Multidisciplinary management of missing maxillary central incisors in Children and Adolescents

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Introduction

Maxillary central incisors are essential to smile aesthetics and function. Their loss at an early age will have a psychological impact. A missing central incisor can be encountered in clinical practice for various reasons, including avulsion, developmental anomalies, such as gemination, fusion or dilaceration of a maxillary central incisor or as a result of local pathology necessitating extraction due to a poor prognosis. Hypodontia of maxillary central incisors is rare, accounting for only 1% of teeth missing.[1]

There are multiple management options available for replacing missing maxillary central incisors. Their management demands a multidisciplinary approach as treatment planning requires consideration of a variety of factors. This team may include specialists in orthodontics, paediatric and restorative dentistry. This paper will discuss the multidisciplinary management of missing maxillary central incisors.

Aetiology

The aetiology of a missing central incisor can be broadly classified into two categories; accidental and developmental.

Accidental

Traumatic injuries are common in childhood and adolescence with the proportion of children in the United Kingdom sustaining accidental damage to their permanent incisors estimated to be from 5.4% at age 8 to 12.5% by age 12, with higher prevalence in males.[2] Increased

overjet and inadequate lip coverage of maxillary incisors are considered significant risk factors for dental trauma.[3,4]

The most common traumatic injury for the permanent dentition is reported as crown fractures, and for the primary dentition luxation injuries are the most common.[5] Avulsion contributes to 0.5-16% of dental injuries.[6]

Developmental

Maxillary central incisors may be affected by a variety of developmental malformations, including dilaceration, anomalies in tooth morphology, ectopic canines causing resorption and hypodontia.

Dilaceration is defined as an acute deviation of the long axis of a tooth between the crown and root, developing from traumatic non axial displacement of hard tissue in relation to the developing soft tissues.[7] This malformation can affect the maxillary incisors, the aetiology is thought to be due to either developmental factors, or trauma to the primary dentition resulting in alteration of the development of the permanent predecessor.[8] If there is an unfavourable crown/root inclination, orthodontically aligning the tooth would be unrealistic and loss of the maxillary central incisor would be indicated.[8]

Anomalies of tooth morphology, including macrodontia, gemination and fusion are relatively rare conditions. The prevalence of gemination and fusion has been reported as 0.6% in the primary dentition and 0.1% in the permanent dentition amongst the Caucasian population.[9] These developmental conditions result in a larger than average tooth size, and commonly affect the incisors.[10] For such cases management is complex and treatment options include hemisection or interproximal reduction.[10] However, often the most aesthetic option is to remove the affected tooth.

Ectopically positioned canines can result in the resorption of both maxillary central and lateral incisors, with a prevalence of 11.1% and 66.7% respectively[11]. The presence of supernumeraries, particularly mesiodens, can result in various complications affecting the prognosis of the maxillary central incisor. These include abnormal root formation, ectopic positioning, cyst development, infection and root resorption.[12] In cases where the pathology

affecting the maxillary incisor is severe, extraction and subsequent space management may be the most appropriate treatment option.

Hypodontia is the developmental absence of at least one permanent tooth and may occur either as part of a syndrome or as a non-syndromic form.[13] Hypodontia of maxillary central incisors is rare, accounting for only 1% of teeth missing.[1]

Management

There are a number of patient, facial and dental factors which influence treatment decisions for missing maxillary central incisors, these are listed in Table 1.

In the short term a possible management option for a maxillary central incisor that has been lost due to avulsion is reimplantation.[14] This option is only feasible for patients with suitable medical and dental health, as well as optimal local conditions including the tooth being stored in the appropriate medium and timely reimplantation. The tooth should still be treated with a guarded prognosis, as there is a high risk of loss of vitality and replacement resorption.[14]

The options for the long-term management of missing central incisors include:

1. Accept the space and undergo no treatment
2. Space maintenance and eventual restorative replacement
3. Orthodontic space closure and restorative camouflage
4. Orthodontic space idealisation with restorative replacement
5. Autotransplantation

Option of no treatment

It should be appreciated that option 1, accept space and undergo no treatment, is commonly not the treatment of choice for patients due to the negative implications to the smile aesthetic. However, as part of informed consent all feasible treatment options should be discussed.

