Indications for the use of auto-transplantation of teeth in the child and adolescent

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Abstract

BACKGROUND: Tooth auto-transplantation has been successfully performed for over 50 years and yet the procedure has still to receive the widespread acceptance that it deserves. AIM: This study demonstrates the numerous clinical situations in which auto-transplantation can be used in order to give a child or adolescent an excellent biological long-term replacement. INDICATIONS: Seven cases are presented that demonstrated the versatility of auto-transplantation in a range of clinical situations. The aim was to show that this technique is not only useful for replacing teeth that are lost due to trauma but has applications for the replacement of teeth that are developmentally missing, or teeth with otherwise poor long-term prognosis. TREATMENT: All cases presented were managed with autotransplantation and included patients with hypodontia, trauma, dilacerated incisors, ankylosis, failed endodontic treatment and aesthetic management of a patient with cleft lip and palate. FOLLOW-UP: Medium and long-term outcomes were demonstrated. CONCLUSIONS: Auto-transplantation provides an excellent outcome in a growing child with the advantage that it is a biologically compatible method of tooth replacement, which promotes pulp and periodontal healing and enables orthodontic movement if necessary.

Introduction

Tooth auto-transplantation is a biological way of managing missing teeth and has many advantages over conventional tooth replacement in the growing patient [Slagsvold and Bjercke, 1978; Vilhjalmsson et al., 2011]. Formation of a functional periodontal ligament allows continued eruption of the tooth, promoting bony infill in deficient sites [Paulsen and Andreasen, 1998; Day et al., 2008]. This approach prevents ankylosis, so allowing orthodontic movement after 3-9 months [Jonsson and Sigurdsson, 2004; Kinde- lan et al., 2008]. The gingival contour is often superior to that achieved with prosthetic alternatives, and the impact on the overall oral health is lower [Slagsvold and Bjercke, 1978; Czochrowska et al., 2000]. While the survival rate of auto-transplantation is high, estimated to be up to 90% [Andreasen et al., 1990; Czochrowska et al., 2002] even in the case of failure the auto-transplantation will have helped maintain bone essential for possible future implant placement once growth is complete.

Although most published literature concerning auto-transplantation relates to replacement of missing teeth and the treatment of impacted canines, there are a large number of clinical situations where this can be used as a technique of choice (Table 1). The successful outcome of this technique depends on a multidisciplinary treatment plan, with the involvement of Paediatric Dentists, Orthodontists and often Oral Surgeons. An audit of a series of auto-transplanted cases was carried out. Pre- and post-transplantation orthodontics is demonstrated to achieve a good final result. The principle aim of this report is to demonstrate the versatility of auto-transplantation as a technique of choice in a growing child where replacement of a tooth with poor prognosis is necessary and where a malocclusion requires extractions to be carried out as a part of the orthodontic treatment plan.

Indications

Chronic apical infection and extensive inflammatory root resorption of central incisors. Patient 1, a 10 year old female, presented with a recurrent abscess on upper right permanent central incisor (FDI notation 11) following trauma one year previously when both upper permanent central incisors were avulsed and replanted within the hour. Despite repeated root canal therapy, a diagnosis of chronic apical infection and extensive external inflammatory resorption was reached and both the central permanent incisors were deemed to have a poor prognosis (Figure 1a-b). Treatment: The patient underwent bilateral transplantation of upper second premolars into the extraction sockets of the upper permanent central incisors (Figure 1c). Post-operative restorative camouflage was undertaken after two weeks, followed by orthodontic alignment and further restorative care (Figure 1d). Follow-up: Six-year follow-up has demonstrated completed root development (Figure 1e), periodontal healing and pulp vitality. Definitive porcelain veneers are planned once gingival maturation is complete.

Absent central incisor Patient 2, an 11 year old boy, presented missing the maxillary right permanent central incisor (FDI 11) which had been lost due to trauma approximately two years previously. The patient was wearing a partial denture but examination revealed a worsening buccal bone defect. Treatment: Following pre-operative orthodontics to create sufficient space (Figure 2a), the 35 was transplanted to 11 region with a bone graft to repair the buccal dehiscence (Figure 2b). Follow-up: Post-operative restorative and orthodontic treatment was completed and four-year review demonstrated continued pulp and periodontal health with no evidence of periapical pathology or root resorption (Figure 2c-d).
Auto-transplantation of teeth in children

Table 1. Clinical situations where auto-transplantation may be considered the treatment of choice

