Case Report

A patient with protrusion and multiple missing teeth treated with autotransplantation and space closure

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ABSTRACT

Objective: To present a patient treated with submerging autotransplantation (SA) of an immature premolar and subsequent orthodontic space closure (OSC) and to report a 10-year follow-up result.

Case and Method: A 10-year-old boy had multiple missing premolars with an asymmetric pattern (maxillary right first and second premolars, teeth 14 and 15; maxillary left second premolar, tooth 25; and mandibular right second premolar, tooth 45). After considering several treatment options, tooth 35 with immature root development underwent SA into the missing site of tooth 15 at a depth 5 mm below the occlusal plane and was stabilized with sutures to create a symmetric missing condition of the premolars in the four quadrants.

Results: Three months after autotransplantation, spontaneous eruption of the transplanted tooth was observed. Nine months after autotransplantation, presence of the lamina dura of the transplanted tooth was confirmed with a periapical radiograph. Active orthodontic treatment was initiated to reduce lip protrusion by closing the missing spaces of teeth 14, 25, 35, and 45 and to correct dental midline deviation. After 33 months of active orthodontic treatment, Class I canine and molar relationships were obtained. During the 10-year follow-up, the pulp vitality of the transplanted tooth was maintained without any pathologic findings, including root resorption or pulp canal obliteration.

Conclusions: In a patient with lip protrusion and multiple congenitally missing premolars with an asymmetric pattern, SA of one premolar from the normal quadrant into the quadrant missing two premolars with subsequent OSC of the missing sites of the other premolars can be an effective treatment modality. (*Angle Orthod.* 2014;84:561–567.)

KEY WORDS: Multiple congenital missing teeth; Autotransplantation; Orthodontic space closure

INTRODUCTION

It is quite common to encounter patients who have a congenitally missing tooth or teeth in everyday clinics. According to the results from a recent meta-analysis,[1] the prevalence of dental agenesis ranged from 2.5% to 6.9% in several races. However, the frequency of dental agenesis in Koreans was reported to be 11.2%, which is somewhat higher than that observed in other races.[2]

For the White population, the most affected tooth is the mandibular second premolar, followed by the maxillary lateral incisor and the maxillary second premolar.[1] However, in the Asian population, the mandibular lateral incisor and the mandibular second premolar are the most frequently absent teeth.[2,3]

If a preteen or adolescent patient has a congenitally missing tooth or teeth and the missing space is already closed, the space can be regained and maintained until growth is completed. However, prolonged space maintenance of such a missing site in a growing patient usually results in atrophy of the alveolar bone, which creates difficulty for implant installation and requires a bone graft. Early implant installation in a growing patient also cannot keep up with the normal

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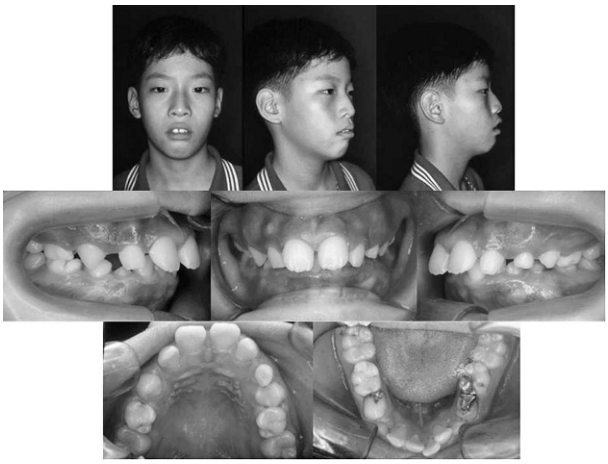

Figure 1. Pretreatment facial and intraoral photographs (10 years, 10 months).

growth of the alveolar bone adjacent to the implant.[4,5] On the contrary, an autotransplanted developing tooth is known to stimulate growth of the alveolar bone as it erupts.[6] Therefore, autotransplantation and subsequent orthodontic treatment may be an effective alternative to implant prosthesis.

