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Orthodontic Management of the Developing Dentition

Chapter 2

Space loss and Crowding

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Abstract

Crowding and spacing within the dental arches is largely under genetic control, but is affected by a number of local factors. This chapter describes these local factors, discusses how they can influence the development of the dentition and also describes the interceptive measures available to the orthodontist.

Introduction

So far the normal development of the dentition has been described including the transition from the deciduous to the permanent dentition. In later chapters the management of Class I, II and III incisor relationships during this phase will be described. However, as orthodontists not only might we be asked how to manage the incisor relationships, but we are often also asked to try to predict, prevent and treat the effects of crowding and space loss during the developing dentition phase. Although this may entail comprehensive treatment, more often than not it comprises short, interceptive measures. Before describing such measures we should first look at the aetiology of crowding and space loss.

Aetiology of crowding

For the teeth to fit perfectly within the dental arches and to be in the correct relationships with the teeth in the same and opposing jaws, the mesio-distal tooth widths should be a match with the jaws. Any discrepancy in the sizes of either the teeth or the jaws is likely to lead to spacing or more commonly, crowding. Although the aetiology is most likely to be genetic in origin, other more local factors can have an effect on how this crowding or spacing may present within an individual patient. These include for example extra teeth, missing teeth, retained deciduous teeth and early unscheduled loss of teeth.

It is worth at this point perhaps asking the question "*Has crowding and space loss always been an issue in the developing dentition?*" Studies on pre-industrialised civilisations have shown that in most instances there little evidence that dental crowding was present to the same extent as is seen today [1,2]. This has led to the theory that early civilisations ate a more abrasive diet, which resulted in the loss of tooth tissue, not only occlusal but also interdentally. As a result, the mesio-distal tooth widths of the teeth were thought to gradually reduce over time, permitting all of the teeth to fit within the arches, including the third permanent molars [3,4]. Therefore pre-industrialised occlusions were not without crowding, it was perhaps just less common.

Predictors of crowding in the developing dentition

As has previously described in Chapter 1, the presence of severe crowding in the deciduous dentition is relatively rare. More often than not the teeth, in particular the incisors, are slightly spaced. Indeed it is thought the degree of crowding or spacing of the deciduous incisors can be used as a possible predictor of the likely crowding that may be initially seen in the early permanent dentition. It was Leighton in 1969 [5] who suggested that if the deciduous incisors

were well aligned, with no spacing or crowding, then there was a more than 2 in 3 chance the permanent incisors would be crowded. If the sum of the spaces was less than 3mm the chance of crowding was slightly better than 1 in 2 and if the sum of the spacing was between 3mm and 6mm this improved to 1 in 5. Where the total was greater than 6mm then there was little chance of permanent incisors being crowded. Other than this, there is little in the way of predictors of crowding.

Local factors affecting crowding and space loss

The local factors that may affect crowding and subsequent space loss includes:

- Early loss of deciduous teeth
- Retained deciduous teeth
- Developmental absence of teeth
- Unscheduled loss of permanent teeth
- Extra teeth (supernumerary and supplemental)
- Anomalies in tooth form (microdont and megadont)
- Anomalies in tooth position

Of all of these local factors it is relatively easy to understand how the presence of large, small, or extra teeth will have a direct influence on the presence of spacing or crowding. What is not quite so easy to understand is the effect when teeth are lost prematurely through trauma or disease. The most important factor is most probably the presence or absence of crowding. If the arches are spaced, in both the mixed or permanent dentition, then the effect of early loss on the remaining teeth within the same arch is likely to be minimal. However, in the presence of crowding, the loss of a tooth is likely to lead to drifting of the adjacent teeth towards the site of loss. This space loss in turn can affect occlusal relationships, leading to a change in the molar relationship or a shift in the dental centreline. The earlier a tooth is lost the greater the likely effect on the developing occlusion.

Each of the local factors will now be described in turn:

1. Early loss of deciduous teeth

The effect of early loss of deciduous teeth will, as previously described, depend largely on the underlying crowding within the permanent dentition. If there is no crowding the effect will be minimal. However, in the presence of crowding the effect will depend on which tooth is lost and the age at which this occurs. In general, the more anterior the tooth loss the greater

the effect on the centreline and the more posterior the tooth loss the greater the effect on the buccal segment tooth relationship, usually as a result of mesial movement of the first permanent molar. In order to try to prevent a shift in the dental centreline it is sometimes useful to extract the same tooth on the opposite side of the same arch, known as a balancing extraction.