Space Maintenance and eventual restorative replacement

Loss of a maxillary central incisor in a young patient may require the maintenance of the edentulous space to facilitate subsequent placement of a prosthesis i.e resin retained bridge (RBB) or an implant in adulthood. This option is favourable where orthodontic intervention is contraindicated and there is adequate space available both at the gingival and interradicular

sites. A suitable case for space maintenance would be a Class I occlusion with no space requirements and optimal positioning of the adjacent teeth. The advantage of space maintainers includes the preservation of space for future prosthesis, therefore negating the need of future orthodontic treatment to re-open the space. However, patients should be warned of space loss which may occur if there is non-compliance with removable space maintainers or if there is a breakage of a fixed space maintainer. Furthermore, there will be loss of alveolar bone dimension in the edentulous region which may discount certain future restorative options, such as implants, or an adjunctive bone graft may be required.

There are various options for space maintenance, these are broadly categorised into fixed and removable options. Removable space maintainers can be effective (Figure 1), and use can continue into the fixed appliance stage if indicated, however they can be associated with poor compliance, and are frequently lost leading to space loss.[15] It is for this reason the authors would opt for the use of a fixed space maintainer, due to the reduced dependence on patient compliance. Various fixed options have been described in the literature and include the use of pontics attached to a transpalatal arch, which are retained by bands on the first permanent molars.[16] Alternatively a RBB, constructed from fibre reinforced composite, could be used, accepting that this will need replacing at a later stage.[17] A chairside approach can also be utilised by using an acetate strip crown form and composite (Figure 2). The composite pontic is then bonded to the adjacent central incisor using the etch and bond technique. A fixed approach will help alleviate possible compliance issues seen with removable space maintainers.

Space opening or closing?

As part of informed consent, the advantages and disadvantages of space closure and space idealisation should be discussed thoroughly with the patient as outlined in Table 2.

Orthodontic space closure and restorative camouflage

Orthodontic space closure involving the substitution of the lateral incisor for the central incisor, supported through restorative camouflage techniques, can be an effective management option (Figures 3, 4 and 5). Benefits include the preservation of alveolar bone and the reduced economic burden as a prosthesis is not required. However, patients should be aware of the financial burden involved in the maintenance of any restorations involved in

camouflaging the lateral incisor as a central incisor. Certain malocclusions are suited for orthodontic space closure, namely Class I crowded cases and Class II malocclusions. In cases where there is one missing central incisor, challenges in centreline preservation can arise during orthodontic space closure. This can be overcome with the aid of temporary anchorage devices (TADs) which will allow for reinforced anchorage, facilitating the protraction of the buccal segment thus the preservation or correction of the centreline. Various factors should be considered to achieve optimal aesthetics for such a solution, these are outlined in Table 3.

Multidisciplinary treatment planning prior to treatment commencing between Orthodontists and Restorative/Paediatric Dental Specialists dentists can aid in the decision-making process for where the teeth should be positioned for optimal restorative camouflage treatment.

It should be appreciated that the maxillary central incisor has a flat mesial surface, and a wider curved distal surface. In the case of a unilaterally missing maxillary central incisor to ensure the ideal emergence profile and restoration, the lateral incisor should be positioned parallel to the contralateral maxillary incisor, close to the midline with a greater space distally to enable a wider distal build-up of the lateral incisor. In the case of bimaxillary missing central incisors the lateral incisors should be positioned parallel to each other. To aid these positioning requirements wire bending as part of the finishing and detailing can be undertaken. Alternatively, alterations to the usual bracket choice can be considered. However, the authors do not advocate the use of bracket modifications due to the possible unwanted tooth movements although it is important to plan on a case by case basis.

The gingival margins of the lateral incisor, canine and first premolar should be carefully planned for symmetry, in particular, the positioning of the gingival margin on the lateral incisor should be matched to that of the contralateral maxillary incisor. This is an especially important consideration when the smile line is high. An adjunctive gingivectomy or crown lengthening can be considered to lengthen the crown height and idealise the gingival margins.[18]

The size, shape and colour of all the anterior teeth are important for this management option. Wide lateral incisors are preferable and whiter canines with a less pointed cuspal morphology as recontouring of the canine for lateralisation will also be required, with the tip of the canine

flattened, mesiodistal reduction considered and potential flattening of the canine eminence. To improve lateralisation of the canine, inversion of the canine bracket will increase the palatal root torque, thus masking it more effectively as the lateral incisor.[18] Bleaching and the addition of composite can also aid camouflage of the canine. The first premolar may also require recontouring of the palatal cusp, a slight mesiopalatal rotation and increased buccal root torque from either bracket positioning or wire bending can aid its camouflage as a canine.

Space closure has been shown to be an acceptable treatment option, from a patient's perspective and clinical outcomes.[19] To allow patients to visualise the final aesthetics of these complex cases a diagnostic Kesling wax up is a useful tool to aid decision making and ensure the patient understands what can be achieved with treatment [20, 21]

Another management option is one of space idealisation for prosthetic replacement of the missing maxillary central incisor (Figures 6 &7). In Figure 6 the implant has been positioned and aligned to allow for some labial bone loss and has been restored with a screw-retained implant crown.

