

Case Report

Case Report: Autotransplantation for a Missing Permanent Maxillary Incisor

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Abstract: *Patients with nonrestorable or missing anterior teeth are typically seen by their general or pediatric dentist who directs the course of consultation, referral, and treatment. In the mixed dentition stage, loss of permanent maxillary incisors is usually treated by various forms of removable/fixed prosthetic appliances. Because premolars are developing during this time period, transplantation of an available premolar to an incisor position is a viable alternative, that may provide a better biological substitute for a missing incisor than other choices. The purpose of this case report was to describe the treatment of the loss of a permanent maxillary central incisor by transplantation of a maxillary first premolar to the incisor position. Autotransplantation allowed normal alveolar bone development and a future option of permanent restoration without implants or partial dentures. Autotransplantation should be given consideration as a reasonable option for the treatment of missing incisors in mixed dentition. (Pediatr Dent 2008;30:160-6) Received May 31, 2007 / Last Revision August 12, 2007 / Revision Accepted August 14, 2007.*

KEYWORDS: AUTOTRANSPLANT, MISSING CENTRAL INCISORS, PREMOLAR TRANSPLANT

Currently, practitioners have multiple solutions available to treat missing permanent maxillary anterior teeth that are lost during the mixed dentition years due to trauma, decay, and developmental origins. These solutions include fixed or removable partial dentures, osseointegrated implants, orthodontic space closure, and autotransplanted permanent teeth. Fixed and removable partial dentures have been a mainstay for replacement of missing anterior teeth. These are costly, require a lifetime of maintenance, and have shortcomings relative to gingival health and marginal integrity when definitively restored.^{1,2}

Osseointegrated implants can provide esthetic replacements when the space for the prosthesis is managed until the patient becomes a nongrowing adolescent. They provide technical challenges, however, especially regarding the gingival and papillary contour and interface.^{2,3} Orthodontic space closure is another option that has notable strengths when properly selected and augmented with restorative care.⁴ Some combinations of malocclusion and space conditions however can make this option more problematic. For example, with the

loss of a permanent maxillary incisor in a patient with excessive anterior spacing and a Class I molar relationship, attempting space closure without disturbing posterior occlusion may result in inadequate overjet. Also, asymmetric space closure for 1 missing anterior tooth can be difficult.^{5,6} Although not popular in the United States, autotransplantation of permanent teeth has been described in the dental literature on numerous occasions and is often chosen in Scandinavia.^{1,2,4,7-10} Because pediatric and general dentists provide primary care for many patients with missing permanent anterior teeth, they should be familiar with autotransplantation as a viable option for many of these patients.

The purpose of this case report was to demonstrate the clinical application of autotransplantation during the mixed dentition when a permanent maxillary incisor is missing.

Case description

The patient, a 9-year, 6-month old Asian female in excellent health with no medical contraindications to treatment, presented to the Ohio State University Graduate Orthodontic clinic, Columbus, Ohio, with the chief complaint of an unerupted permanent maxillary left central incisor. She had multiple restored and extracted primary teeth. At the time of examination, she had no active caries or oral habits, fair oral hygiene, and a developmental status of cervical vertebral maturation stage 1, indicating considerable remaining pre- and postpubertal growth.¹¹

Diagnostic records included intra- and extraoral examinations, diagnostic casts, and panoramic, maxillary anterior

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occlusal, and lateral cephalometric radiographs along with photographs. Figure 1 shows the frontal and maxillary occlusal intraoral photographs, while Figure 2 shows the initial panoramic and occlusal radiographs. The oral exam revealed the maxillary midline 1.5 mm to the left of the midsagittal plane with a Class II molar relationship on the right and Class I molars on the left. The patient demonstrated 2 mm of overjet with 20% overbite. A Tanaka and Johnston space analysis revealed 5 mm of maxillary crowding with little or no mandibular arch crowding. The patient had a lower lingual arch in place.¹² The radiographs showed an ectopically erupting (inverted) permanent maxillary left central incisor with delayed root development (Figure 2).