With this in mind, "*Should balancing extractions always be performed*?" The loss of a deciduous incisor is not usually balanced. However, whenever a deciduous canine is lost, due for example to resorption of its root by the permanent lateral incisor, or a first deciduous molar is lost prematurely due to caries, it is worth balancing the loss. This can be done either by the extraction of the opposite deciduous canine or first deciduous molar, in order to prevent a shift of the dental centreline. If a second deciduous molar is lost prematurely, the effect on the centreline is minimal and so it should not be balanced. The greatest effect of early loss of the second deciduous molar is mesial drifting of the first permanent molar, which is then likely to encroach on the space for the second premolar. This often results in the premolar being squeezed out of the arch (Figure 2.1) and eventually erupting palatal to the arch. In all cases the earlier the loss of the deciduous tooth, the greater the effect it has on either the centreline, or the buccal segment relationship.

"Should we ever retain the space following early loss of a deciduous tooth?" In most instances the answer is no and there are a number of reasons for this. Firstly, if the deciduous tooth has been lost prematurely due to caries, then such a patient is unlikely to be a good candidate for the long term wear of either a fixed or removable space maintainer. Secondly, as has already been mentioned, in the absence of crowding there is no need to maintain the space and thirdly, if there is moderate to severe crowding extractions may be required at a later date in any case. Only very occasionally is space maintenance the treatment option of choice and an example would be the enforced extraction of an ankylosed and submerging deciduous tooth, where space maintenance might obviate the need for any future orthodontic treatment. In such a case the space can be maintained with a removable or a fixed space maintainer (Figure 2.2).

"*What about compensating extractions?*" A compensating extraction is an extraction of a tooth in the opposing arch and the aim is to preserve the buccal segment relationships of the teeth. In general compensating extractions in the deciduous dentition are less often performed than balancing extractions.

2. Retained deciduous teeth

Deciduous teeth are not infrequently retained beyond their normal age of eruption. This may be associated with the ectopic path of eruption or developmental absence of the permanent successor, or the presence of chronic infection at the deciduous tooth root apex (Figure 2.3), all of which may delay the normal process of root resorption that leads to the tooth being naturally shed. In some instances this failure of resorption can lead to ankylosis and the appearance of a submerging tooth. In reality it is not the affected deciduous tooth that is submerging. What is in fact happening is that with continued facial growth the adjacent teeth erupt relative to the ankylosed tooth, which then appears to submerge. Submergence is most commonly seen in the deciduous molar regions and if left unchecked, can lead to the adjacent teeth tipping over the occlusal surface of the submerging deciduous molar (Figure 2.4). In extreme circumstances the deciduous tooth can submerge so far that it will not be visible in the mouth, only on a radiograph. Not only does this make removal of the submerged tooth somewhat difficult, but it can also lead to space loss, with insufficient room left for the permanent successor to erupt.

This begs the question "*If and when should a submerging deciduous tooth be extracted?*" In reality a degree of submergence during the lifetime of a deciduous molar is a relatively common part of normal occlusal development. The eventual natural loss of a deciduous tooth is a dynamic process of root resorption and repair, and provided there is more resorption than repair, the tooth may submerge a little, re-erupt and then is ultimately shed. However, if there is more repair and little resorption the tooth is likely to ankylose and continue to submerge. If a permanent successor is present and the deciduous tooth is only slightly submerged, being above the contact points of the adjacent teeth and with no signs of these teeth tipping over its occlusal surface, then the deciduous tooth can be kept under observation. If the tooth submerges below the contact points of the adjacent teeth and they begin tipping over the occlusal surface then extraction of the deciduous tooth and space management might be required [6].