In cases involving multiple congenitally missing teeth with an asymmetric pattern, accurate diagnosis and treatment planning are required because simple orthodontic space closure of the missing site will lead to worsening of the dental midline discrepancy. However, there have been only a few patient reports related to autotransplantation for congenitally missing teeth with an asymmetric pattern and subsequent orthodontic treatment.[7,8] Therefore, the purposes of this article are to report on a 10-year follow-up result of autotransplantation of an immature premolar and the subsequent orthodontic treatment in a growing patient who had multiple congenitally missing premolars and complained of lip protrusion and dental midline deviation and to explain the considerations for treatment of multiple congenitally missing premolars with an asymmetric pattern.

CASE REPORT

Diagnosis

A 10-year-old boy visited the clinic with chief complaints of lip protrusion and dental midline deviation. An initial examination revealed a Class II skeletal relationship, hyperdivergent facial pattern, and lip protrusion (ANB, 7.2°; SN to mandibular plane angle, 37.3°; U1 to SN, 114.1°; IMPA, 94.4°; upper lip to Ricketts' esthetic line, 3.8 mm; lower lip to Ricketts' esthetic line, 5.3 mm; Figure 1; Table 1).

The patient was in a late mixed dentition stage and exhibited multiple missing maxillary and mandibular premolars with an asymmetric pattern (the maxillary right first and second premolars, the maxillary left second premolar, and the mandibular right second premolar; teeth 14, 15, 25, and 45, respectively; Figure 2). Deviations of the maxillary and mandibular dental midlines in the opposite directions (3 mm of the dental midline discrepancy) were observed as a result of the asymmetrically missing premolars. In addition, the absence of the three maxillary premolars had led to 13 mm of spacing in the maxillary anterior teeth region. However, 6 mm of crowding of the mandibular anterior teeth had occurred because all of the mandibular deciduous molars still remained.

Treatment Objectives

The treatment objectives were the establishment of Class I canine and molar relationships, resolution of lip protrusion, and correction of the dental midline deviation.

Treatment Options

One of the patient's chief complaints, lip protrusion, could be resolved by retraction of the protrusive anterior teeth and closure of the missing premolar sites in the maxillary and mandibular arches. However, simple orthodontic space closure of the missing sites could worsen the preexisting dental midline deviation because of the difference in the number of missing teeth (two missing premolars in the maxillary right

Table 1. Cephalometric Measurements at the Initial, Beginning of Fixed Treatment, Debonding, and 10-Year Follow-Up Stages

Measurement	Mean	Initial (10 y, 10 mo)	Beginning of Fixed Treatment (12 y, 2 mo)	Debonding (14 y, 11 mo)	10-Year Follow-Up (24 y, 4 mo)
SNA (°)	81.8	86.4	84.1	81.1	81.1
SNB (°)	80.2	79.2	79.3	79.1	80.9
ANB (°)	1.8	7.2	4.8	2.1	0.2
SN to mandibular plane (°)	32.8	37.3	39.3	38.2	35.8
U1 to SN (°)	109.3	114.1	105.6	104.4	107.0
IMPA (°)	90.2	94.4	84.5	85.3	81.3
Interincisal angle (°)	126.2	114.2	130.7	132.2	135.9
Upper lip to aesthetic line (mm)	1.0	3.8	1.6	−1.4	−3.6
Lower lip to aesthetic line (mm)	0.3	5.3	3.7	−0.7	−2.3
Nasolabial angle (°)	93.2	86.3	85.5	101.1	100.2