Several options were entertained for treatment, including extraction of the ectopic incisor followed by either: 1) prosthetics; 2) asymmetric orthodontic space closure; 3) surgical uncovering followed by orthodontic repositioning; or (4) autotransplantation of the inverted tooth to a more acceptable position

followed by orthodontic repositioning (Figure 2). Because extraction eliminated the future options to move the tooth and could be implemented later, it was initially rejected. Surgical uncovering and orthodontic repositioning, although possible, appeared difficult given that the tooth's occlusal and facial rotation in the anterior maxilla beneath cephalometric point A would most probably force the tooth through nonkeratinized tissue and compromise its periodontal support.

Autotransplantation with orthodontic traction to reposition such teeth has been reported in nearly identical cases¹³⁻²¹ and was the initial treatment plan selected. Specifically, the anterior teeth were aligned and space was created for the inverted permanent incisor. This incisor was to be surgically repositioned and then orthodontic traction applied for final positioning.

The 3 erupted permanent maxillary incisors were bonded and the permanent maxillary molars banded. An open coil (medium force NiTi) on a 0.016-inch stainless steel archwire



Figure 1. (a) The initial intraoral views show the absence of the inverted permanent maxillary left central incisor and the crowding in that area due to the mesial drifting of the permanent maxillary left lateral incisor. (b) The initial maxillary occlusal view demonstrates the anterior and potential maxillary left posterior crowding.

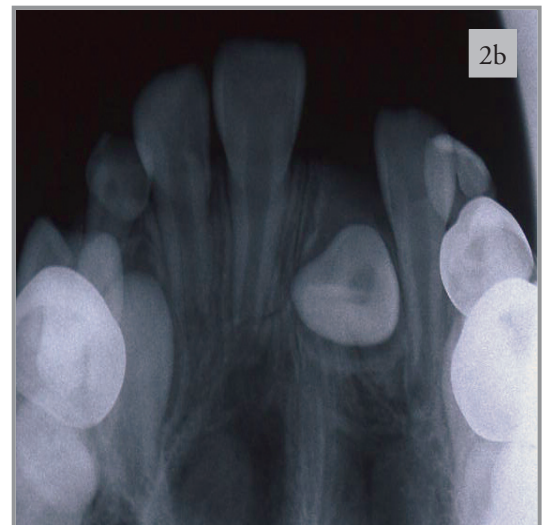
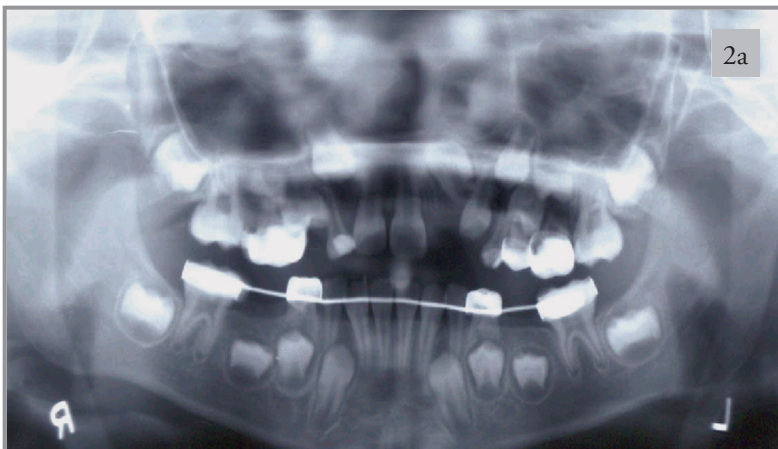


Figure 2. (a) The initial panoramic radiograph shows the inverted permanent maxillary left central incisor, the drift of the permanent maxillary left lateral incisor, and the unerupted developing premolars. (b) The anterior occlusal radiograph confirms the impression of the unerupted permanent maxillary central incisor from the panoramic radiograph.

was used to align the permanent incisors and create space between the maxillary right central and left lateral incisors. After 3 months of orthodontic treatment, the patient demonstrated adequate space for repositioning of the maxillary left central incisor and was referred for oral and maxillofacial surgery.

The patient was sedated, and local anesthesia was administered. A mucoperiosteal flap was raised to expose the ectopic central incisor. Flap elevation revealed a significant dilaceration of the root, which mandated tooth extraction due to the potential difficulty of moving the tooth with the dilaceration.^{15,20} The socket was curetted, and the flap was replaced and sutured in place. The extraction site was allowed to heal for a period of 4 weeks, after which the patient was referred back to the orthodontic clinic.