3. Developmental absence of teeth

It is very rare that deciduous teeth are developmentally absent. However, the developmental absence of permanent teeth is relatively common. Excluding the third permanent molars, there are reports that it may affect between <0.1% [7] and 10.3% of children [8]. The most common missing tooth, apart from the third permanent molar, is the upper second premolar,

followed by the upper lateral incisor, the lower second premolar and the lower central incisor. In the early permanent dentition, when it is discovered on a radiograph that a permanent tooth is developmentally absent, there a number of possible treatment options for the retained deciduous tooth, including:

- Preservation of the deciduous tooth for as long as possible provided it is in good condition. It can then be replaced when naturally shed with a prosthetic tooth. There are reports of second deciduous molars being retained in the mouth until the fifth decade of life [9], which is longer than many intraoral prosthesis are able to survive.
- To extract the deciduous tooth in order to encourage mesial movement on eruption of other, as yet unerupted permanent teeth. In this way the space created by the missing tooth is either closed or reduced, eliminating or reducing the need for later orthodontic treatment or a prosthetic replacement tooth. For this to work there should be some underlying crowding, otherwise the teeth may not spontaneously drift into the primary tooth extraction space.
- To preserve the deciduous tooth until a later date when it can be extracted as part of a comprehensive orthodontic treatment plan to relieve crowding, align the teeth and close the space or relocate the space prior to the provision of a definitive prosthetic replacement.

Whichever treatment option is chosen, it is important a full orthodontic and radiographic assessment is undertaken, being mindful that in the case of apparently missing second premolars these may not become apparent radiographically until 9 years of age [10].

4. Unscheduled loss of permanent teeth

As with the deciduous dentition, the effect of the loss of a permanent tooth will be dependent on a number of factors, including the presence or absence of crowding, the position of the tooth within the dental arch, the patient's age and the occlusion. These will be described in turn:

- **Presence or absence of crowding** – as with the loss of a deciduous tooth, the loss of a permanent teeth will have a greater effect within the same arch in the presence of crowding. This is because crowding will promote drifting of the adjacent teeth into the extraction site.
- **Position of the tooth within the arch** – the more anterior the tooth loss the greater the effect on the centreline. Therefore the loss of a central incisor in a crowded arch will

have a profound effect on the centreline (Figure 2.5), while the loss of a second permanent molar will have minimal effect. Conversely the loss of a posterior tooth will have a greater effect on the buccal segment relationship than the loss of an incisor.

- **Patient age** – in general and in the presence of crowding, the earlier the tooth loss the greater the effect, as the adjacent erupted and also unerupted teeth will drift towards the extraction site. Therefore the effect will be greater in the developing dentition than in the mature adult dentition.
- **The occlusion** – the angulations of the teeth adjacent to the extraction site and the interdigitation of remaining teeth within the arch with those in the opposing arch will both have an effect on space loss. Erupted teeth will more readily tip than bodily move into an extraction site. Therefore, if the crown of a tooth is angulated away from an extraction site, it is more likely to move into the extraction site than if it is angulated towards it (Figure 2.6). The interdigitation of teeth, particularly in the buccal segments may also have an effect on space loss. If the interdigitation in the buccal segments is very good it may prevent the teeth adjacent to an extraction site from spontaneously drifting into it and closing the space. Indeed, such interdigitation can be sufficiently effective in this regard as to sometimes make space closure even with fixed appliances more difficult.

Previously we have described the various treatment options available when a permanent tooth is found to be developmentally absent during the developing dentition, including timely deciduous tooth extractions to encourage spontaneous space closure. When a permanent tooth is lost due to disease, *e.g*. caries or periodontal disease, the treatment options are often fewer and include either the maintenance of space for a prosthetic replacement, or space closure as part of a more comprehensive orthodontic treatment plan involving usually fixed appliance. The treatment choice will depend on various factors including the presence of crowding and type of malocclusion, the skeletal pattern, overjet, overbite and buccal segment relationships. At this point it is worth perhaps considering the unscheduled loss of each permanent tooth in turn during the developing dentition:

Central incisor (see also Chapter 7) – the loss of a permanent central incisor due to trauma or caries can result in rapid space loss (Figure 2.7). As a result, in the upper arch it is usually worth fitting a space maintainer, not only from the point of view of the immediate aesthetic improvement for the patient, but also because orthodontic space closure and restoration of the lateral incisor to simulate the central incisor, rarely gives a good long term aesthetic result. In

the lower arch the loss of a central incisor in the presence of crowding can be incorporated into an overall orthodontic treatment plan at a later date and in most instances space should not be preserved whilst awaiting the development of the remaining occlusion. This is because it can lead to alveolar bone loss which can make later space closure more challenging.

