Multiple congenitally missing teeth treated with autotransplantation and orthodontics

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Treatment of children with several congenitally missing teeth is challenging, because growth and development of the oral structures must be considered. The treatment options include retaining the deciduous teeth and postponing treatment until later or extracting the deciduous teeth and doing one of the following: allowing the space to close spontaneously, closing the space orthodontically, or in patients whose growth is finished, using a prosthetic or implant replacement. One other viable option, if donor teeth are available, is autotransplantation. The treatment plan for patients with missing teeth should be based on a comprehensive evaluation of the patient’s age, occlusion, and space requirements as well as on the size and shape of the adjacent teeth. This case report presents the management of a patient in the early mixed dentition with multiple missing teeth. The treatment consisted of a combination of autotransplantation of the maxillary right first premolar to the mandibular right first premolar region and orthodontic treatment with a 5-year follow-up after autotransplantation. (Am J Orthod Dentofacial Orthop 2012;141:641-51)

Congenitally missing premolars are often a diagnostic challenge to the orthodontist. With autotransplantation, it is possible to solve complicated treatment problems in the dental arches. Autotransplantation of immature premolars is a viable method of restoring edentulous areas in young patients whose alveolar growth is not yet complete. This method can potentially replace a missing tooth with a natural tooth rather than with a prosthesis or an osseointegrated implant.

Autotransplantation of premolars with partly formed roots has been reported to be a predictable treatment modality.1-6 This is because transplanted teeth also have the capacity for functional adaptation7,8 and preservation of the alveolar ridge.9 Premolars can be transplanted from 1 site in a crowded arch to another site to replace congenitally absent premolars.

This case report presents the management of a patient with multiple missing teeth in the early mixed dentition. It describes a conservative treatment approach: autotransplantation of the maxillary right first premolar to the mandibular right first premolar region was combined with orthodontic treatment.

DIAGNOSIS AND ETIOLOGY

The patient was a 9-year-old boy with an unremarkable medical history. No signs or symptoms of temporomandibular disorders were reported. His general dentist referred him for orthodontic consultation. Pretreatment records showed that the patient had normal vertical facial proportions and good facial symmetry.

His profile was convex. On clinical examination, the boy was found to be in the early mixed dentition stage. Analysis of the study models disclosed a mesial-step molar occlusion on both sides. The erupting maxillary left central incisor had a 3.7-mm overjet and a 3.2-mm overbite. No crossbites were noted. The dental midline was coincident with the facial midline (Figs 1-3). A pretreatment panoramic radiograph showed agenesis of the maxillary left second premolar, the mandibular right first premolar, and the mandibular left and right second premolars. Considering his age, the maxillary right second premolar tooth bud was developing slowly, and the maxillary first molars were erupting slowly. There were no radiographic signs of the...
maxillary second and third molars in the initial records (Fig 3, A).

Cephalometric analysis indicated a Class II skeletal pattern (ANB, 7.7°) with a hyperdivergent growth pattern (SN-MP, 39.9°). The maxillary incisors were normally inclined, and the mandibular incisors showed a slight proclination (Table; Fig 3, B). The etiology of the patient’s malocclusion and missing teeth was probably genetic, because no history of trauma or infection to the mouth, teeth, or jaws was reported.

TREATMENT OBJECTIVES

Autotransplantation of teeth can significantly reduce treatment time in certain patients with aplasia, tooth loss, or ectopia when a suitable tooth is available and the anatomic conditions allow for it. In this study, the treatment plan included transplanting the maxillary right first premolar in the mandibular right first premolar region, extracting all retained deciduous teeth and closing the space. The objective was to achieve Class I molar and canine relationships on both sides and normal overjet and overbite.

Due to skeletal discrepancies that resulted from an unfavorable growth pattern, surgical treatment could be an option in the future, including genioplasty, after the patient’s growth is complete.

TREATMENT ALTERNATIVES

There are several treatment alternatives for patients with congenitally missing teeth. Extracting the deciduous teeth to allow spontaneous space closure is a conservative treatment option that can be considered for missing teeth. According to Bjerklin and Bennett, retaining the deciduous teeth is also a possible option for dental aplasia. They reported that the rate of resorption of the deciduous teeth diminishes with age; clinically, no further root resorption is evident after age 20.