<table>
<thead>
<tr>
<th>Replacement of absent teeth 10-13 yrs old</th>
<th>Developmentally absent (hypodontia, cleft lip and palate)</th>
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<td>Tooth lost due to trauma (avulsion)</td>
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<th>Replacement of a tooth of poor prognosis</th>
<th>Trauma (root fracture)</th>
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<td>Caries</td>
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<td>Chronic periapical infection</td>
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<td>Periodontal disease</td>
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<td>• Internal root resorption</td>
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<td>• External inflammatory root resorption</td>
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<td>• Replacement resorption</td>
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<td>• Cervical invasive resorption</td>
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<td>• Pressure resorption caused by the ectopic eruption of an adjacent tooth such as a permanent canine</td>
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<th>Infra-occlusion (following replacement resorption)</th>
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<th>Replacement of a tooth with developmental defects</th>
<th>Dilaceration of permanent teeth</th>
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<td>Severely hypoplastic tooth</td>
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<tr>
<th>Surgical reposition of an impacted or ectopic permanent tooth</th>
<th>Ectopic teeth</th>
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Hypodontia with failing endodontic treatment in the adjacent first permanent molar

Patient 3 a 14 year old girl presented with concerns regarding the lower left quadrant where the lower first permanent molar (FDI 36) had persistent apical infection following root-canal therapy after a carious pulpal exposure (Figure 3a). Treatment: Treatment planning was complicated by a developmentally absent second premolar (FDI 35). Following assessment by the multidisciplinary team, transplantation of both the upper second premolars (FDI 15, 25) to replace the absent premolar and adjacent permanent molar with poor prognosis was planned. This was completed in early 2008. Due to the complete root formation and closed apices of the donor teeth, root canal treatment was commenced as appropriate (Figure 3b). Follow-up: Three years post-operatively the auto-transplanted teeth are functioning successfully (Figure 3c).
Dilaceration of a central incisor

Patient 4 a 12 year old girl was referred after extraction of a midline supernumerary tooth followed by exposure and traction of the central incisor which failed to induce eruption (Figure 4a). Further investigation with cone beam computed tomography (CBCT) indicated that a root anomaly, suspected to be a dilaceration, was preventing eruption of the incisor. Due to the extent of the dilaceration and inability to move the tooth, extraction was indicated. Treatment: A premolar with closed apex was transplanted into the extraction socket (Figure 4b). Root canal therapy was successfully completed 3 weeks post-surgery (Figure 4c). Follow-up: Four year radiographic review shows signs of arrested replacement root resorption, but the auto-transplant has been left in-situ as it continues to have satisfactory aesthetics and occlusion.

In the long-term it will maintain bone and space, effectively maintaining a range of treatment options available at a later date if this becomes necessary.

Dilacerated central incisor in association with cleft lip and palate

Patient 5 a 12 year old girl was first referred to the Paediatric Dentistry department following concerns regarding hypoplastic primary teeth. The patient had a Pierre-Robin Sequence and had a cleft palate repair at 8 months of age. Full-mouth rehabilitation was undertaken but later, in the permanent dentition, the patient was diagnosed with dilaceration of the maxillary left permanent central incisor, severely crowded maxillary dentition and palatally displaced second premolars (Figure 5a). Treatment: Following thorough examination and treatment planning, considering both the premolars and the canine as potential donor teeth, the decision was made to transplant the maxillary left permanent canine into the position of the dilacerated maxillary left permanent central incisor region. The patient was advised of guarded prognosis due to reduced bone support and the need for surgical removal of the maxillary permanent central incisor. Follow-up: The permanent canine has undergone auto-transplantation, endodontic therapy and composite reshaping and at two year follow-up was functioning successfully as a permanent central incisor with excellent periodontal health (Figure 5b-c).
Auto-transplantation of teeth in children

Replacement resorption and infra-occlusion of a permanent central incisor Patient 6 a 11 year old boy presented with an infra-occluded maxillary right permanent central incisor secondary to trauma to this tooth 3 years earlier (Figure 6a-b). CBCT confirmed the tooth was ankylosed, with severe infra-occlusion and significant replacement resorption indicating a poor long-term prognosis (Figure 6c). Treatment: A mandibular right first premolar with incomplete root development was transplanted into the extraction socket of the maxillary right permanent central incisor. It was considered that following revascularisation of the auto-transplant, continued root development would result in eruption of the tooth which would bring the alveolar bone with it in order to achieve equalisation of gingival margins of the transplanted tooth with the contralateral. The splint was removed one week later and was followed by composite camouflage of the transplant (Figure 6d-e). Follow-up: One year post-treatment, the transplant exhibits normal signs of vitality, periodontal health and continued eruption with associated alveolar bone growth.

