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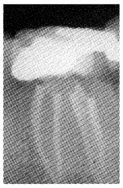

CASE REPORT

Autotransplantation of an ectopic impacted premolar with sinus lift and allogenic bone graft

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Abstract

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Aim This article presents a case report of autogenous tooth transplantation to a site which had insufficient bone volume using a sinus lift and allogenic bone graft.

Summary An ectopic, fully impacted premolar tooth was autotransplanted from its ectopic impaction site into its original site, where there was insufficient recipient vertical bone volume because of sinus expansion. The deciduous tooth was extracted from the recipient site, and the sinus membrane detached and elevated via the alveolar socket. Allogenic bone grafting was performed, and the impacted premolar was transplanted into the prepared site. To improve adaptation, the recipient site was prepared using a rapid prototype tooth model, a replica tooth which allowed complete socket preparation in advanced of the actual removal of the donor tooth. The donor tooth was fixed with sutures and maintained for 17 days to allow physiologic movement. Root canal treatment was initiated 24 days after autotransplantation, and an intra-canal medicament was used for 4 months. Canal filling was completed 5 months after autotransplantation. There was no root resorption of the transplanted tooth, and the grafted bone was well preserved and had no signs of infection.

Key learning points

- When the recipient bone volume is insufficient, autotransplantation can be preceded by bony augmentation.
- The preparation of the recipient tooth socket using a tooth replica from CBCT reduces the extra-oral time of the actual tooth and promotes better periodontal ligament healing.
- Careful evaluation of the pulp status of the donor tooth is important in advance of timely endodontic treatment.

Keywords: allogenic bone graft, autogenous tooth transplantation, ectopic impacted tooth, periodontal ligament cell, recipient alveolar bone insufficiency, sinus lift.

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Introduction

Autotransplantation is defined as the transplantation of embedded, impacted or erupted teeth from one site to another in the same individual, into either extraction sites or surgically prepared sockets (Natiella *et al.* 1970). Autotransplantation offers several advantages over other treatment alternatives such as dental implantation and other prosthetic approaches. First, this procedure can be conducted during a single visit (Kim *et al.* 2005). Secondly, successful autotransplantation will result in normal periodontal healing, and so proprioceptive function, the perception of natural chewing and natural biological responses will be restored (Nethander 1995, Kim *et al.* 2005). Moreover, autotransplantation may allow osseous development to continue, especially in young patients, by avoiding alveolar bone resorption (Thomas *et al.* 1998). Teeth for which only one-third to three-quarters of the root was formed have been transplanted successfully with root formation continuing as normal (Mendes & Rocha 2004).

For the last 3–4 decades in orthodontics, autotransplantation has often been suggested as an option to replace missing teeth or for those that have a poor prognosis. Long-term follow-up studies of autotransplantation confirmed that autotransplantation had a high survival rate and reacted normally to orthodontic treatment (Jonsson & Sigurdsson 2004). A recent follow-up study on autotransplantation reported that the success rate of 269 transplants in 215 patients was 81%, with 90% in cases of premolar transplantation (Kvint *et al.* 2010). When there is a choice between dental implant and transplanted premolar, especially in the case of young patient, transplantation may be the best treatment option (Jonsson & Sigurdsson 2004).

The protocol for successful autotransplantation of teeth is informed by an evidence-based transplantation technique (Thomas *et al.* 1998). Tsukiboshi (2002) postulated that there were two major factors underlying successful transplantation: periodontal ligament (PDL) healing and pulpal healing. The status and preservation of PDL cells are important for both mature and immature teeth. Various techniques for PDL preservation have been introduced. In all of these, the extraction should be performed carefully using minimal mechanical force, and the extraoral time should be minimized to reduce damage to the PDL cells, because the extraoral time is strongly inversely correlated with both the PDL survival and the success of tooth transplantation (Kristerson 1985, Lee *et al.* 2001, Kim *et al.* 2005, Amos *et al.* 2009).