Another alternative for a patient with congenitally missing teeth is replacement with implants. In growing
patients, however, implants impede normal growth of the alveolar process and are contraindicated. For this reason, if implant replacement is the treatment option of choice, lengthy space maintenance would be necessary and could be accomplished by using a conventional fixed bridge. However, in adolescents, preparation of the abutment teeth might need to be delayed because of the size of the pulp chamber. Alternative space maintenance with a removable prosthesis is also problematic because of its temporary nature and the need for periodic replacement caused by patient growth. Although a resin-bonded fixed bridge is another option, it also has disadvantages, because of the irreversible tooth preparation that is required and the uncertain longevity of this type of prosthesis. All treatment alternatives were explained to our patient and his parents.

**TREATMENT PROGRESS**

Tooth transplantation and an orthodontic approach were chosen to solve the occlusal problems and to close the spaces corresponding to the missing teeth. Informed consent was obtained. A panoramic film was taken with a metal ball in place to estimate the amount of magnification before the transplantation. The proper size of the recipient site was calculated when adjusted for magnification. The patient’s development was checked every 3 months to monitor tooth eruption. Autotransplantation was performed when he was 11 years 7 months old. The mandibular right first deciduous molar was removed under local anesthesia, and the socket was fully prepared with care to preserve the buccal and lingual alveolar bone during extraction. The intra-alveolar septum was trimmed with a chisel, and the socket was irrigated.

To allow for the physiologic mesial drift of mandibular permanent molars with congenitally missing mandibular second premolars, controlled slicing of the mandibular second molars was followed by hemisection of the distal portion of the teeth. After the mandibular right first deciduous molar and the maxillary first and second deciduous molars were extracted, then the donor tooth (maxillary right first premolar) was carefully removed, keeping the root and remaining periodontal ligament intact and untouched to avoid separation of Hertwig’s epithelial root sheath. At this time, root development was about 75%.

Autotransplantation of tooth germs at 75% to 100% of the root length with a wide-open apical foramen (root development in stages 3 to 4 according to Moorrees et al) is recommended. As quickly as possible, the transplanted tooth germ was placed in the socket.

![Fig 2. Pretreatment dental casts.](image)
prepared for it slightly below the occlusal plane. Inadequate buccolingual width of the alveolar process made it necessary to leave the transplant in a rotated position. The flaps were sutured with 4-0 nylon sutures, and the transplant was fixed with the same suture material crossing the occlusal surface. Occlusal adjustment of the implanted tooth was done to eliminate the possibility of premature contacts. Chlorhexidine rinse and amoxicillin were prescribed for a week, and the patient was not allowed to chew on the transplant side during the first month of the postoperation period.

After this period, the patient was allowed to start chewing soft foods for 1 month and gradually increase

<table>
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<tr>
<th>Measurement</th>
<th>Japanese norm</th>
<th>Pretreatment</th>
<th>Posttreatment</th>
<th>26 mo posttreatment</th>
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<td>1.3</td>
<td>−2.1</td>
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Fig 3. Pretreatment radiographs: A, lateral cephalogram; B, posteroanterior cephalogram; C, panoramic radiograph.
the chewing load to normal function within 3 months. He was examined on the first postoperative day to determine whether the transplant had retained its position. The stability and the position of the transplant were then inspected weekly. Sutures were removed a week after transplantation. After that, composite adhesives and a flexible stabilization wire were used to connect the transplanted tooth to the adjacent teeth. Clinical and radiographic examinations were conducted at 1, 4, and 12 weeks, and 6 months after surgery. Pulpal healing and signs of pulp canal obliteration were evaluated. Periodontal healing, root growth, and tooth eruption after the transplantation were also monitored by radiographic examinations. Nine months after the autotransplantation, the mesial portions of the mandibular second deciduous molars were extracted, and active orthodontic treatment was started before pulp canal obliteration.4-6 Little root growth was observed during this period, with the crown-to-root ratio steady at nearly 1:1. A periodontal ligament space and a lamina dura were observed. After carefully observing the response of the transplanted tooth, 0.018 edgewise brackets (3M Unitek, Monrovia, Calif) were bonded in both arches. To minimize the extrusive effect of the maxillary first permanent molars and to correct the anteroposterior skeletal discrepancies during treatment, a high-pull headgear was used. At the end of active orthodontic treatment, the radiographic examination showed completed root growth with an intact lamina dura and a defined periodontal space with partial pulp obliteration in the transplanted tooth. The levels of the alveolar ridges were similar to those of the adjacent teeth, and the final crown-to-root ratio was greater than 1:1. The total treatment time was 34 months. After the treatment, a 0.0175-in Twistflex wire (OrthoCare, Bradford, United Kingdom) was bonded from lateral incisor to lateral incisor in the maxillary arch, and from first premolar to first premolar in the mandibular arch (Figs 4-7). The patient was last examined at age 16 years 7 months, 5 years after
the transplantation procedure and 26 months after orthodontic treatment. The response of the transplant to electric pulp testing was positive. The mobility of the teeth was normal, and the sulcus depth was less than 3 mm (Figs 8-10).