Lateral incisor – When an upper lateral incisor is lost due to trauma or caries once again the decision should be made whether to preserve the space or close the space. If the lateral incisor is lost prior to the eruption of the upper permanent canine it is likely the canine will erupt into the upper lateral incisor position (Figure 2.8). In which case the decision whether to close or reopen the space can only be made once the canine has erupted. This decision will depend on other features of the occlusion, but principally the degree of crowding/spacing and also the shape and colour of the permanent canine as a possible substitute for the lateral incisor. Once again in the lower arch in the developing dentition, the loss of a lower permanent lateral incisor is usually accepted and the occlusion treated on its merits in the permanent dentition.

Permanent Canine – the permanent canine is rarely lost due to trauma or caries, but is more commonly absent due to an ectopic path of eruption. This will be dealt with in chapter 7.

Premolars and Molars – When a first premolar tooth is lost, usually due to caries, this can lead to spontaneous space closure and unwanted affects such as a shift in the centreline or buccal segment relationship. As a result when there is the enforced loss of a first premolar in a crowded arch, consideration should be given to the loss of the first premolar on the opposite side of the same arch, a balancing extraction. If the buccal segment relationship is to be preserved then sometimes a compensating extraction is also required. However, such balancing and compensating extractions may not be necessary if a space maintainer is fitted to allow for example a crowded upper permanent canine to drop into the line of the arch. In the case of second premolars and first permanent molars in the developing dentition, it is not necessary to carry out a balancing extraction to preserve centrelines, but a compensating extraction may be required to once again preserve the anteroposterior buccal segment relationship. Other factors that will effect whether or not to compensate the loss of a first permanent molar include the presence of second and third permanent molars, and whether or not the unopposed molar tooth is likely to over erupt. If all of the other molars are developing normally then consideration should be given to the compensating extraction of the unopposed molar. Not only will this reduce the likelihood of trauma from biting on the gingivae, but it

will also improve the likelihood the second molar will move into the correct anteroposterior position without hindrance from an overupted first molar in the opposing arch.

5. Extra teeth – supernumerary and supplemental teeth

The extra teeth that most commonly disrupt the normal development of the dentition include the upper midline conical supernumerary tooth or mesiodens and the tuberculate supernumerary. The mesiodens can displace the path of eruption of the upper central incisors and lead to the development of a midline diastema, in which case it should be extracted. The mesiodens itself may or may not erupt and is obviously easy to remove if it does so (Figure 2.9). The tuberculate supernumerary usually prevents the eruption of the central incisor tooth, as it lies directly over the cingulum of the tooth. Neither the supernumerary nor the central incisor will erupt. As a result the supernumerary tooth should be extracted and the central incisor may then erupt spontaneously. If it doesn't it may then require exposure and bonding to bring it into the line of the arch [11]. Occasionally additional teeth of similar form to the normal series develop and may erupt into the arch and these are known as supplemental teeth. Sometimes there is sufficient space to accommodate such a tooth within what would otherwise be a spaced dentition. However, in most cases it leads to localised crowding, in which case a decision has to be made as to the best tooth to remove, the supplemental or the one of the normal series. Sometimes it can be very difficult to tell which is the supplemental tooth and the extraction decision will be dependent on factors such as the condition of the tooth/teeth, the position within the arch and which extraction will promote the best spontaneous improvement in the alignment of the remaining teeth.

6. Anomalies in tooth form (microdont/ megadont)

Large or small teeth within the arch can lead to either crowding or spacing and where they are very obviously of a different size to the normal series. Extraction may be the best option. The decision whether or not to maintain or perhaps recreate some of the space will be dependent on the position of the tooth in question (see 4. Unscheduled loss of permanent teeth) and other features of the malocclusion.

7. Anomalies in tooth position

The most common ectopically positioned teeth are the permanent upper central incisor and the maxillary permanent canine. The sequelae and management will be described in Chapters 7 and 8

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Figures