A permanent central incisor with failed endodontic treatment, perforations and poor prognosis Patient 7, a 11 year old boy was referred by a General Dental Practitioner for continued endodontic management of tooth 21. After suffering trauma some years back, the patient had undergone several unsuccessful attempts at endodontic management which had resulted in multiple perforations. Treatment: The tooth was deemed to be of a hopeless prognosis (Figure 4. A. An unsuccessful attempt to apply orthodontic traction on 21 which had root dilacerations. B. Auto-transplant in-situ with initial build up with composite resin. C. Endodontically treated premolar auto-transplant.)
Pre-transplant orthodontics (Figure 7c) was performed to create optimum space for a mandibular premolar to be transplanted (Figure 7d). This was built up with composite resin (Figure 7e) and the orthodontic treatment will resume in the next 4 months in order to achieve the final occlusion.

**Discussion**

One of the main advantages of auto-transplantation is that it can be provided for a growing child. If this is carried out as a part of a multidisciplinary approach, then pre-transplant orthodontics can be carried out to create the best possible environment for the transplant to be placed. This may involve creating the appropriate amount of space, encouraging bone development and uprighting the roots of adjacent teeth. Post-transplant orthodontics is usually started 4-6 months post-surgery to finalise the occlusion [Day et al., 2008].

Most transplanted teeth can be modified with composite resin to mimic incisor teeth when placed in the anterior region and this can be done within 7-10 days of the transplantation. This provides an aesthetically acceptable result for the patient during the period of growth [Lima et al., 2009]. Once orthodontic treatment and gingival maturation is complete a more comprehensive aesthetic solution such as porcelain veneers may be considered.

Despite reports of successful auto-transplantation since the 1960’s [Slagsvold and Bjercke, 1978] there seems to be a lack of interest in the technique, although it is still used sporadically in a few centres in the UK and Europe. This technique can be used effectively in a wide range of clinical situations within the framework of a multidisciplinary treatment plan. Paediatric Dentists, Orthodontists, Oral Surgeons, and Restorative Dentists should all contribute to the comprehensive planning for the patient with the aim of achieving a tooth with functioning periodontium, good gingival margins and an aesthetically pleasing outcome for the patient. Pre-transplant assessment should include careful consideration of the height and quality of bone into which the transplant will be placed; this will have an important impact on the outcome, both for periodontal healing and the final gingival margin.

In this report the successful use of auto-transplantation for patients with appropriate clinical indications for this technique is demonstrated other than the widely reported use as replacement of tooth loss following trauma. In case 6 severe infra-occlusion had already occurred and continued bone loss in that region would have had a detrimental effect on the long-term management of this space. Transplanting an immature premolar and placing it at the height of the infra-occluded predecessor meant that continued eruption encouraged alveolar bone growth. This has already resulted in improved bone margins and with further eruption it will result in the equalisation of the bony margins which will give the patient a good aesthetic result. Where infra-occlusion.

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**Figure 6. A-B.** Intra-oral photograph (a) and periapical radiograph (b) showing severe infra-occlusion of 11 and replacement resorption. **C.** CBCT assisted in planning treatment and allowing measurements of remaining bone to be made. **D-E.** Auto-transplant in recipient site, which is erupting. Continued root development will allow further eruption and equalisation of gingival margins.
becomes obvious, dentists should consider decoronation to prevent the alveolar bone loss that is associated with ankylosis in a growing patient. In the case presented here (Case 6) bone volume and quality was assessed during treatment planning using CBCT. This imaging technique is extremely useful for complex cases where conventional radiographs do not provide sufficient information for diagnosis and treatment planning [Sedentexct, 2009]. In case 4 use of CBCT also assisted in the diagnosis of the dilacerated incisor and abandonment of futile orthodontic treatment in favour of auto-transplantation.

While high success rates are reported with auto-transplantation, a small number do fail. When this occurs the auto-transplant acts as an ideal natural space maintainer, preserving alveolar bone levels, gingival tissue and space in the dental arch. If the auto-transplant can be maintained until dentoalveolar maturation and growth cessation then the recipient site may be more suitable for future restorative options such as dental implants, hence reducing the need for extensive pre-implant preparation.

The patients discussed above were all identified as having failing or missing teeth, with suitable donor teeth due to dental crowding. Additionally they were highly motivated with good oral hygiene and willing to undergo extensive dental care and orthodontics, making them ideal for tooth auto-transplantation. As these children were still growing alternative treatments would have relied on space maintenance until maturation enabled implant-retained or prosthetic replacement, potentially leading to significant concerns with bone loss, gingival aesthetics and the health of the rest of the dentition. Whilst this technique is not without flaws, the authors’ opinion is that successful auto-transplantation provides significant long-term advantages for the growing patient over conventional restorative alternatives.

**Conclusion**

Transplantation should be considered for suitable patients during treatment planning as a valuable treatment option in a wide range of clinical situations.

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**References**