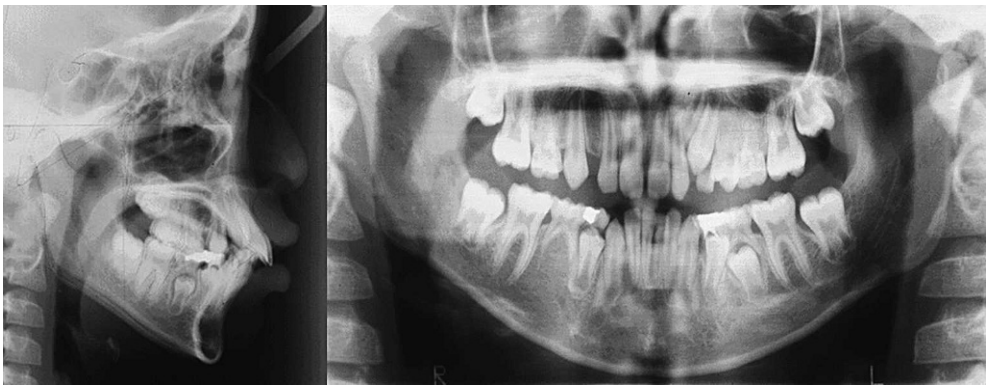

Figure 2. Pretreatment lateral cephalogram and panoramic radiograph (10 years, 10 months).

quadrant and one missing premolar in the maxillary left quadrant). Therefore, it was necessary to prevent worsening of the dental midline deviation associated with the asymmetrically missing premolars.

To avoid dental midline deviation, it was necessary to extract tooth 35 and the primary second molars to close the spaces in the maxillary left quadrant and the mandibular right and left quadrants. However, maintenance of the missing site of one premolar for implant installation in the maxillary right quadrant can be problematic. In such situations patients must wait for the completion of growth to receive an implant in the maxillary right quadrant. In that case, atrophy of the alveolar bone and downward growth of the maxillary sinus floor into the maxillary right quadrant during the prolonged space maintenance seem to be inevitable. This phenomenon not only makes installation of the prosthetic implant difficult but it also leads to unesthetic results even after completion of the restoration. In addition, extraction of tooth 35 seemed to result in a major loss in cases with multiple congenitally missing premolars.

Therefore, the autotransplantation of one premolar from the normal quadrant into the quadrant missing two premolars to create a symmetrical missing condition of the premolars in the four quadrants and subsequent orthodontic space closure of the missing sites seem to be more advantageous than the above-mentioned options. This option can achieve early resolution of the chief complaints, preserve the sense and reflex of the natural teeth, aid in new bone formation, and maintain the natural appearance of the gingiva.[9,10] Even if the autotransplanted tooth fails at a later stage, the adequate recipient site for implant installation can be maintained as long as the transplanted tooth is present.

After discussion about several treatment options with the patient and his parents, we chose an option involving autotransplantation of tooth 35 into the site of missing tooth 15 to create a symmetrically missing condition of the second premolars in the four quadrants and subsequent orthodontic treatment to reduce lip protrusion and to correct dental midline deviation in the maxillary and mandibular arches.

Treatment Progress

After the initial clinical examination, all of the deciduous molars were extracted, and a Nance holding arch was cemented to the maxillary arch to maintain the recipient site for the transplanted tooth. Autotransplantation was planned after confirming that the root length of the donor tooth was slightly greater than one-half of the expected final root length, as recommended by Kristerson.[11]

Prior to extraction of the donor tooth (tooth 35), flap elevation and preparation of the recipient bed (the missing site of tooth 15) were performed to minimize the exposure time of the donor tooth outside of the mouth. The donor tooth was extracted atraumatically to prevent damage to the periodontal ligament, Hertwig's epithelial root sheath, and cementum. The donor tooth was then submerged 5 mm below the