The second factor influencing successful transplantation is pulpal healing, which occurs in 95% and 15% of transplanted teeth with incomplete and complete root formation, respectively. Andreasen *et al.* (1990) analysed the incidence of pulp healing after transplanting 370 premolars at various developmental stages and classified tooth development into seven stages. They found that healing of the dental pulp occurred until stage 5 (complete root formation with the apical foramen wide open). Considering both the healing of the dental pulp and the continued development of roots, the ideal time to transplant developing teeth is when the donor tooth roots are three-quarters to four-fifths completed (at developmental stage 4 or 5, respectively).

Meanwhile, the appropriate donor tooth and recipient bone volume are the primary requisites for the success of autotransplantation (Thomas *et al.* 1998, Amos *et al.*2009). As well as an adequate donor tooth, adequate alveolar bone width and length of the recipient site are essential. Therefore, insufficient recipient alveolar bone volume is generally contraindicated for transplantation, such as in the posterior maxillary region with severe sinus expansion. Whilst the sinus graft procedure is often considered to be a predictive treatment modality for dental implant surgery, in those cases (Woo & Le 2004), few reports on the use of bony augmentation in autotransplantation cases exist. This report describes the autotransplantation of an ectopic impacted maxillary premolar tooth into a recipient bony site which had insufficient bone volume, using sinus lift and allogenic bone graft.

Case report

A healthy 13-year-old boy was referred from a local clinic to a specialist in orthodontics in relation to an ectopic impacted maxillary left second premolar. Clinical evaluation revealed the maxillary left second primary tooth to be retained. The maxillary sinus was severely expanded up to the furcation area of the primary tooth. Computed tomography (CT) images were taken with a Hi-Speed Advantage system (GE Medical Systems, Milwaukee, Wisconsin, USA) using a high-resolution bone algorithm with the following parameters: 512×512 matrices, 120 kV, 200 mA and 1-mm slice thickness. The CT evaluation revealed that the maxillary left second premolar was impacted in the palate around the apex of the left canine (Figs 1 and 2). The orthodontist examined the patient and reported that the tooth impaction was too deep to allow controlled orthodontic tooth movement. He therefore referred the patient to an Oral Surgeon and an Endodontist for autotransplantation of the impacted tooth into its original location rather than orthodontic extrusion of the impacted premolar.

The CT evaluation for transplantation suggested that a sinus lift and allogenic bone graft would be necessary to provide sufficient bone volume in the recipient site. The risks and benefits of the procedure were explained to the patient and his parents, who provided written informed consent. Because he had a history of rhinitis, prophylactic antibiotics and a nasal decongestant were prescribed for the patient to take 5 days before surgery. A rapid prototype (RP) artificial donor tooth model was made with the aid of the CT to minimize the extraoral time and hence preserve the PDL. The RP tooth model was constructed with the same size and shape as donor tooth (CEP Tech, Seoul, Korea). Whilst the recipient bone was being prepared, this RP tooth model was used for repeated fitting

Figure 1 Initial panoramic radiograph. The maxillary left second premolar was ectopic and fully impacted, and the maxillary left second deciduous tooth was retained. The recipient bone volume was not sufficient.

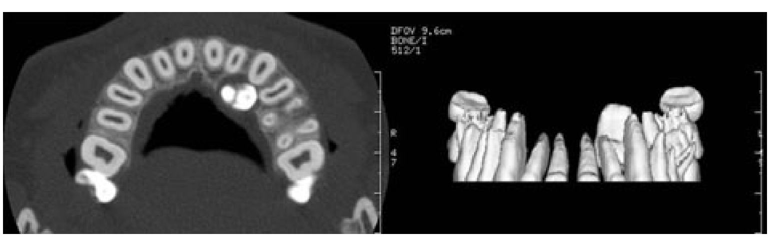

Figure 2 Computed tomography axial image (left) and three-dimensional reconstruction image (right). Tooth 25 was located palatal to tooth 23.

in the prepared bone socket in place of the real donor tooth. This procedure makes it possible to reduce the extra socket time of a donor tooth and eventually minimize damage to PDL cells on the donor root surface.

All procedures were performed under local anaesthesia. The deciduous molar was first extracted and the recipient bone was then prepared using the artificial RP tooth model and a piezoelectric device (Surgybone, Silfradent, Sofia, Italy) to minimize tearing of the sinus membrane. After bone preparation, the sinus membrane was elevated using a curved sinus curette (by up to 15 mm) without tearing, as checked by the RP tooth model (Fig. 3).