Class III malocclusion or a Class I malocclusion case with no space requirements, or presence of excess space, diminutive lateral incisors, and pointed yellowish canines are better suited for the prosthetic replacement of the maxillary central incisor. The benefit of this option includes it relies less heavily on the anatomy of the underlying dentition to achieve optimum aesthetics, as is the case with space closure as outlined in Table 3. However, patients should be aware of the financial burden associated with future prosthesis as well as the risk of alveolar bone loss which may limit restorative options in the future, such as implants, or require an adjunctive bone graft.

Orthodontic treatment may be indicated to idealise space for prosthetic replacement, with the aim to achieve root parallelism to facilitate a full range of restorative treatment options in the future, including implants.

The widths of the contralateral anterior dentition should be noted, and the space created should complement the size of the adjacent teeth for symmetry aiding optimal aesthetics. The average width of a maxillary central incisor is 9mm, however if there is microdontia then it can be more aesthetic to match the space idealisation to the proportions of the rest of the

dentition. The ideals of the golden proportion ratio, 1.616:1.0:0.618 for the central incisor, lateral incisor and canine respectively could be applied to such cases. Golden proportions ideally need to be applied in all cases including space closure.[22]

Alveolar bone condition should also be considered for the eventual prosthetic replacement, if this is deficient a bone graft may be indicated, especially if an implant is required.

A fixed prosthesis would be preferred by most patients. Resin-bonded bridge success is over 10 years in most circumstances so long as sound design principles have been observed.[23] It will not be an automatic decision to offer implant treatment at maturity as the RBB may be entirely satisfactory. If an implant is indicated the RBB may continue as interim replacement during the course of implant treatment which may be between 3-12 months depending on whether bone grafting or augmentation has been carried out.

If orthodontics has been carried out the fixed-fixed design of the RBB will contribute to orthodontic stability. With all restorative treatment there will be a burden or cycle of repair and replacement. This will involve a lifelong time and financial commitment for the patient. Therefore, treatment plans minimising restorative treatment should always be considered.

Autotransplantation

Finally, autotransplantation can be considered as a management option (Figure 8, 9 & 10). The patient must have a favourable medical history for this treatment option.

A suitable patient would be one whose malocclusion includes space requirements necessitating extractions of premolars as part of their overall orthodontic treatment plan, which would then be used as the donor tooth.[24] The most common tooth to be autotransplanted is a second premolar for a maxillary central incisor.[8] The patient's age is a crucial factor to be considered, as the root should ideally be half to two third developed for an optimal outcome.[24] Research has shown good long term survival rates for replacement, comparable to those of conventional restorative replacements.[25] Additionally there is the advantage of maintenance of the alveolar bone height, the presence of a biological replacement tooth that will respond to both growth changes and orthodontic treatment.[24,25] This is particularly advantageous for a young growing child where an implant is contraindicated until cessation of growth. Autotransplantation offers many advantages, however, it must be remembered that it is an invasive procedure, and the morphology of the

premolar is not easily camouflaged as a central incisor. Extensive restorative treatment will be required to achieve an ideal aesthetic result.

Discussion

This article describes the management options for missing maxillary central incisors. Each individual case should be assessed in detail to formulate holistic treatment plan to achieve optimal results for these complex and challenging cases. Advantages and disadvantages of each option should be clearly presented to the patients to facilitate informed decisions being made. The requirement of restorative treatment should be anticipated and discussed with patients from the outset. Furthermore, patients should appreciate their responsibility in committing with long-term orthodontic retention to maintain orthodontic outcomes.

There is limited research directly comparing the different management option for missing maxillary central incisors, with the main body of evidence compromised of mainly case reports and case series.[19, 20,21,25] This is perhaps a reflection of the complexities of these cases, and the need for tailored individual treatment planning for missing maxillary central incisors.

Conclusion

There are several management methods for patients with missing maxillary central incisors. Attention to detail and careful planning at all stages of treatment is crucial to achieving high-quality outcomes for patients. Patients should be informed of all potential treatment alternatives for their individual case. Each management solution for these complex cases requires a high restorative burden and the requirement for lifelong maintenance and retention. This should be made clear to the patient from the outset of treatment.

Declaration of interests

The authors have no conflict of interest to disclose.

Author contributions statement

All authors have made substantial contribution to the design of the work, acquired clinical photographs, drafted and revised the manuscript.

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