Technical and clinical procedures for intra-oral repair of fixed dental prostheses

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KEYWORDS
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ABSTRACT
Aim. The intra-oral repair is a conservative approach for removal of the FDP avoiding and multiple clinical sessions and high cost for the patient.

Materials and methods. The clinical protocol of intraoral repairs using resin composite starts with application of a suitable rubber dam, use of correct sequence of surface conditioning for each substrate and meticulous finishing and polishing procedures.

Conclusion. When intra-oral repair is properly indicated and performed using adhesive technologies and resin composite, it is a viable and convenient option: esthetic and functional problems caused by ceramic fracture can be quickly solved chairside, preventing replacement of the prosthesis.

Introduction
Dental ceramics have been the favorite aesthetic materials by clinicians and technicians for metal-ceramic fixed dental prosthesis (FDP) for more than five decades.

Unfortunately, the brittle nature of this material contributes to the increased incidence of failures, in the form of chipping or fracture of the veneering ceramic ranging between 3 to 5% per year (1).

Chipping is frequent especially in the cervical region of the FDPs, mainly due to insufficient preparation in this area, resulting in a thinner ceramic (2). Other causes related to fractures and chipping of ceramic are inadequate design of infrastructure, irregular preparation, inadequate laboratory procedures, mismatch of the thermal expansion coefficient between ceramic and metal or ceramic infrastructure, incompatibility between the ceramics used, porosity in the ceramic after laboratory processing, inadequate occlusal adjustment, trauma, parafunctional habits, biological causes, such as caries and periodontal problems or a combination of some of these factors (2-5).

Case selection

• Why to repair?
  The removal and remake of a new prosthesis increases the time and cost, requires sophisticated laboratory procedures, and enhances the risk of unnecessary preparation of dental tissues unless the fracture is not a consequence of less preparation (4,5,7).

  Due to the high cost of the reconstructions, most patients do not accept the replacement of recent prostheses that have undergone a failure after a short period of time. However, there are also failures that occur as a result of fatigue after many years of service. Even in such occasions, removal and remake of FDPs could be avoided by chairside repair actions just for the sake of economic reasons.

  Also, removal of the FDP yields to distortion of the framework especially at the margins of the reconstruction. The fractured area usually is an aesthetic and functional problem for the patient and by chairside repair such problems are solved immediately (4,6,7).

• When to repair?
  Before attempting repair of the fractured area, it is important to check if the prosthesis has a satisfactory marginal fit, proper occlusion and aesthetics.

  FDPs not fulfilling these aspects require replacement (4,5).

  Typical, ceramic fractures in FDPs are observed in 4 forms:
  • ceramic is fractured and the metal framework is
exposed as in the case of metal-ceramic FDPs;
• ceramic is fractured and the ceramic framework
  is exposed as in the case of bilayered all ceramic
  FDPs;
• tooth preparation is exposed, as in the case of
  veneers, inlays, onlays and monolithic crowns;
• cohesive chipping of the veneering ceramic only
  (5).

The type and size of fracture should also be carefully
evaluated.

The size of the failure dictates whether or not to
replace. While small to medium failures are suitable for
intraoral repair, failures at the approximal areas, where
the contact to the neighbouring teeth or restorations
is lost, usually intraoral repairs are difficult. In such
occasions, replacement could be considered (5,7).

• How to repair?

In order to achieve long term durable intra-oral repair,
the substrate materials should be recognized and
conditioned accordingly with the appropriate adhesive
technologies (4,8).

Technique description

This clinical report suggests the following sequence
based on the best available knowledge from \textit{in vitro} and
clinical studies.
1. Identify the substrate material (tooth, metal and
ceramic etc.) to be conditioned and observe if there is
tooth substance involved or not (Figure 1) (5).

Apply the most effective surface conditioning method
for the corresponding substrate (Table 1).
2. Identify the cause of the fracture.

Intra-oral repairs should to be contemplated if the
cause is less tooth preparation or inadequate laboratory
procedures. However, evaluation of the occlusion and
the elimination of the premature contacts on the FDP
can minimize a possible failure of the intra-oral repair
(Figure 2) (8).

