Resin-bonded restorations: A strategy for managing anterior tooth loss in adolescence

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Abstract

In children or adolescents with anterior tooth loss, space closure with the patient's own teeth should be considered as the first choice to avoid lifelong restorative needs. Thorough diagnostics and treatment planning are required when autotransplantation or orthodontic space closure is considered. If these options are not indicated and a single tooth implant restoration is considered, implant placement should be postponed until adulthood, particularly in young women and in patients with hyperdivergent skeletal growth pattern. A ceramic resin-bonded fixed dental prosthesis with 1 retainer is an excellent treatment solution for the interim period; it may also serve as a long-term restoration, providing that sound enamel structure is present, sufficient framework dimensions have been provided, adhesive cementation techniques have been meticulously applied, and functional contacts of the cantilever pontic avoided. In contrast, a resin-bonded fixed dental prosthesis with a metal framework and retentive preparation is indicated if the palatal enamel structure is compromised, interocclusal clearance is limited, splinting (such [..])

Reference


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Resin-bonded restorations: A strategy for managing anterior tooth loss in adolescence

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Tooth loss in the anterior region requires immediate replacement with an interim or definitive restoration for esthetic and/or functional reasons. Anterior tooth loss, particularly in children or adolescents, usually results from an accident and/or complications from previous trauma (such as external root resorption or ankylosis).1,2 Maxillary central incisors are the teeth most frequently affected by trauma.1,2 Because of the potential for complications with implant infraposition, particularly in the maxillary anterior region in young women and in patients with a hyperdivergent growth pattern, single-tooth implants should be postponed until adulthood.3 During this time, which is particularly critical during puberty, a noninvasive long-term interim restoration should be planned until an implant is indicated. Alternatively, space closure with the patient’s own teeth may be considered, which dispenses with repeated treatments throughout the lifetime of the patient. Particularly in children, the potential of autotransplantation of premolars, orthodontic space closure, or resin-bonded fixed dental prostheses (FDP) should be considered.4,5

Treatment plan for managing anterior tooth loss during growth

When a permanent tooth is lost in the mixed dentition during adolescence, a thorough clinical examination should be performed and supplemented by a panoramic radiograph to evaluate potential aplasia. Further, the facial morphology and skeletal situation should be analyzed (orthognathic, prognathic, or retrognathic) and skeletal growth evaluated (normal/mesocephalic, hyperdivergent, or hypodivergent).3 The form, contour, and color of the maxillary incisors and canines should also be analyzed, particularly if orthodontic space closure is considered (Table 1).5-7

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Autotransplantation facilitates the replacement of the
missing tooth and the stabilization of the adjacent teeth,
and, more importantly, the continuation of the alveolar
bone growth accompanied by an enlargement of the
gingival tissue volume at the recipient site. High success
rates after autotransplantation have been reported,
particularly when premolars were transplanted into the
area of maxillary incisors (100% after a median of 4.8
years). The ideal time for transplantation is when the
root of the selected tooth has reached two thirds to three
quarters of the root length. If root development is
already complete, endodontic treatment is inevitable and
can be initiated before or during the first 2 weeks after
transplantation. Keeping the periodontal ligament cells
on the root surface vital during the procedure is decisive
and can be ensured by careful handling and by storing
the extracted tooth in a cell culture medium (Dentosave,
Medice; or Save-a-Tooth, Phoenix-Lazerus Inc) (Fig. 1).
After preparation of the recipient site, the transplanted
tooth is inserted and splinted for 2 to 4 weeks.

Generally, the splinting time depends on the amount of
regeneration that has to take place and can be reduced
with a perfect fit into the recipient site (for example, after
tooth avulsion and replacement), but the time should be
increased in cases of greater incongruence between the
alveolar bone and the root morphology.

If neither autotransplantation nor orthodontic space
closure is indicated, the single tooth space must be
maintained and movement of the adjacent teeth into the
space avoided. Short-term interim restorations can be
fabricated chairside by adhesive fixation or as indirect
resin-bonded interim prostheses (Table 1). As short-
term or long-term interim solutions, resin-bonded res-
torations provide a minimally invasive treatment option
that allows implant placement to be postponed.