After preparing the recipient site, extraction of the impacted tooth began using a palatal approach. The impacted tooth was fully luxated, but remained in the alveolar socket until the recipient site was completely prepared. One cubic centimetre of allogenic bone material (Orthoblast II; Isotis, Irvine, CA, USA) was grafted into the prepared recipient site. The impacted tooth was immediately transplanted into this site and fixed in place with 3-0 black silk sutures to allow physiologic movement of the tooth. The extraoral time was 30 s, and root formation in the transplanted premolar was approximately 90% complete (Fig. 4). Panoramic and periapical radiographs confirmed that the autotransplanted tooth had been placed in infraocclusion and had incomplete root formation (Fig. 5). Antibiotics, anti-inflammatory drugs, and a decongestant were prescribed for 2 days. The soft-tissue healing proceeded uneventfully and the sutures were removed at 17 days after surgery. The transplanted tooth was positive to sensibility testing at 7 days after surgery; however, at 17 days after surgery, it gave a negative response to the electric pulp test.

Root canal treatment was therefore commenced at 24 days after tooth transplantation. All root canal treatment procedures were carried out under aseptic conditions with a rubber dam. After access canal preparation, the pulp was found to be necrotic. Chemomechanical canal shaping was conducted and calcium hydroxide dressing (MetaPaste; Meta Biomed, Seoul, Korea) was applied on three occasions over 4 months to encourage continued root development and to prevent root resorption. A radiographic

Figure 3 Sinus lifting and allogenic bone grafting using a piezoelectric device.

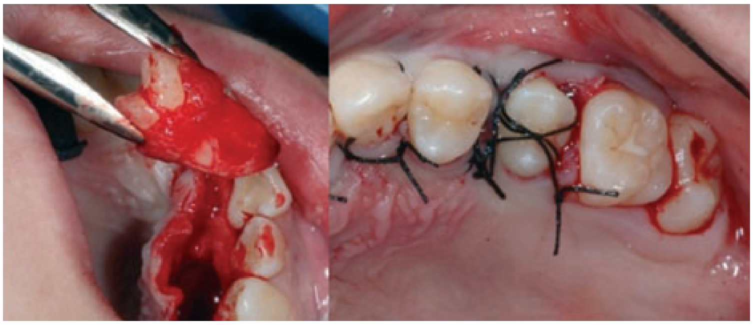

Figure 4 The extraoral time was 30 s. The photographs show that root formation was complete about 90%, and suture fixation was in infraocclusion.

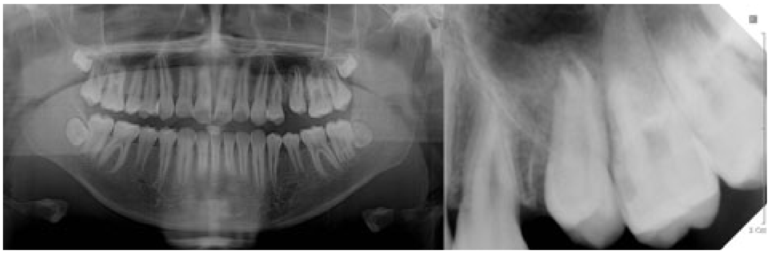

Figure 5 Radiograph taken after autotransplantation of the maxillary left second premolar.

evaluation performed at 4 months after root canal treatment revealed an apical barrier and lamina dura, and no root resorption. The root canal was then filled with Gutta-percha using a vertical compaction technique, and a coronal seal was achieved using a resin core (Fig. 6).

Clinically, the mobility and probing depth of the tooth were normal, and a periotest value of +9 was obtained; this compared favourably with the periotest value of +8 for the control tooth (the maxillary right second premolar). The tooth remained in infraocclusion but had extruded considerably relative to the initial transplantation position (Figs 7 and 8).

