Management of missing maxillary anterior teeth with emphasis on autotransplantation

Björn U. Zachrisson, DDS, MSD, PhD, Arild Stenvik, DDS, PhD, and Hans R. Haanaes, DDS, PhD
Oslo, Norway

Over 40 years ago, Slagsvold and Bjercke developed a method of transplanting teeth with partly formed roots. After transplantation, root growth continues, and the teeth maintain their capacity for functional adaptation. Endodontic treatment is usually not necessary.

The 3 main indications for autotransplantation of developing premolars are unevenly distributed multiple agenesis, agenesis of the mandibular second premolars in low-angle face types with normal or weak facial profiles, and accidentally lost or congenitally missing maxillary central and lateral incisors. Most traumatic injuries with accidental loss of maxillary incisors occur in children between 7 and 10 years of age. This makes autotransplantation of developing premolars an interesting treatment alternative.

The optimal time for autotransplantation of premolars to the maxillary anterior region is when the root development has reached two thirds to three fourths of the final root length. The prognosis for complete periodontal healing at this stage of root development is better than 90%. The most important factors are the skill and experience of the surgeon (autotransplantation is not a quick fix; damage to the periodontal ligament must be avoided because it might lead to ankylosis), the presence of adequate space on the mesial and distal sides of the transplant, the avoidance of interference (jiggling contacts) between the graft and the opposing teeth during the first 2 months, and physiologic mobility during the fixation period. Conventional sutures are generally preferred for fixation when the transplant is placed in a half-erupted position (Fig 1).

One sign of a successful autotransplantation is that root development continues. Figure 2 shows the usual sequence of continued root growth 2 years after transplantation of a premolar to replace an accidentally lost maxillary left central incisor. The part of the root that was formed at the time of operation always shows pulp obliteration, whereas the part formed afterwards often has a normal pulp chamber. Although the transplanted tooth sometimes does not respond to electric pulp testing, endodontic treatment is generally not necessary. However, when the pulp obliteration is rapid (which in traumatology is defined as almost complete obliteration of the entire pulp chamber within a year), preventive endodontics might be safer than expectation, to avoid the risk for perforations later if periapical problems develop.

Long-term survival and success rates

The long-term outcome of tooth transplantation, including gingival and periodontal conditions, was examined in a recent study from the University of Oslo. Patients’ attitudes about treatment and outcome were also evaluated. The follow-up period for 33 transplanted premolars ranged from 17 to 41 years, with a mean of 26.4 years. Both the survival (teeth still present at the examination) and success (teeth fulfilling defined success criteria) rates were high—90% and 79%, respectively. The patients generally responded favorably regarding their perception of the treatment. The study showed that autotransplantation of teeth with partly formed roots compares favorably in a long-term perspective with
other treatment modalities for substituting missing teeth.

**Orthodontic and restorative treatment for autotransplanted teeth**

Because the root of an autotransplanted premolar continues to develop and a normal periodontal ligament is established, such teeth can be moved orthodontically like any other tooth that has erupted into occlusion. It is generally recommended to wait for an observation period of 3 to 4 months before orthodontic treatment is started.

Premolar crowns can be reshaped to resemble incisor morphology. We first make a direct composite resin buildup and later replace it with a porcelain laminate veneer (PLV). However, there are some drawbacks with the resin buildups, because it is difficult to establish normal incisor width along the gingival margin, and the buildups tend to have a triangular crown form. Furthermore, composites tend to discolor with time. Both problems can be solved by using thin PLVs instead (Fig 1, B). The 2 main reasons to avoid cemented crowns in children and adolescents—that the large pulp chambers limit preparation and that the gingival retraction over time could lead to unesthetic root display—are not valid for PLVs. The reflection of incoming light will not be stopped by a bonded PLV, and any later root exposure will display normal color and no darkening of the gingiva.

In a recent study, 4 45 premolars autotransplanted to the maxillary incisor region in 40 adolescent patients were evaluated, after restoration, with a mean observation period of 4 years. Mean age at surgery was 11.0 years. Clinical criteria assessed tooth mobility, plaque and gingival conditions, probing pocket depths, and reaction to percussion. The interproximal gingival papilla fill was assessed according to an index. Pathosis, pulp obliteration, root length, and crown-root ratios were studied on standardized radiographs. The results showed that the clinical variables for transplants did not differ from those of the natural incisors, except for some increased mobility and more plaque in a few transplanted premolars. The interproximal gingival papillae adjacent to all transplanted teeth were normal or slightly hyperplastic, and no interdental gingival recession (black triangles) were seen. As expected, all transplants showed varying degrees of pulp obliteration. The findings also demonstrated that tooth transplantation has an inherent potential for bone induction and reestablishment of a normal alveolar process.
Esthetic outcome and patient satisfaction

A comprehensive study comparing the esthetics of 22 autotransplanted premolars reshaped to incisor morphology with their natural, intact contralateral incisor was made. Features considered important for esthetics (color, soft tissue appearance, tooth morphology, and position) were compared. Most of the transplanted teeth matched the contralateral incisor, and most patients were satisfied with the appearance of the transplant. The distribution in set categories assessed professionally and by the patients was not significantly different. However, the color and the gingival width of the transplanted tooth were scored as different from the natural incisor in almost half of the bilateral comparisons. A potential for esthetic improvement was identified, because suboptimal positioning and morphologic transformation of the transplant were responsible for the discrepancies. The findings demonstrated that interdisciplinary planning is important for successful esthetic results.