**TREATMENT RESULTS**

The posttreatment records showed that the treatment objectives were achieved. Class I canine and molar relationships were established with canine-protected
occlusion. The dental midlines were aligned with the facial midline, and acceptable overbite and overjet were established (Figs 4-6).

The posttreatment panoramic radiograph showed proper space closure and acceptable root parallelism except for the mandibular left second premolar, with no significant signs of bone or root resorption (Fig 6, A). The mandibular second molars were slightly extruded because of slow eruption of the maxillary second molars. Posttreatment lateral cephalometric analysis and superimposition showed slight skeletal changes in the maxillary skeletal base (SNA, 85.2°), whereas the mandibular skeletal base increased (SNB, 80.9°). The maxillary and mandibular anterior teeth were retracted and slightly tipped lingually. There was no significant improvement in the anteroposterior chin position during his growth stage, so the patient still had a relatively convex profile (Table; Figs 6, B, and 7). At the 26-month follow-up, he had a stable occlusion, with the results of the orthodontic treatment maintained. The maxillary left second molar was erupting slowly. Radiographic examination showed fairly stable results (Figs 8-10).

**DISCUSSION**

Autotransplantation of teeth has evolved as an accepted treatment in orthodontics. Zachrisson et al described 3 main indications for autotransplantation of teeth: multiple agenesis, mandibular second premolar agenesis in hyperdivergent patients with normal to weak musculature, and congenitally or traumatically missing maxillary central and lateral incisors. Tooth transplantation offers several benefits when compared with other methods such as implants. Most tooth transplantation procedures can be accomplished in 1 surgery. After successful surgery, the transplanted tooth recovers its proprioceptive function with normal periodontal healing. Thus, the patient feels normal when chewing. Furthermore, a tooth transplant in growing children can offer the benefit of continued alveolar bone induction.

Recently, autotransplantation has been performed widely, and many publications have reported that the survival rate of transplanted teeth might be as high as 90%. However, there are still some undesirable complications, such as root resorption or dentoalveolarankylosis. The evaluation of transplants to the mandibular second premolar region showed a survival rate of 92% with immature roots, whereas teeth with mature roots had an 82% survival rate after 4 years.

For successful autotransplantation, the following factors should be considered. For the surgical protocol, an atraumatic technique and minimal handling of the transplant are necessary and important considerations.
to preserve an intact periodontal ligament and Hertwig’s root sheath; otherwise, root growth could be compromised, leading to ankylosis or root resorption and attachment loss.\textsuperscript{20,21} It has been suggested that minimizing the time a tooth is out of the mouth during transplantation is important for successful autotransplantation.\textsuperscript{20,21} Kim et al\textsuperscript{22} found no relationship between the extraoral time and either ankylosis or root resorption in their experimental time frame of 7.8 minutes. For our patient, a meticulous surgical technique was used during the operation to prevent damage of the periodontal ligament and Hertwig’s root sheath, and the donor tooth was transplanted to the recipient area immediately after extraction.