### Table 1. Treatment strategy for anterior maxillary tooth loss according to patient age

<table>
<thead>
<tr>
<th>Patient Age Range (y)</th>
<th>Treatment Option</th>
<th>Indications</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-8</td>
<td>Autotransplantation of deciduous mandibular canine</td>
<td>When space should be maintained and continuing growth of bone and soft tissue ensured</td>
<td>If autotransplantation is postponed, early extraction of adjacent deciduous teeth may be required to enable orthograde eruption of adjacent permanent teeth</td>
</tr>
<tr>
<td>≥9</td>
<td>Autotransplantation of permanent premolars</td>
<td>When space should be maintained and continuing growth of bone and soft tissue ensured</td>
<td>For adequate tooth selection, evaluate residual dentition (potential aplasia or expected crowding) and root anatomy of premolars</td>
</tr>
<tr>
<td>≥11</td>
<td>Orthodontic space closure and recontouring of molar regions for single-tooth implant at age 20 (risk of infraposition is less critical in premolar regions)</td>
<td>In patients with a convex profile and protruded incisors that have to be inclined lingually</td>
<td>During orthodontics, denture tooth can be fixed in multiband appliance and subsequently reduced</td>
</tr>
<tr>
<td>≥14</td>
<td>Orthodontic space closure and space opening in premolar region</td>
<td>With light color of canines, which are moved mesially into position of lateral incisors</td>
<td>Instead of canine-protected occlusion, anterior group function has to be established</td>
</tr>
<tr>
<td>≥16</td>
<td>Short-term interim restoration performed chairside and adhesively fixed at mesial or distal, or both adjacent teeth, or indirect with coarse metal reinforcement (Rochette type), or as fiber-reinforced composite resin-bonded restorations</td>
<td>With similar tooth widths of central and lateral incisors (wide lateral and small central incisors)</td>
<td>Use coronal tooth portion of extracted tooth, denture tooth or composite buildup in combination with glass-fiber reinforcement</td>
</tr>
<tr>
<td>≥20</td>
<td>Conventional FDP</td>
<td>As interim solution if autotransplantation is not feasible and space should be maintained</td>
<td>Possibly requires retreatment due to maturation of soft tissues with physiologic recession of gingival margin reaching to cemento-enamel junction at adjacent teeth</td>
</tr>
<tr>
<td>≥25</td>
<td>Single tooth implant</td>
<td>As short- or long-term interim prosthesis</td>
<td>Postponed in women and in patients with long face type</td>
</tr>
</tbody>
</table>

FDP, fixed dental prosthesis.

### Resin-bonded restorations

For resin-bonded FDPs, metal or ceramic frameworks
have been used and veneered with feldspathic porcelain.
Figure 1. A, 17-year-old adolescent with left lateral incisor in need of extraction due to external root resorption 4 years after trauma. Second premolar is in palatal position. B, Clinical situation after extraction of lateral incisor and autotransplantation of second premolar. Tooth had been adjusted mesiodistally to fit into recipient bed and has been splinted to adjacent teeth. C, Clinical situation after root canal treatment and direct restoration with composite resin. D, Radiograph 4 years after autotransplantation.

### Table 2. Options and indications for 1-wing and 2-wing metal or ceramic adhesive fixed dental prostheses

<table>
<thead>
<tr>
<th>Location</th>
<th>No. of Pontics/ Teeth to be Replaced</th>
<th>No. of Abutments (1- or 2-Wing)</th>
<th>Material*</th>
<th>Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>1</td>
<td>1</td>
<td>Ceramic</td>
<td>Short or long term</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Metal</td>
<td>Long term, little intermaxillary space</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Metal</td>
<td>Long term, when splinting required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Metal</td>
<td>Long term, stable splinting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or 2x 1-wing</td>
<td>Ceramic</td>
<td>Replacement of mandibular central incisors</td>
</tr>
<tr>
<td>Posterior</td>
<td>1</td>
<td>2</td>
<td>Metal</td>
<td>Not routinely</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Zirconia</td>
<td>Not routinely</td>
</tr>
</tbody>
</table>

*Ceramics comprise lithium disilicate or zirconia.
Fiber-reinforced composite resin-bonded restorations are potential alternatives but are limited as interim FDP, as survival rates were only 73% after 4.5 years. Metal resin-bonded FDPs can be designed with 1 or 2 wings (single or 2 retainers) and retention at a mesial and/or distal abutment tooth. They can replace 1 or more missing teeth with up to 4 pontics when, for example, the mandibular incisors have to be replaced and the canines serve as abutments (Table 2). A retentive preparation facilitates the retention of the metal resin-bonded FDP in addition to the adhesive cementation and may be particularly indicated if the enamel structure on the lingual surface of the abutment tooth is compromised, such as in elderly patients or those with erosive defects.