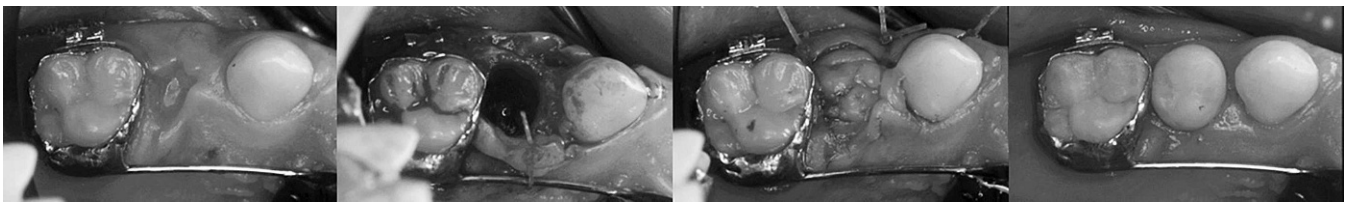

Figure 3. Intraoral photographs taken just before, during, just after, and 3 months after autotransplantation arranged from the left side to the right side.

Figure 4. Periapical radiograph taken 9 months after the autotransplantation procedure.

occlusal plane and stabilized with sutures at the recipient site. Three months after autotransplantation, spontaneous eruption of the transplanted tooth was observed (Figure 3).

Nine months after autotransplantation, the presence of the lamina dura of the transplanted tooth was confirmed in the periapical radiograph, and active orthodontic treatment was initiated (Figure 4). Nickel-titanium archwires were used to level and align the maxillary and mandibular dentitions, and curved stainless-steel wires (0.019 × 0.025 inches, compensating curve of Spee in the maxillary archwire and reverse curve of Spee in the mandibular archwire) were used to resolve the deep overbite. Since the autotransplantation of tooth 35 into the missing site of tooth 15 allowed this patient to resemble the patient with extraction of the second premolars from each quadrant, the resolution of lip protrusion and correction of the dental midline deviation were possible. After 33 months of active orthodontic treatment, all of the fixed appliances were removed (Figures 5 and 6).

Treatment Results

At the debonding stage, Class I canine and molar relationships were established. Lip protrusion was resolved by retraction of the anterior teeth and growth of the nose and mandible (ANB, 2.1°; U1 to SN, 104.4°; IMPA, 85.3°; upper lip to Ricketts' esthetic line, −1.4 mm; lower lip to Ricketts' esthetic line, −0.7 mm; Figures 5 through 7; Table 1). The facial and dental midlines were coincident and the dental midline deviation was also corrected (Figures 5 through 7).

The transplanted tooth exhibited an increase in root length, although it was still slightly shorter than the other premolars. The pulp vitality of the transplanted tooth was verified by electrometric pulpal test and cold test. There were also no pathological changes, including root resorption, ankylosis, or pulp canal obliteration, in the transplanted tooth (Figure 6). The

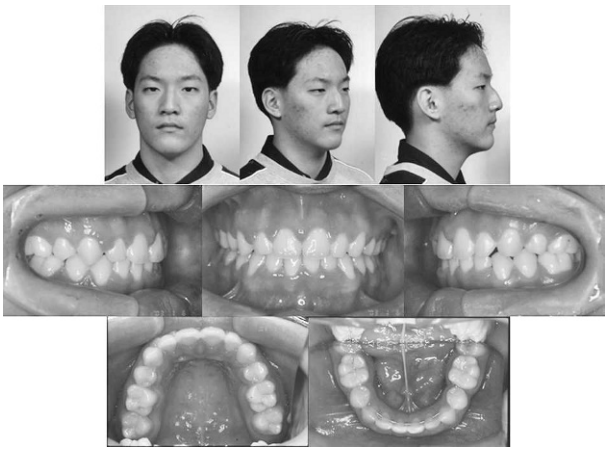

Figure 5. Posttreatment facial and intraoral photographs (14 years, 11 months).

transplanted tooth induced the normal formation of the alveolar bone and gingival papillae without any difference compared to the adjacent teeth (Figures 5 and 6).

