Long-term Stability of Autotransplanted Premolars as a Substitute for Molars in Adults

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Abstract

Autotransplantation is a viable treatment option for tooth replacement when a suitable donor tooth is available. This case report presents 2 cases that describe successful treatment outcome and prognosis after autotransplantation of a mature premolar as a missing molar. The first premolar was extracted for orthodontic purposes and transplanted to the missing first molar site in the mandible. The transplanted tooth was monitored up to 7 years. The transplant was functional and maintained a normal bone level throughout the follow-up period. Clinical examination showed normal physiologic movement without any signs of ankylosis and root resorption. Autotransplantation of a mature premolar to a molar site is a viable treatment option showing successful results. The selection of a functional donor tooth, adequate surgical procedures, and timely application of orthodontic movement may have positively contributed to the favorable prognosis. (J Endod 2016;42:1286–1290)

Key Words

Adult, autotransplantation, mature premolar, missing molar, periodontal ligament

Since the 1950s, a fairly high success rate of 75%–91% has been reported for autotransplantation along with the clinical considerations for patient selection and surgical techniques (1, 2). For adult patients, autotransplantation of an immature tooth can be a useful treatment option to replace a missing tooth because the autotransplanted tooth can erupt in harmony with the neighboring teeth allowing vertical alveolar bone growth, whereas restorations such as dental implants for fixed prosthetics cannot adapt to dynamic natural growth (3). However, for adults, autotransplantation of a mature tooth to replace an edentulous site is less common. This could be because of the advancement of dental implants as a standard of care for missing teeth in adults (4). Nonetheless, it is noteworthy that a recent systematic review and meta-analysis reported autotransplantation of a mature tooth with complete root formation as a viable treatment option with limited failure, root resorption, and ankylosis (5). Moreover, long-term follow-up studies suggest prognostic factors that affect clinical success after autotransplantation of a mature tooth, which can be useful in predicting treatment outcome and prognosis (6).

Autotransplantation has a number of advantages over dental implants, such as better esthetic outcomes and maintenance of the periodontal ligament (PDL) and the alveolar bone (7). Although these advantages are well acknowledged, most clinicians initially consider a dental implant for single tooth replacement for several reasons (4). Clinicians generally believe that tooth autotransplantation involves complex procedures compared with dental implants, and their clinical outcomes are difficult to predict. In addition, although donor teeth for autotransplantation are limited in terms of number and morphology, various forms of implant fixtures are easily accessible. Clinically, third molars are mostly used in adult autotransplantation cases to replace a missing molar with similar morphology, probably because the third molars are usually nonfunctional and available within the oral environment (6, 8, 9).

Nowadays, there is a tendency of an increase in adult or aged orthodontic patients (10). Multiple premolar extractions are usually recommended for orthodontic reasons such as to correct tooth crowding or to compensate for skeletal or dental discrepancies (11). However, in many cases, adult and aged patients have edentulous sites or subsequent prosthetic replacements, mostly in the molar region. This impedes the clinician from extracting additional healthy premolars for orthodontic treatment (12, 13).

Previous cases have shown high success rates and long-term favorable prognosis in cases of premolar autotransplantation to replace missing anterior teeth (14–16). On the contrary, the information on the use of a mature premolar to replace a molar with stronger occlusal force is limited. Therefore, the purpose of this case series was to report the long-term follow-up of adult autotransplantation cases in which premolars were used to substitute the mandibular first molars.

Significance

Autotransplantation of a mature premolar to a molar site is a viable treatment option showing successful results. The selection of a functional donor tooth, adequate surgical procedures, and timely application of orthodontic forces may have contributed to the favorable prognosis.

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Case Reports

Case 1

In March 2008, a 38-year-old female patient was referred from the Department of Orthodontics at Gangnam Severance Hospital, Yonsei University, Seoul, South Korea, for transplantation of a right mandibular first premolar. The patient’s dental history revealed that teeth #19 and #20 were extracted because of severe dental caries, and the edentulous site was restored with a 4-unit porcelain-fused gold bridge. Intraoral examination showed severe crowding, lower midline deviation to the left, and a skeletal class II relationship. Conventionally, it would require 4 premolar extractions, one on each quadrant, for the orthodontic treatment. Considering the large edentulous site of 2 missing teeth on the lower left quadrant, tooth #21 was maintained. Among the 3 premolars that were to be extracted, tooth #28 was selected as the donor to replace the missing tooth #19 because of the morphology/size of the root and the convenience of orthodontic alignment (Fig. 1A). A computed tomographic (CT) image was taken to analyze the volumetric size of the donor tooth and recipient site and to fabricate the computer-aided rapid prototyping (CARP) model. Three-dimensional data (Digital Imaging and Communications in Medicine format) of the donor tooth were obtained from the CT Highspeed Advantage Scanner and a DentaScan program produced by GE Medical Systems (Milwaukee, WI). The CT protocol used for this procedure involved a slit thickness of 1 mm. The 3-dimensional digital data obtained were fed into a visualization program (V-works; Cybermed Co, Seoul, Korea) and then exported to the rapid prototyping machine for fabrication of the actual-sized tooth starch model (17).