Figure 2. A, Diagnostic preparation in a 16-year-old adolescent for metal resin-bonded retainer because of limited intermaxillary space. Adjacent canine selected as abutment tooth with intraoral parallelometer mounted on diagnostic cast. B, Preparation with vertical grooves ending palatal of incisal edge and providing tooth engagement buccolingually; marginal gingivectomy for exposure of entire enamel area. C, One-wing resin-bonded fixed dental prosthesis luted with opaque cement; distally composite resin was added. D, Buccal view after 8 years. E, Palatal view at 8-year recall.
The preparation may be performed with an intraoral parallelometer (Parallel-A-Prep; Dentatus). This involves establishing parallel walls to house the parallel guiding grooves, which facilitate retention and resistance against buccolingual forces, an occlusal/palatal rest, and sufficient palatal clearance, as well as eliminating undercuts to use the entire enamel surface. To apply the intraoral parallelometer, a diagnostic preparation on a diagnostic cast is recommended to select a similar path of insertion to that planned for the preparation of the parallel guiding grooves (Fig. 2). These grooves should be sufficiently embraced by the metal framework, which is not visible from the labial aspect. The grooves are aligned slightly palatally to miss the incisal edge and avoid metal coverage of the incisal third (Fig. 2E). During the interim period until the definitive restoration is fabricated, the grooves can be covered with white gutta percha (DeTrey Dentsply).

For metal resin-bonded FDPs, noble or base metal alloys can be used. They should be waxed on investment casts to facilitate the casting of the thin pins and grooves. While with noble alloys the conventional ceramic firing process can be applied, base metal alloys allow for thinner retainers and smaller connectors because of their higher elastic modulus but necessitate the use of a gold layer to cover the dark oxide surface before ceramic veneering. Early studies documented reduced survival rates for resin-bonded FDPs of 88% after 5 years and loss of retention in 19% of the restorations. A retentive preparation provided better results than the nonretentive design, with a survival rate of 95% after 10 years. Ceramic restorations are pressed or milled and made from lithium disilicate glass ceramics (IPS e.max Press; Ivoclar Vivadent), glass-infiltrated aluminum oxide (In-Ceram; Vita), or zirconia (Lava; 3M ESPE). Because these materials do not allow the replication of thin grooves or pins, fixation relies solely on the adhesion of the resin cement to sound enamel (Fig. 3). The preparation involves removing undercuts with a slight proximal wrap around, delineating a clear marginal demarcation line on the palatal surface, and providing a cingulum rest to enable exact positioning during the cementation procedure. Palatal clearance of 0.7 mm is required for zirconia and at least 1 mm for lithium disilicate. The requirement that the

**Figure 3.** A, 18-year-old woman with edentulous space after traumatic loss of right central incisor (situation 6 weeks after connective tissue grafting in pontic region). B, Minimally invasive preparation within palatal enamel layer. C, D, Resin-bonded FDP (lithium disilicate) with 1 wing cemented. Occlusal, and functional contacts were avoided.
Table 3. Cementation of metal or ceramic adhesive fixed dental prostheses

<table>
<thead>
<tr>
<th>Restoration Material</th>
<th>Resin Cement</th>
<th>Cleaning/Microretention at Restoration (After Try-in)</th>
<th>Conditioning of Restoration</th>
<th>Intraoral Microretention</th>
<th>Enamel Conditioning</th>
</tr>
</thead>
<tbody>
<tr>
<td>General procedure (irrespective of material)</td>
<td>Polymerization process initiated by blue light; for example, Panavia requires protection from oxygen exposure by glycerine gel for anaerobic curing</td>
<td>Cleaning and degreasing (chloroform, isopropanol) after definitive evaluation; surface roughening and modification; water spray or ultrasonic bath and air dry</td>
<td>Adhesive resin</td>
<td>Enamel etching (phosphoric acid 37%, 60 seconds)</td>
<td>Adhesive resin</td>
</tr>
<tr>
<td>Zirconia or nonprecious alloys (chromium-molybdenum)</td>
<td>MDP containing resin cement (for example, Panavia F 2.0, Rely X Ultimate) or conventional bis-GMA-based resin cement (for example, Variolink II)</td>
<td>Airborne-particle abrasion with alumina particles coated with silica (for example, CoJet 30 μm or Sillet 30 μm)</td>
<td>Ceramic primer containing MDP monomer and silane coupling agent (for example, Clearfil Ceramic Primer, Scotchbond Universal Adhesive)</td>
<td>Bonding agent (for example, ED Primer II, Scotchbond Universal Adhesive)</td>
<td></td>
</tr>
<tr>
<td>Lithium disilicate glass ceramics (etchable)</td>
<td>MDP containing resin cement (for example, Panavia F 2.0, Rely X Ultimate)</td>
<td>Hydrofluoric etching (for example, 5% hydrofluoric acid, 20 seconds)</td>
<td>Silane coupling agent (for example, Clearfil Ceramic Primer, Scotchbond Universal Adhesive, Monobond Plus)</td>
<td>Bonding agent (for example, ED Primer II, Scotchbond Universal Adhesive, Syntac Classic)</td>
<td></td>
</tr>
<tr>
<td>High noble alloys</td>
<td>MDP containing resin cement (for example, Panavia F 2.0, Rely X Ultimate)</td>
<td>Airborne-particle abrasion with alumina particles coated with silica (for example, CoJet 30 μm or Sillet 30 μm) Or airborne-particle abrasion with Al₂O₃</td>
<td>Silane coupling agent (for example, Clearfil Ceramic Primer, Scotchbond Universal Adhesive, Monobond Plus) Metal primer (for example, Alloy Primer) containing thiophosphoric methacrylates</td>
<td>Bonding agent (for example, ED Primer II, Scotchbond Universal Adhesive)</td>
<td></td>
</tr>
<tr>
<td>Fiber-reinforced composites</td>
<td>MDP containing resin cement (for example, Panavia F 2.0, Rely X Ultimate), or conventional bis-GMA-based resin cement (for example, Variolink II)</td>
<td>Airborne-particle abrasion with alumina particles coated with silica (for example, CoJet 30 μm or Sillet 30 μm)</td>
<td>Silane coupling agent (for example, Clearfil Ceramic Primer, Scotchbond Universal Adhesive, Monobond Plus)</td>
<td>Bonding agent (for example, ED Primer II, Scotchbond Universal Adhesive, Syntac Classic)</td>
<td></td>
</tr>
</tbody>
</table>