At this time, the treatment plan was revised to incorporate the loss of the permanent maxillary left central incisor. Periapical radiographs of the unerupted maxillary premolars were taken to assess their root development. The maxillary left first premolar was chosen as a prospective donor because of the potential crowding in that quadrant and the status of the root development. The tooth was monitored for a period of 4 months until half the root was completed (Figure 3). At that point, the patient was referred back to oral surgery for the extraction of the primary maxillary left first molar and autotransplantation of its successor, the maxillary left first premolar, to the site of the permanent maxillary left central incisor.



Figure 3. The periapical radiograph of the developing maxillary left first premolar with approximately half root formation.

The patient was again sedated and anesthetized. A flap was raised in the maxillary anterior region, and bone was removed to create enough space to accommodate the roots of the premolar. The surgeons prepared the socket within the alveolus in the location of the permanent maxillary left central incisor using a bur and saline coolant. The maxillary left first premolar was exposed by elevating another flap. The overlying primary molar was extracted. Then the premolar was extracted and transplanted into the incisor's position. The premolar was rotated along its vertical axis and placed with its mesial

surface facing labially to encourage better gingival contour in the esthetic zone and stabilized in infraocclusion with sutures. The patient was instructed to use an antiplaque rinse for 2 weeks and begin cleaning the surgical area at 2 days. The site was allowed to heal for a period of 2 months, during which the patient was monitored monthly in the orthodontic clinic.



Figure 4. (a) The transplanted maxillary left first premolar is stable and erupted. (b) A temporary build-up with composite resin is in place.

Clinical evaluation of the transplanted tooth at 8 weeks post surgery demonstrated grade 2 mobility. Enameloplasty was performed on the transplanted tooth to flatten the labial and lingual surfaces and reduce the mesial and distal surfaces. The space between the cusps of the premolar was restored with composite to simulate an incisal edge (Figure 4). An edgewise bracket (0.022-inch slot) was bonded onto the tooth, and a 0.016-inch stainless steel archwire was tied in with step-up bends on the permanent maxillary laterals and a step-down bend on the transplanted tooth. The labial and lingual surfaces were reduced incrementally to avoid pulp sensitivity and maintain vitality. The vertical bends were gradually increased during subsequent visits until the laterals were relatively intruded and the transplanted tooth was extruded (Figure 5). The decision to stop extrusive mechanics was based on obtaining gingival marginal heights comparable to the contralateral incisor with incisal edge adjustment to be attained by resin bonding and definitive restoration at a later time (Figures 6 and 7).

The patient complained of some discomfort during first 3 months of postsurgical therapy. By the end of the treatment, the transplanted tooth demonstrated physiologic mobility and normal periodontal attachment characteristics. A periapical radiograph of the tooth demonstrated no signs of root resorption (Figure 8). The patient finished with a bilateral Class I canine relationship, with Class I molars on the right and Class II molars on the left. She was pleased with the interim esthetic result.

Future treatment includes definitive orthodontic treatment when the remaining permanent teeth erupt, followed by final anterior tooth positioning and restorative treatment for the transplanted premolar.

Summary timeline

The following sequence of clinical events summarizes the progress of the case:

1. initial records and treatment planning;
2. appliance placement and space creation for transplantation by diverging adjacent roots away from the transplantation site (3 months);
3. selection of donor tooth based on the root development stage (one half to three quarter root completion);
4. surgical preparation of the socket at the recipient site with at least 1 mm of space around the periphery of the donor root;
5. transplantation of the donor tooth to its new site and stabilization with sutures;

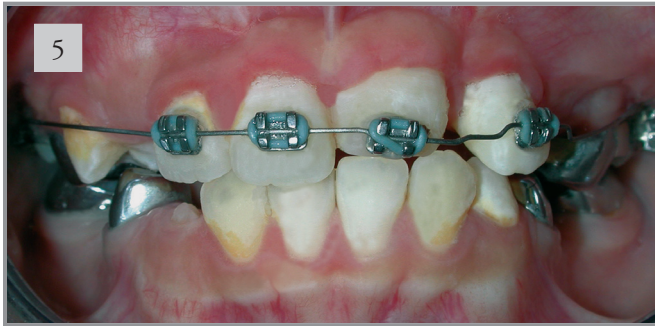


Figure 5. Orthodontic appliances are in place to simultaneously extrude the transplanted premolar and intrude the maxillary left lateral incisor.