Root morphology is also important. The donor tooth should have a conical, smooth root that will enable atraumatic extraction, thus preventing damage to the periodontal ligament. Successful periodontal healing, which is completed within 2 months in most patients, is marked by the absence of root resorption and the presence of a lamina dura.\textsuperscript{9} The fate of a transplanted or reimplanted tooth depends on the viability of the periodontal ligament attached to the root.\textsuperscript{21,23} When there is only minor damage to the cementum during transplantation, healing will occur by regeneration of the periodontal ligament into the area of damage. When extensive damage of the cementum has occurred, the tooth will heal by replacement resorption after ankylosis.\textsuperscript{24,25}

The recipient site should have enough space for the donor tooth, with adequate height and width of bone. However, if there is insufficient buccolingual width to accommodate the donor tooth, there might be resorption of the alveolar ridge at the recipient area. Changing the direction of the donor tooth by rotating it 90° can help to cause a better fit if the original direction is not possible. Attention must be paid during the transplantation not to damage the periodontal ligament of the donor tooth mechanically by pushing it into the recipient site.
Fixation with a suture is an easy and effective stabilization method when the transplanted tooth is stable in the recipient site. When fixation is performed with a suture, occlusal adjustment must be completed before the fixation. A physiologic splint can be used that allows some movement of the tooth, while immobilizing it enough to allow healing. Allowing some minor movement reduces the incidence of ankylosis and adverse effects on the periodontal ligament pulpal healing of the tooth.

The stage of physiologic apical closure has also been cited as a critical factor in achieving good success rates after transplantation. Although greater success rates are achieved by using teeth with immature roots for autotransplantation, teeth in the early stages of root development show less posttransplant root growth than those with more mature roots but incompletely formed apices. Complete development, however, will not be achieved in all transplanted teeth. Development of roots can be classified to include total arrest, which indicates no development after transplantation; partial arrest, which indicates some development; and nonarrest, which indicates complete development of the roots. Andreasen et al showed root development rates of 14% for total arrest, 65% for partial arrest, and 21% for nonarrest regardless of the developmental stage of the root or the method of transplantation. Since there is a possibility of no additional root growth after transplantation, it has been suggested that the donor tooth should have at least three quarters of its root formed and an apical opening of more than 1 mm at the time of autotransplantation. Northway also stated that the preferred stage of root development is between one third and three fourths complete.

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Andreasen et al also reported that the incidence of pulp necrosis and root resorption was greater in mature premolar transplants because of their closed apices. Transplantation of a fully formed root negates the potential for pulp regeneration, but adequate endodontic therapy will still ensure a high survival rate. In our patient, the donor tooth was transplanted when the root development was approximately three fourths complete. Pulpal healing was achieved because the transplanted tooth was immature with a wide apical opening. Five years after transplantation, periapical radiographs showed partial obliteration, and no endodontic treatment was needed.

With traditional orthodontic techniques, tooth movement is usually limited to short distances at best, but when auto transplantation is added as a treatment option, there is a much broader range of possibilities. For instance, a tooth can be moved to a different location in the same dental arch or even to the opposite side of the jaw under the right circumstances. What's
more, there still are potential benefits with the procedure such as bone induction and the reestablishment of a normal alveolar process. Even though the transplant might fail at some time in the future, there would still be a recipient site adequate to support a dental implant.

Orthodontic forces should not be applied to a tooth during the first 3 to 6 months after it has been transplanted, and when force is applied, its amount and duration should be minimized. According to Hama-moto et al, orthodontic treatment can be initiated just after regeneration of the periodontal space and confirmation of the presence of the lamina dura radiographically.

In our patient, active orthodontic treatment began 9 months after autotransplantation when a lamina dura and a periodontal ligament were observed, but before pulpal obliteration had begun. At the end of active orthodontic treatment, the crown-to-root ratio was acceptable, and the prognosis of the transplant was good. Five years after the autotransplantation, the transplanted tooth showed excellent long-term stability.

CONCLUSIONS

Autotransplantation combined with orthodontic treatment should be considered as an alternative treatment option for children with missing permanent teeth.

REFERENCES