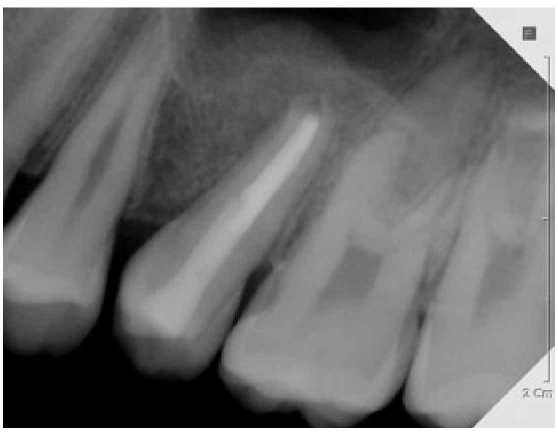

Figure 6 Radiograph taken after canal filling (at 5 months after surgery), showing the completion of canal filling and the application of a resin core.

Cone-beam CT (Volux; Genoray, Gyeonggido, Korea) revealed that the PDL space surrounded the root of the donor tooth, the presence of ossified grafted bone and the absence of pathosis (Fig. 9).

A recall at 24 months after autotransplantation checked for changes in tooth colour, position, mobility and abnormal percussion sounds that might indicate ankylosis or other pathosis. The transplant was still positioned slightly out of occlusion. No abnormality was observed in terms of mobility, percussion at periodontal disease. The periotest value was −1 to +1 as compared +0 to +4 on the adjacent tooth and control tooth. Panoramic and periapical radiographs were taken to assess continuity of PDL space, root resorption, allogenic graft bone volume and consistency and adjacent alveolar bone level. A definitive continuous lamina dura surrounding the root was noted with no resorption on root surfaces. Grafted bone was resorbed just above the apex of the transplanted tooth but bone consistency was similar to the adjacent bone. The radiopacity of the inferior border of the left sinus revealed cortical bone forming within the allogenic graft bone (Fig. 10). A further recall was scheduled in 1 year.

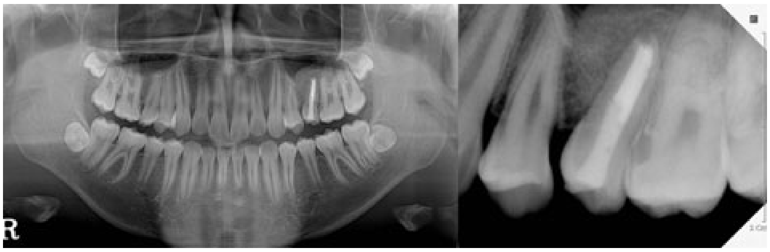

Figure 7 Radiographs taken at 6 months after surgery. The radiopacity of the apex of the transplanted tooth had increased. Comparison of panoramic radiographs taken at 4 months after surgery with those taken on the day of surgery revealed that tooth 25 had extruded in occlusion, confirming that periodontal ligament healing was occurring without ankylosis.

Figure 8 Clinical appearance of the autogenously transplanted maxillary second premolar at 5 months after surgery.

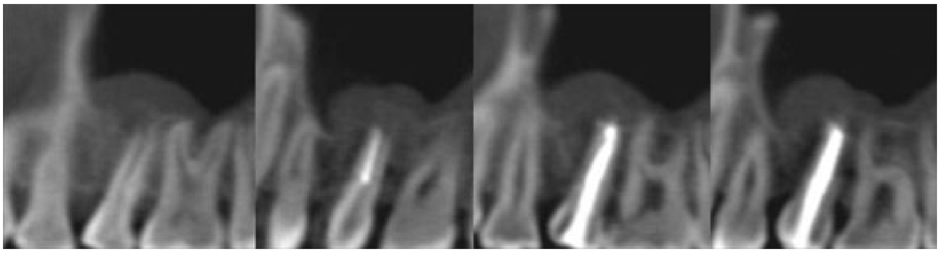

Figure 9 Cone-beam computed tomography reformative sectional view series taken at 5 months after surgery.

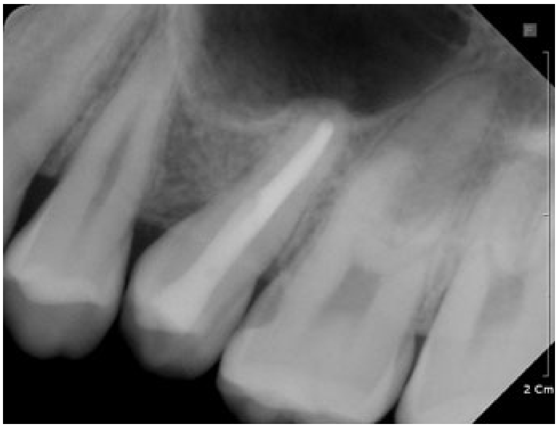

Figure 10 Radiograph taken at 24 months after autotransplantation, showing no significant radiographic abnormality.