Figure 6. (a) An interim resin restoration has been placed that will be replaced with a future permanent restoration. Note that the gingival margin on the distal side of the transplanted tooth is higher and that its mesiodistal width is greater than the contralateral incisor. Final positioning will be accomplished when the permanent teeth have erupted. (b) The faciolingual dimension of the crown was reduced during the restoration process.

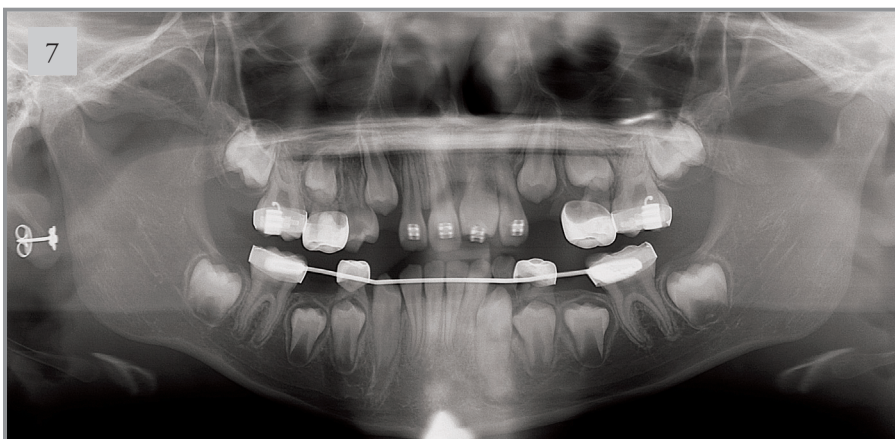


Figure 7. A progress panoramic radiograph demonstrates the final tooth position with good alignment of the transplanted tooth and adequate space for eruption of the canines and remaining premolars. Figure 8. The periapical radiograph demonstrates no loss of root structure of the transplanted premolar, some obliteration of the root canal, and a normal periodontium.

6. latent healing phase (2-3 months);
7. orthodontic extrusion of the transplanted tooth with esthetic recontouring and composite build-up (6 months);
8. restorative treatment to match the contralateral incisor.

Discussion

Autotransplantation procedures have demonstrated high survival (90%) and success (79%) rates, as documented in the dental literature.^{1,2,22} Although autotransplantation procedures are frequently cited in the orthodontic literature, most of these cases have been treated in Europe.^{1,2,7-9,23-26} Zachrisson et al have described 3 main indications for autotransplantation of teeth:

1. multiple agenesis;
2. mandibular second premolar agenesis in hypodivergent patients with normal to weak musculature; and
3. congenitally or traumatically missing maxillary central/lateral incisors.²

Most traumatic injuries to permanent incisors occur in the early mixed dentition,^{27,28} which is the time when premolar roots are forming. Since partial root formation (two thirds to three fourths) is one of the requirements for a good prognosis,²⁹ premolars are likely donors for transplantation into incisor recipient sites.

Various factors are considered for determining the prognosis of this procedure: good general health of the patient, incomplete root formation of donor tooth, adequate space preparation at the recipient site, and stability of the transplanted tooth for the first 2 months.² Previous studies that evaluated the ideal stage of root development for transplantation revealed a range from two thirds to three fourths root formation. At half root formation, there is an 80% chance of optimal root length and over 90% chance of pulpal and periodontal healing.^{2,24} The presence of open apices seems to be crucial for a good prognosis. Recipient site preparation involves providing enough space to accommodate the donor tooth without damaging its supporting structures. To do this, the bone area should be 1 to 2 mm wider and deeper than the dimension of the donor root.²⁴ Lastly, good surgical skills to ensure proper technique and minimum periodontal trauma are mandatory.

Zachrisson et al recommend restoration of autotransplanted premolars with porcelain laminate veneers (PLV) over composite build-ups for better esthetics. Incoming light on the tooth is not blocked by a bonded PLV, resulting in no darkening of the gingival margin even upon root exposure.² This minimum tooth reduction technique can, therefore, permit earlier placement of a permanent restoration.