Endodontic treatment was completed in tooth #28 before extraction. The surgical technique was completed as was previously reported (18). Briefly, 2% lidocaine (with 1:100,000 epinephrine) was administered, and the mucoperiosteal flaps were raised in the area surrounding tooth #19. The recipient site was prepared with a round burr with abundant saline irrigation. To minimize injury to the transplant PDL, a soft curette was used to obtain a socket of the proper size. After the recipient site was ready, donor tooth #28 was extracted gently, paying special attention not to touch the cementum with the beak of the forceps. The tooth was wrapped with wet gauze to keep the root surface moist throughout the extrarural procedure, and an apicectomy retrofilled with super ethoxybenzoic acid cement (Super EBA; Harry J. Bosworth, Skokie, IL) was performed to prevent possible endodontic complications. After the apicectomy, the donor tooth was rotated 90° during placement in the recipient site. The transplant was sutured and stabilized with a flexible resin wire splint (Fig. 1B). After 5 weeks, a bracket was bonded to the transplant, and conventional orthodontic treatment was continued (Fig. 1C).

At the 6-month follow-up, the bone level was equivalent to that of the mesial bone of tooth #18 (Fig. 1D). After 30 months of orthodontic treatment, the brackets were removed. For the final restoration, the transplanted premolar was shaped as a first molar (Fig. 1E). The patient returned for annual clinical and radiographic follow-up. At the last 7-year follow-up visit, the transplant was asymptomatic and maintained a normal bone level (Fig. 1F).

Case 2

A 37-year-old female patient was referred from the Department of Orthodontics at Gangnam Severance Hospital, Yonsei University for the evaluation of tooth #19 before orthodontic treatment planning. Tooth #19 had a crack in the mesial root, the distal root had caries with a periapical lesion and showed class III furcation involvement (Fig. 2A and B). Accordingly, tooth #19 was diagnosed as hopeless. The patient had moderate to severe crowding and was scheduled to receive orthodontic treatment with extraction of tooth #12. Therefore, a treatment plan was established to replace the hopeless tooth #19 with the extracted tooth #12 via autotransplantation. Similar to case 1, CT images were taken to analyze the volumetric size of the donor tooth and recipient site and to fabricate the CARP model.

Endodontic treatment was completed in tooth #12 before extraction, and mucoperiosteal flaps were elevated surrounding tooth #19 under local anesthesia. After the extraction of tooth #19, the recipient site was prepared, and donor tooth #12 was extracted and an apicectomy retrofilled with mineral trioxide aggregate (MTA) (ProRoot MTA; Dentsply, Tulsa, OK) was performed. After the apicectomy, the donor tooth was rotated 90° during placement in the recipient site (Fig. 2C and D). The transplant was sutured and stabilized with a flexible resin wire splint. After 7 weeks, a bracket was bonded to the transplant, and orthodontic force was applied to continue conventional orthodontic treatment. The orthodontic treatment was completed as previously reported (19).

For the final restoration, the transplanted premolar was shaped as a first molar (Fig. 2E and F). The patient returned annually for clinical and radiographic follow-up. The deficient alveolar bone level was regained surrounding the transplant. At the last 7-year follow-up visit, the transplant was asymptomatic and maintained a normal bone level (Fig. 2G and H).