10-Year Follow-Up Result

Class I canine and molar relationships were maintained during the 10-year follow-up despite slight deepening of the overbite (Figure 8; Table 1). Pulp vitality of the transplanted tooth was also maintained without any pathologic findings, including root resorption or pulp canal obliteration. The probing revealed normal gingival sulcus depth (Figure 9).

DISCUSSION

Installation of a prosthetic implant into the missing tooth site is contraindicated in growing patients because this impedes the normal growth of the alveolar process. Therefore, the missing tooth space should be maintained with a removable or fixed space maintainer for a lengthy period of time. However, lack of patient cooperation or fracture of the space maintainer frequently requires retreatment to regain the space. Therefore, in growing patients with a missing tooth or teeth, autotransplantation may be more advantageous than space maintenance based on its low cost, the one-time procedure that ensures no waiting time for prosthetic restoration, and esthetic periodontal status around the transplanted tooth.[10]

Some Considerations in Autotransplantation

Root development stage of the donor tooth. For successful autotransplantation, regular checkups are required to monitor the root development of the prospective donor tooth and to determine the proper timing for the procedure. Since Andreasen et al.[12]

Figure 6. Posttreatment lateral cephalogram and panoramic radiograph (14 years, 11 months).

reported that 65% of transplanted teeth had a slightly shorter root length than the normal counterparts and that 14% exhibited no further root development, Kristerson[11] recommended that the donor tooth should reach at least one-half of its expected final root length at the time of autotransplantation.

In terms of success rate and pulp vitality, a donor tooth with an open apex is preferred as a result of the higher survival rate of the pulp and lower possibility of inflammatory root resorption compared to those of a tooth with a closed apex.[13,14] Therefore, the preteen or early teen years seems to be a proper time for autotransplantation, considering root development and degree of apex closure of the donor tooth.

Atraumatic extraction and preparation of the recipient bed. Preservation of sound periodontal ligament, Hertwig's epithelial root sheath, and cementum of the transplanted tooth is paramount for successful autotransplantation and subsequent orthodontic treatment.[12,14] Such preservation can be achieved through the careful and atraumatic extraction of the donor tooth and rapid preparation of the recipient bed.

In a tooth with a curved or long root, atraumatic extraction of the donor tooth and preparation of the recipient bed are difficult. For example, a tooth with a long root has a possibility of penetration of the sinus floor or the inferior alveolar canal. A 3D-CAD/CAM-made donor tooth template can be used for rapid preparation of the recipient bed prior to extraction of the donor tooth with a curved or long root.[15,16]

Autotransplantation of the donor tooth: the submerging technique. In this case, we transplanted a developing tooth with one-half of the expected final root length and an open root apex. The tooth was submerged 5 mm below the occlusal plane to reduce initial trauma from the occlusal force and to preserve the attached gingiva around the transplanted tooth.

Rigid fixation of the donor tooth is known to cause more ankylosis and pulp necrosis compared to stabilization of the donor tooth with a suture.[17] In a study involving a monkey, Kristerson and Andreasen[18] also reported that semirigid fixation with an acrylic splint produced negative effects on periodontal and

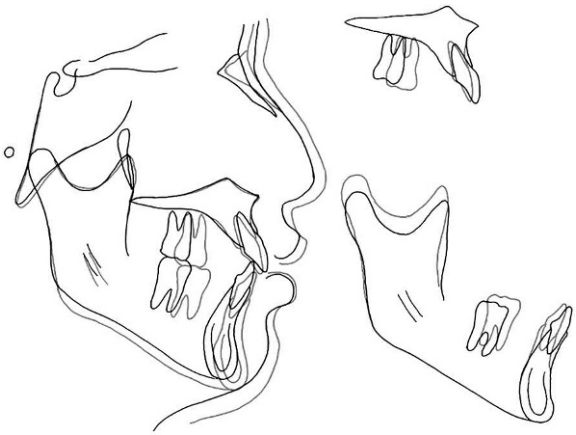

Figure 7. Superimpositions of the lateral cephalograms between the beginning and end of fixed treatment: black line, fixed appliance bonding (12 years, 2 months); red line, posttreatment (14 years, 11 months).