MDP, 10-methacryloyloxydecyl dihydrogen phosphate (10-MDP) creating covalent bond between crystalline ceramics and resin cement.

With zirconia 1-wing resin-bonded FDPs, early debonding occurred in 2 of 15 restorations. These were successfully recemented, and the survival rate was 100% after 4 years (mean 53 months).²³

Cementation of resin-bonded FDPs

The improvements in long-term results with resin-bonded FDPs are mainly related to new cementation techniques. The adhesion obtained relies both on micro-mechanical retention and on chemical interactions of specific monomers (preferably phosphate monomers in Panavia F2.0; Kuray, or RelyX; 3M ESPE) with the bonding substrate (Table 3). On the tooth surface, optimal mechanical retention can be achieved after etching of the enamel surface with phosphoric acid (35% to 37%, for 30 to 60 seconds), and any subsequent contact with saliva must be avoided. If zirconia or alloys are used, the restoration surface requires roughening by airborne-particle abrasion. Tribochemical silica coating provides the most durable results and is applied either chairside (for example, CoJet; 3M ESPE) or with the corresponding laboratory facilities (Rocatec soft; 3M ESPE). Airborne-particle abrasion with 30 μm silica-coated aluminum oxide particles creates a silica layer on the restoration surface material of the attachment (wing) be sufficiently thick may interfere with the need for sound enamel structure along the entire lingual surface, since only 0.5 mm enamel thickness is present in this area²⁰ and adhesion to dentin is reduced.²¹ On the basis of this discrepancy between space requirements and the need for intact enamel, a deep vertical overlap may contraindicate ceramic retainers, while metal, particularly base metal alloys, can be thinner (0.3 to 0.5 mm). The indication for lithium disilicate is restricted to the anterior region with large connector sizes of 16 mm².²²
and facilitates a chemical bond to the resin cement through the corresponding silane-containing primer. 27

For high noble alloys lacking a superficial layer of metal oxides, either silica coating with silane primers or conventional airborne abrasion in combination with specific metal primers is applied (Table 3). 28

The polycrystalline ceramic zirconia is free of silica and adheres less well to resin-based cements than its glass ceramic or metallic framework counterparts. 29

With lithium disilicate ceramics, the microretentive surface is achieved by etching with hydrofluoric acid, which selectively removes the glass matrix and exposes the crystalline ceramic structure.

After accomplishing the microretentive surface on the inner aspects of the attachments, the resin-bonded FDP is cleaned with water spray or in an ultrasonic bath and dried with pressurized air. As final conditioning, the corresponding primer is applied to the restoration and to the etched tooth surface (Table 3). To cement metal restorations, opaque luting cements are selected to avoid any gray shine-through and discoloration. If the interface on the labial aspect is still slightly visible after cementation, a thin layer of composite resin can be applied after cement excess has been removed and the surface again etched and bonded as for a conventional direct composite restoration (Fig. 2C).

REFERENCES


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