as caries or abscess formation.

The generally held view is that normal resorption and exfoliation of deciduous teeth depends on the presence of permanent successors. The rate of root resorption in deciduous teeth without successors is often slowed and these teeth are often retained into adulthood, however, spontaneous root resorption does occur in some of these teeth. Studies have shown that a considerable number of primary molars can remain in the arch unaltered up to 15 years after their expected exfoliation time, when there is agenesis of their successors. The retention of these teeth may be acceptable as a semi-permanent solution, but further follow-up studies are still needed to ascertain whether this could serve as a life-long option.

A deciduous molar with a permanent successor should be expected to exfoliate within 6 months of its opposite number. Therefore any deciduous tooth that is 6 months past its normal exfoliation date should be extracted. An ankylosed deciduous tooth without a permanent successor is less likely to exfoliate spontaneously and so thought should be given to the patient’s age, condition of the deciduous molar, patient preference for treatment and the occlusion. It is always wise to send patients with a developing malocclusion for orthodontic opinion prior to carrying out any extractions.

A general overview of treatment options for retained deciduous teeth is:
1. Permanent successor present and close to eruption:
   - Extract deciduous tooth if not mobile and not about to exfoliate.
2. Permanent tooth 12 months from erupting:
   - Slight submergence – review in 6 months;
   - Moderate submergence – restore occlusal surface, eg with composite or stainless steel crowns and review in 6 months;
   - Severe submergence – extract (careful surgical procedure required) and consider space maintainer.
3. Permanent successor absent:
   - Extract early to achieve complete spontaneous space closure (more likely in maxilla);
   - Extract as part of overall orthodontic treatment plan;
   - Consider space maintenance;
   - Leave into adulthood if not infra-occluded making patient aware of guarded prognosis and need for restoration and probable prosthetic replacement at a later date.

Cases to illustrate clinical problems with deciduous teeth and the solutions follow.

**Case 1: Single tooth space maintainer**

A 13-year-old patient attended the clinic with retained upper deciduous canines and a retained lower left second deciduous molar. The upper right canine was palpable but the upper left canine was not. The lower right second deciduous molar had been lost 9 months earlier and the second premolar had erupted to a good position (Figure 1).

The radiograph gave an indication of the upper left canine being in a slightly more palatal position than the upper right canine as its crown size was magnified compared to the palatable canine. Also, the lower right second premolar appeared to be in an ectopic position and erupting towards the root of the lower left first molar. No resorption of the roots of the deciduous molar was evident.
Treatment recommended at this stage was removal of the remaining deciduous teeth to encourage the permanent successors to erupt into a more favourable position. Because the lower left second premolar was probably 12 months from eruption, it was decided to maintain the space between the lower first premolar and first molar.

A unilateral space maintainer was duly constructed and fitted (Figure 2). This involved selecting an orthodontic band for the first molar and taking an alginate impression over the top and sending this to the laboratory. A 1.0 mm stainless steel wire was fashioned to engage the disto-occlusal surface of the lower first premolar to prevent space closure and mesial movement or tipping of the first molar after the deciduous second molar is extracted.

A check radiograph taken 12 months later shows that, following the deciduous tooth extractions and provision of a space maintainer, all three permanent teeth have assumed a more normal path of eruption (Figure 3).

**Case 2: Timely extractions of deciduous and permanent teeth**

A 12-year-old girl presented with congenital absence of lower second premolars and retained lower second deciduous molars which had drifted mesially following removal of the deciduous first molars. This is sometimes a helpful strategy in cases with congenital absence of lower second premolars, to help with spontaneous space closure in the lower arch. These deciduous molars, however, were now preventing the eruption of the lower first premolars. In the upper arch, the upper left second premolar was congenitally absent and there was marked crowding of the upper right quadrant (Figure 4).

Careful examination of the radiograph revealed a very slight shortage of space in the upper left quadrant to allow the upper canine to erupt fully and a much more severe space deficit in the upper left quadrant (Figure 5).