Discussion

In both of our cases, premolars with complete root formation were used as donor teeth. Maintenance of proprioception and alveolar bone preservation, which is an advantage of autotransplantation in comparison with implants, can be achieved when the PDL is preserved. The PDL is the fibrous connective tissue, with neural, vascular, and cellular components, that serves supportive, nutritive, and sensory functions (20). Therefore, it is essential to preserve as many viable cells as possible in the donor tooth root and promote the formation of new PDL in the recipient site for successful tooth autotransplantation. From a PDL preservation perspective, adult mature premolars have several advantages over immature teeth. First, PDL damage that may occur during extraction can be minimized in mature premolars. It is widely known that PDL cells are easily damaged by mechanical trauma and dehydration (21). PDL damage is a primary cause of postautotransplantation inflammatory root resorption, and many autotransplantation-related studies have mentioned that traumatic extraction is an important element of surgical success (22). Fully erupted premolars can be extracted with forceps alone without the use of elevators, which offers the advantage of less physical damage to the PDL. Simple extraction of the donor tooth is associated with a significantly lower incidence of inflammatory root resorption compared with the surgical extraction of the donor tooth (6). The second advantage of using a mature premolar as the donor tooth is the fact that the PDL of the donor tooth is functional because it has maintained occlusal contact (23–25). Third molars used as donor teeth are mostly hypofunctional nonoccluding teeth, whereas the premolars in general have occlusal contact and are subject to various oral functions. The 2 cases in this study also involved premolars withstand normal occlusal force. Functional teeth with occlusal contact reportedly present a sound and healthier periodontium, especially in case of the PDL compared with that of hypofunctional nonoccluding teeth (26). The loss of occlusal contact leads to atrophic changes in the PDL, such as narrowing of the periodontal space and less blood circulation (27, 28). Similar to the animal studies, clinically, there was less chance of root resorption when the donor tooth had occlusal contact (26).
Despite these advantages, clinicians may question the use of a premolar to replace a missing molar because of the morphologic differences between the 2 teeth. There is no major difference in the buccolingual diameter of the cervix between a premolar and a molar crown restoration when 90° rotation of the premolar is allowed during the transplantation (29). However, unlike the crown, the morphology of the root is virtually impossible to change. Root surface area is an important element in determining the maximum stress each tooth can withstand. Ante (30) suggested in 1926, in fixed partial dentures, the sum of the root surface area in the abutment tooth should not exceed the sum of the root surface area in the missing tooth. This concept is accepted in the field of prosthodontics even today (31). The root surface area of the mandibular first premolar and the mandibular first molar is around 210 mm² and 390 mm², respectively (32). According
to Ante’s law, a tooth can withstand twice as much force as the root surface area, and, therefore, it is believed that using a premolar to replace a missing molar would be possible. Moreover, the maximum occlusal force exerted on each tooth is influenced primarily by the occlusal contact number and the area of the tooth rather than the position and the skeletal pattern/occlusion (33). In addition, a greater bite force in the posterior dental arch may be dependent on the number of posterior teeth loaded with increased occlusal contact during the biting action (34). Therefore, when a premolar is used as the donor tooth in individuals with high occlusal force, the bite force exerted on the transplant can be clinically reduced by making the occlusal surface area smaller than the molar to prevent unwanted long-term failures such as root fractures.

Factors that are known to influence ankylosis and root resorption include the condition of the remaining PDL attached to the donor tooth and splint type (35, 36). Kristerson and Andreassen (37) reported that periodontal revascularization after tooth transplantation is enhanced by physiological movements of the transplanted tooth, which implies delayed vascularization on the transplanted tooth with a rigid splint. Jang et al (6) also suggested that low initial stability was associated with a significantly lower incidence of ankylosis compared with high initial stability. In addition, early loading of light orthodontic forces after autotransplantation promotes PDL healing with less ankylosis (38) and allows conventional orthodontic treatment to proceed without a delay (39). In our cases, low initial stability was achieved through a flexible resin wire splint in both cases, and orthodontic force was applied relatively early at 5–7 weeks after transplantation. These procedures led to successful transplantation by preventing ankylosis.

In addition to applying light orthodontic force after tooth transplantation, orthodontic loading before extraction also positively influences periodontal healing of the transplanted tooth. Animal experiments on rats indicate that the root surface of teeth extracted after applying orthodontic force of 1.5 cN showed greater PDL attachment than those without force application. Moreover, replanted teeth that had prior orthodontic loading, namely priming, showed less root resorption than replanted teeth without loading (40). Preapplication of orthodontic force to the donor teeth increases the PDL space and enhances tooth mobility, which facilitate extraction. In our cases, preoperative orthodontic loading was not applied because the donor teeth were functional with good intercuspation. However, when a nonfunctional tooth is selected as the donor, prior orthodontic loading may be helpful for better prognosis.

We used MTA in 1 case and Super EBA in the other case as root-end filling materials. Similar to the previous report indicating a comparable clinical success rate between Super EBA and MTA for endodontic microsurgery (41), clinical and radiographic examination during the follow-up period did not reveal any specific changes between the 2 different filling materials.

In the 2 cases, the bone level was maintained up to the cervical area for more than 3 years without any root resorption, ankylosis, or root fracture. Moreover, in case 2, vertical bone growth occurred around the transplanted tooth without membrane application or bone graft. Such a favorable outcome may have been caused by the well-maintained sound and viable PDL of the transplant. Thus, the selection of a functional donor tooth, adequate surgical procedures, and timely application of orthodontic forces may have contributed to the long-term stability.

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