Figure 8. 10-Year follow-up facial and intraoral photographs (24 years, 4 months).

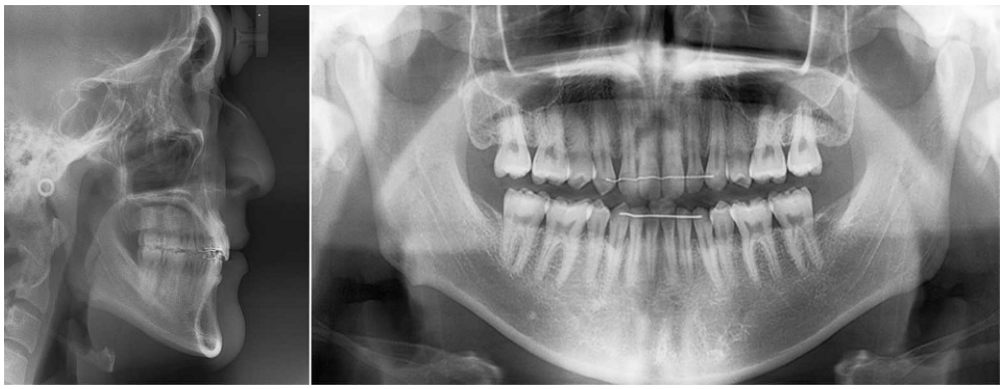

Figure 9. 10-Year follow-up lateral cephalogram and panoramic radiograph (24 years, 4 months).

pulpal healing of the transplanted tooth. Considering the importance of the initial stability of the transplanted tooth, the submerging technique can help maintain initial stability due to reduction of the occlusal force.

According to Paulsen and Andreasen,[19] the submerged donor tooth continuously erupted, and its fastest eruption rate occurred in the period occurring 6 to 12 weeks after transplantation as a result of periodontal healing. Their results were in accordance with our observation of the spontaneous and prominent eruption of the submerged donor tooth 3 months after the procedure. After eruption of the transplanted tooth, it passed through the similar course of normal eruption and root development seen in natural teeth.[6] During this period, the transplanted tooth can induce normal growth of the alveolar bone and produce a satisfactory esthetic result in the periodontal aspect.[20]

Although the submerging technique can provide initial stability to the donor tooth, a sufficient amount of the attached gingiva, and normal growth of the alveolar bone, further studies are required to assess the biological, histological, and mechanical backgrounds of this technique.

Initiation of orthodontic treatment. To apply orthodontic force to the transplanted tooth, the tooth should be free of any pathologic signs and symptoms, such as loss of pulp vitality, ankylosis, or pathologic root resorption. The presence of continuous lamina dura and intact periodontal ligament should also be assessed in the periapical radiograph. Since Paulsen et al.[20] reported that the formation of continuous lamina dura generally required 3 to 9 months after transplantation, we started the fixed orthodontic treatment after confirmation of the presence of continuous lamina dura, which was 9 months after the autotransplantation (Figure 4).

In summary, there are several important factors involved in successful autotransplantation and subsequent orthodontic treatment, including a developing tooth with one-half of the expected final root length and an open root apex, rapid preparation of the recipient bed, careful and atraumatic extraction of the donor tooth, submerging transplantation technique of the donor tooth, stabilization of the donor tooth with sutures, initiation of orthodontic treatment after confirmation of the presence of continuous lamina dura and intact periodontal ligament, and careful and regular checkups for pulp vitality and root condition.

CONCLUSIONS

- In a patient with lip protrusion and multiple congenitally missing premolars with an asymmetric pattern, submerging autotransplantation of one premolar from the normal quadrant into the quadrant missing two premolars with subsequent orthodontic space closure of the missing sites of the other premolars can be an effective treatment modality.

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