A decision was made not only to extract the lower deciduous second molars to allow the premolars to erupt and also the lower molars to drift forwards
spontaneously, but also to extract the upper left deciduous second molar and the first premolar on the right. Extracting the upper left deciduous molar will not only allow the first molar to drift mesially to get spontaneous space closure, but will also provide the small amount of space required in the upper left quadrant to allow the canine and first premolar to adopt an almost perfect position within the arch (Figure 6).

Case 3: Late presentation with retained deciduous teeth

A 17-year-old patient presented with retained deciduous canines which were severely worn occlusally and unaesthetic. He also had a retained upper left first deciduous molar which had deflected the upper left first premolar buccally to some degree. The upper first molar had drifted mesially to occupy a half unit Class II position but the occlusion was otherwise good (Figure 7).

The radiograph reveals two normal canine teeth in a vertical position above the deciduous canines (Figure 8). The crowns of both of the canines appear slightly larger than normal, however, they were palpable buccally. Had the two deciduous canines been removed at the correct time, ie at 13 years of age, then the upper canines would almost certainly have erupted into a normal position. If the patient had needed any remedial orthodontic treatment, it could have been provided at the same time as his peer group was undergoing brace treatment.

Case 4: ‘Watch and wait’ approach is generally unhelpful

A 13-year-old girl presented in the late mixed dentition with three second deciduous molars retained. The OPT revealed congenital absence of the lower right second premolar and the other two second premolars were potentially in a reasonable position, although the lower left second premolar was mesially tipped. (Figure 9). The overlying malocclusion was Class 1 with no skeletal discrepancy in the antero-posterior, vertical or transverse dimension.

The lower right second deciduous molar had not been extracted and appeared to be submerging significantly and this would probably get worse over the next few years. The lower left second premolar could not erupt as the deciduous tooth’s distal root was not resorbing. Resorption of the roots of the upper right second molar was almost complete, indeed, the crown was showing signs of internal resorption therefore loss of this tooth should be imminent. Appropriate treatment at this stage was therefore extraction of the remaining second deciduous molars.

The patient returned after a year, having visited her GDP who stated to her he would rather ‘watch and wait’ rather than actively extract the teeth. A second OPT
Figure 8. OPT of Case 3 showing canines in a normal position.

Figure 9. Case 4 on presentation, 3 retained deciduous second molars.

Figure 10. Case 4 after a further period of ‘watch and wait’, 2 retained deciduous second molars still in place.

Figure 11. (a, b, c) A 21-year-old student who had been advised that the deciduous teeth will eventually drop out.

Figure 12. Complex orthodontics required to sort out this difficult malocclusion.
centreline shifts.

Case 5: Prolonged retention of deciduous teeth

A 21-year-old university student presented with a complex malocclusion involving retention of both upper deciduous canines, which had deflected the permanent successors labially, and a retained upper right deciduous first molar which had deflected its permanent successor in a buccal direction (Figure 11).

The patient reported attending for regular dental check-ups, however, no attempt had been made to relieve the patient of his remaining deciduous teeth. As a consequence of this prolonged retention of the deciduous teeth, the orthodontic treatment now required will be much more complex than if the deciduous teeth had been removed at 14. Timely removal of the deciduous teeth would undoubtedly have greatly simplified this course of treatment.

Conclusions

The timing of extraction of deciduous teeth impacts on many aspects of the orthodontic management of patients. The following conclusions may be drawn from this article:

- Any deciduous tooth that is 6 months past its 'sell by date' should be considered for extraction, unless there is a compelling reason to leave it in place.
- Any deciduous teeth whatsoever, in a 14-year-old, needs to be considered as a candidate for removal.
- There needs to be a compelling reason to leave the deciduous teeth in place.
- Retained deciduous teeth often significantly complicate orthodontic treatment and lead to a more serious malocclusion developing (Figure 12).
- There are a few, very specific, reasons for retaining deciduous teeth and these should be understood by all dentists.
- Balancing extractions with deciduous canines should be considered to prevent centreline shifts.

- Balancing deciduous molars to prevent centre line shifts is almost never appropriate.
- Compensating extractions are almost never a good idea.
- Serial extraction of teeth is an outdated approach.
- If in any doubt about extractions, always refer the patient for a specialist orthodontic opinion.

References