Studies on esthetic outcomes reveal no significant difference between autotransplanted teeth and their natural counterparts when assessed by both professionals and patients.⁸ Dissatisfaction in outcome is primarily due to suboptimal positioning and restorative build-up of the transplant. The authors state that interdisciplinary planning is important for successful esthetic results.

Autotransplanted teeth can provide an answer for immediate esthetic concerns and improve the success of the eventual permanent restoration. If the transplant fails, which is relatively rare, final treatment with an implant restoration can still be accomplished and the autotransplantation can be beneficial in maintaining adequate alveolar bone support during growth. This is because the transplanted tooth has normal root development and periodontium, which allow for predictable vertical growth of alveolar bone. This will be important later to provide good papillary fill and angle of convergence for better implant esthetics.

The transplanted tooth in this case was rotated prior to placement into the site. In reality, any orientation can be used and depends on the site, the shape of the tooth, and its anticipated reduction, restoration, and occlusion. If the tooth is reduced or reshaped, this should be attempted incrementally over several visits to reduce pulpal irritation.² It is common to stabilize the transplanted tooth with sutures so that it has physiologic mobility and is out of occlusion.⁷

Immediately following transplantation, the tooth typically does not respond to electric or thermal pulp vitality tests. Partial obliteration of the pulp in the area that was forming at the time of surgery has been observed.³⁰ Radiographic pulpal obliteration is an earlier sign of pulpal healing than is electrometric pulp testing.³⁰ At this stage, based on the lack of a positive response to electric pulp testing, endodontic therapy need not be initiated. Following transplantation, an adequate period for healing is necessary to rule out postsurgical complications. No consensus has been reported in the literature on the ideal postoperative stabilization period for transplanted teeth.^{2,22,24,30-33} Initial periodontal healing around a transplanted tooth takes approximately 4 weeks and radiographic completion of periodontal healing can be seen in 8 weeks.³⁰ Because pulpal necrosis and inflammatory resorption are noticeable within 2 months post surgery, a waiting period of at least 12 weeks is desirable before initiation of orthodontic forces.

Generally, antibiotic therapy in conjunction with the transplant is not required. Despite the lack of overwhelming evidence, antiplaque rinses are used often during the healing period.²²

Pulpal necrosis during orthodontic tooth movement of a transplantation tooth may occur due to strangulation of the vasculature entering the apical foramen, especially in late stages of pulp canal obliteration. Incidences of late pulpal necrosis have been documented 5 years post orthodontic movement in transplanted teeth. Orthodontic treatment can be implemented within 3 to 4 months of the transplantation.² This allows for adequate periodontal healing prior to complete pulpal obliteration, thus preventing late pulpal necrosis.³⁰ Light continuous forces can lead to successful orthodontic treatment in all planes of space, which can remedy any positional problems resulting from the initial transplant placement.

In conclusion, with its high success rates and by following reliable techniques, autotransplantation of a permanent maxillary central incisor with a maxillary premolar is a favorable

option and should be considered and offered, at least to young patients.

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Abstract of the Scientific Literature

Survival analysis of treated traumatized primary teeth

This study aimed to verify the factors that interfere with the success of endodontic treatment of traumatized primary teeth and to determine success rate of the treatment. Dental records of 41 patients between 10 and 60 months of age met inclusion criteria, and the records of 51 treated teeth were analyzed. Factors examined included age of the child at the time of the endodontic treatment, trauma type, pathological root resorption type, localization of the resorption, bone resorption related to root resorption, submucosal abscess and/or fistula, pulp condition, and trauma recurrence. The study concluded 48 months after the completion of the endodontic treatment. The maxillary central incisors were found to be the most often injured (96%), and 82% of the injuries occurred in children over 36 months of age. Statistically, trauma recurrence was found to be the only factor that interfered in the success of endodontic treatment. Most failures occurred between the 7th and 12th months post-treatment, and the level of success stabilized beyond the 19th month. Outcome was considered successful for 65% of all treated teeth at the end of the follow-up period.

Comments: Endodontic treatment of traumatized primary teeth appeared to have merit better than chance in the long run. It is interesting to note that the age of patient, trauma type, severity of resorption, and even presence or absence of an abscess and/or fistula, made no significant difference in survival of endodontically treated traumatized primary teeth. Recurrence of trauma was the only factor that showed a significant effect. Strategies for the prevention of recurrent trauma should be part of the standard post-op discussion with the parents. **RHH**

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