Multiple missing teeth

When 2 or more neighboring incisors are missing, a combination of premolar autotransplantation and orthodontic space closure might be the optimal treatment alternative. As discussed elsewhere, careful detailing throughout the orthodontic progress and finishing stages to achieve optimal positioning and crown inclination of all teeth, coupled with new techniques and materials adapted from esthetic dentistry can, even in these difficult treatment situations, restore natural tooth shapes and sizes and provide normal gingival texture and contours around all the teeth.

The potential for bone preservation in the mixed dentition (before eruption of the canine) by premolar autotransplantation was examined in a follow-up study of 5 patients with alveolar cleft and 2 incisors missing on the cleft side. The observation period was 2.5 to 7.5 years. The transplanted premolars were placed in the central incisor region 14 to 26 months after the bone grafting (cancellous bone chips from iliac crest) to the cleft area. After premolar autotransplantation and space closure, the premolar and canine acting as the central and lateral incisors, respectively, were restored with composite resin buildups. The results showed that, with properly timed alveolar bone grafting, transplantation, and orthodontic space closure, nonprosthetic management of patients with alveolar clefts is possible, even when 2 incisors are missing on the cleft side.

Table. Comparison of outcome between autotransplantation of developing premolars and single-tooth implants after accidental loss of maxillary incisor

<table>
<thead>
<tr>
<th>Transplant</th>
<th>Implant</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Biologic&quot; replacement</td>
<td>“Artificial” replacement</td>
</tr>
<tr>
<td>Creates alveolar bone</td>
<td>Needs alveolar bone</td>
</tr>
<tr>
<td>Normal periodontal membrane</td>
<td>Ankylosed (osseointegrated)</td>
</tr>
<tr>
<td>Adjustable position after surgery</td>
<td>Nonadjustable</td>
</tr>
<tr>
<td>Erupts, in synchrony with neighbors during continued growth and eruption</td>
<td>Does not erupt</td>
</tr>
<tr>
<td>Normal interdental gingival papillae</td>
<td>Frequently interdental gingival recession (particularly with 2 neighboring implants)</td>
</tr>
<tr>
<td>Long-term observations (&gt;40 years)</td>
<td>Long-term observations (&gt;10–15 years) lacking</td>
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Autotransplantation, single-tooth implants, or space closure

Osseointegrated implants are now the preferred treatment alternative for many dentists when it comes to replacing missing anterior teeth. Experience gained to date for survival of single-tooth implants is favorable, with rates in multicenter studies of 90% at 10 years. However, clinical success depends not only on persisting osseointegration, but also on harmonious integration of the crown into the dental arch. The clinical esthetic result for single implants replacing maxillary incisors is sometimes less than desired. The difficulties in obtaining a natural marginal gingival contour are partly due to the relationship between implants and the bone and gingiva surrounding them. The reduction in osseous scallop from facial to interproximal areas and lack of difference in gingival heights above bone from facial to interproximal, compared with natural teeth, can lead to a flat gingival form. In a study comparing 21 implant-supported single-tooth replacements with
their contralateral natural teeth, it was found, after a mean observation time of 3 years, that the implant-supported crown had a lower height of the distal papilla (Fig 3). The implant crowns were longer (1 mm), had more mucositis and bleeding on probing, and had greater probing depths than the natural incisors.

The challenge in treating patients with missing maxillary incisors and any coexisting malocclusion is how to achieve the best esthetic and functional results, particularly in a long-term perspective. In this regard, a comparison between some properties of transplants and implants is relevant. The Table represents a direct comparison of the 2 methods, and at least 6 differences are evident:

- Transplantation represents a biologic approach in which the transplanted tooth germ retains the potential to induce alveolar bone growth; the single implant is an artificial method in which bone-regeneration techniques might be required when the alveolar bone support is insufficient.
- The transplant has a normal periodontal membrane and can be moved orthodontically like any other tooth. The osseointegrated implant is ankylosed to the bone, and its position cannot be changed.
- The transplanted tooth will erupt in synchrony with the neighboring incisors during continued facial growth and eruption of the teeth and adapts to functional stimuli. The implant will not follow the neighboring incisors vertically during tooth eruption at any age.
- A normal marginal gingival contour is routinely established around restored transplanted teeth (Fig 2); this is not the case for single-implant replacements.
- Several patients in Norway have been followed for 30 or more years, after having had premolars transplanted from 1 region of the mouth to another. Scientific long-term studies (more than 10 years) of implant-supported crowns in the esthetic zone are not available.
- A major limitation of premolar transplants is that the technique should be applied only in children who have premolars that are still developing. Transplantation of premolars with fully formed roots and closed apices is less successful and is regarded as an experimental procedure. Implants, on the other hand, should be reserved for nongrowing adults.

A systematic analysis of orthodontic space closure as a treatment alternative when a maxillary central incisor is missing was recently made in a follow-up study (mean 5.7 years) of 20 consecutively treated patients. All patients had received orthodontic treatment with the objective of closing the space for the missing central incisor. Biologic features and the clinical appearance of the recontoured lateral incisor (test tooth) replacing the missing tooth were compared with the neighboring intact central incisor (control tooth). The patients’ opinions regarding the treatment and the result were recorded in a questionnaire. The position of the examined teeth and the appearance of the surrounding tissues were similar in the test and control teeth. However, in some patients (25%), certain aspects of incisor crowns recontoured with direct composite resin buildups (such as the width at the gingival margin) mismatched the appearance of the controls. No obvious detrimental effects were observed on the radiographs. Most patients expressed satisfaction with the treatment result. Space closure treatment can be recommended if the indications for it are present and careful attention to detail is exercised during the orthodontic and restorative treatment (Fig 4).

REFERENCES
3. Czochrowska EM, Stenvik A, Bjercke B, Zachrisson BU. Outcome of tooth transplantation: survival and success rates 17-41