Discussion

When a second premolar is missing, the primary tooth should be maintained until growth completion. Implant treatment would then be considered if the primary tooth is lost. However, autotransplantation is recommended as the ideal treatment option when a suitable donor tooth is available, even though it may be an ectopic impacted tooth. Success rates of autotransplantation can reduce as the patient ages and intraosseous pathosis such as cyst or tumours can develop around the impacted tooth, causing root resorption of the adjacent tooth. After considering all the advantages and disadvantage of each treatment options, it was concluded that autotransplantation was the best option.

Tsukiboshi (2002) postulated that there were two major factors underlying successful transplantation: PDL healing and pulpal healing. In the present case, the extraoral time was only 30 s because of bone preparation at the recipient site using a RP artificial tooth. The RP model can be constructed using either conventional CT or cone-beam CT to obtain digital data of the tooth structure, which can be transformed into stereolithographic data (Lee *et al.* 2001). During the preparation of the recipient site as the donor size, the artificial tooth model can be placed into the prepared socket instead of the real donor tooth, thus helping to reduce the donor tooth extraoral time and mechanical damage to the PDL cells during adaptation.

Non-rigid fixation of the tooth is another method of preserving PDL cells. It is well known that physiologic fluids or a blood supply should flow constantly into the PDL of the donor tooth through the prepared bone surface and extraction socket because of the contact between the PDL of the donor tooth root surface and the recipient bone (Hardy 1982, Pohl *et al.* 2000). In the present case, even the simple suture fixation across the occlusal surface allowed physiologic movement of the donor tooth and prevented excess pressure on the PDL cells. This procedure reduces the chance of root resorption or ankylosis (Bauss *et al.* 2005).

This preservation of PDL cells by these surgical techniques made a considerable impact on the healing pattern of the graft bone. The radiograph taken at 5 months after surgery revealed a remarkable increase in the radiopacity of the grafted bone, especially around the apex of the donor tooth. This rapid bone formation does not usually occur in the case of conventional sinus graft surgery without tooth transplant. Andreasen (1980) demonstrated that the PDL of a donor tooth formed bone tissue around the root even when it was embedded in the soft tissue. The vital PDL cells on the transplanted tooth may have induced a rapid sinus graft healing by acting as a core for healing process at the centre of the graft material.

According to the tooth developmental classification of Andreasen *et al*. (1990), this case was stage 5 and hence pulp healing could have been expected as well as continued root development. However, the open apex was completely surrounded by allogenic bone graft materials rather than recipient bone surface, so pulp revascularization in the canal did not occurred. Also important at this point is the precise evaluation for pulp status. Laser Doppler flowmetry would be better to evaluate tooth vitality related to actual vascular supply. However, pulp necrosis was judged to have occurred by no response to thermal testing (ice stick) and electric pulp tester. This negative response of teeth damaged by trauma or surgery (in this case, transplantation) can be a false negative because of temporary sensibility function loss. In most cases, root canal treatment is required only when inflammatory root resorption or radiographic periapical lesions resulting from pulp necrosis are diagnosed at 1–2 months. In this present case, at 17 day after surgery, the transplanted tooth gave a negative response to the electric pulp test and there was a grey-shaded tooth discoloration. Root canal treatment was started 24 days after transplantation, and the pulp was necrotic.

Radiographic and clinical outcomes of autotransplantation were considered satisfactory at the last recall. Further recall is required to detect root resorption or the rate of the resorption process, because treatment was undertaken in the skeletal growth period of young patient.

Conclusion

The result of this case report suggests that autotransplantation with allogenic bone graft may be considered as a viable treatment option even if the recipient bone volume is not sufficient. Careful surgical techniques for preservation of PDL cells and timely endodontic assessment and treatment are essential to the successful outcomes of autotransplantation.

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