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Surface conditioning method</th>
<th>Reason</th>
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<tbody>
<tr>
<td>Prepared tooth</td>
<td>Etching with 37% phosphoric acid, primer on dentin, followed by application of adhesive resin on both enamel and dentin</td>
<td>The classical 3-step etch and rinse technique is very well documented showing durable longevity for enamel and dentin</td>
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<tr>
<td>Metal</td>
<td>Air-abrasion using alumina particles coated with silica or silica only, followed by silane coupling agent and adhesive resin application</td>
<td>Deposition of silica and alumina particles on the metal surface cleans surface and promotes siloxane bonds between the silane coupling agent on the metal surface and the adhesive resin</td>
</tr>
<tr>
<td>Feldspathic porcelain</td>
<td>Clean the area with fluoride free prophylaxis paste or pumice, followed by etching with hydrofluoric acid 5 to 9.6%, and silane coupling agent, adhesive resin application</td>
<td>HF selectively dissolves the glass or crystalline components of the ceramic and produces a porous, irregular surface, increasing the surface area and penetration of resin into the micoretentions of etched surface</td>
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<tr>
<td>Glass-ceramics</td>
<td></td>
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<tr>
<td>Oxide ceramics (alumina or zirconia)</td>
<td>Air-abrasion using alumina particles coated with silica or silica only, followed by silane coupling agent and adhesive resin application</td>
<td>Oxide ceramics do not contain the silicon dioxide (SiO2) phase in its microstructure. When alumina particles coated with silica are used, a silica layer is deposited on the zirconia surface, interacting with the silane coupling agent, improving adhesion</td>
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</table>

Table 1 Surface conditioning methods for different substrates for durable adhesion of resin composite materials used for intra-oral repair

Figure 1 Ceramic fracture at the cervical area with metal exposure

Figure 2 Check occlusal interference during later movement
3. Determine the shade of the ceramic and resin composite.

For proper shade selection, ceramic or resin composite shade guides can be used (Figure 3).

Before conditioning the surface of the fractured area, it is also possible to apply a small increment of resin composite and photopolymerize it in order to evaluate the shade match between the two dissimilar materials.

4. Insulate the working area using rubber-dam whenever possible since saliva contamination and oral humidity impair adhesion to the surface (6,8).

Rubber-dam can be modified in long-span FDPs (Figure 4).

The use of airborne particle abrasion and hydrofluoric acid (HF) on the substrate may accidentally damage neighboring teeth and soft tissues. Thus, if rubber-dam is not applicable polyfluorethylene (Teflon) tape can also be used.

5. Clean the area to be repaired using fluoride-free prophylaxis paste or pumice.

Clean surfaces are essential for effective surface conditioning and subsequent adhesion (Figure 5).

6. Prepare the veneering ceramic by removing glaze layer at the margins to be repaired using a fine-grit diamond bur, creating a bevel (Figure 6).

This procedure increases the surface area and allows HF and the silane coupling agent react with the vitreous matrix, improving siloxane bonds (9).

The use of abundant water cooling is essential in order not to heat the ceramic and cause formation of cracks.

7. Protect the veneering ceramic except the bevelled area using Teflon tape or glycerine gel (Figure 7).

8. Condition the surface accordingly.

For metals or oxide ceramic surfaces, airborne particle abrasion with alumina particles coated with silica or silica only (particle size range: 30 to 50 microns, blasting pressure: 2.5 bar), approximately 5 s is in circling motion, rotating the nozzle at a distance of approximately 10 mm
(Figure 8) is the most effective conditioning method. For feldspathic or glass-ceramics, HF etching is the most appropriate (feldspathic ceramic: 9.6% HF for 2 to 3 min; leucite reinforced ceramics: 5% HF for 1 min; lithium disilicate reinforced ceramics: 5% HF for 20 s) (10). In case tooth surfaces are exposed, for this substrate phosphoric acid etching should be employed.

9. After etching with HF, rinse thoroughly and dry (Figure 9).
10. Apply one coat of silane coupling agent using a clean brush at each time. Silane makes covalent bonds between the metal or ceramic surfaces and the resin composite (9). Wait 1 min for its reaction with the surface and dry with oil-free air (Figure 10).
11. Mask the metal surfaces with opaque resin to avoid metal shine through. This should be done with the tip of an explorer (Figure 11), making sure that it does not contain air bubbles and photo-polymerize for 120 seconds (8).

12. Apply adhesive resin one coat with a clean brush on the metal, veneering ceramic and tooth preparation (Figure 12). The adhesive resin excess is removed by aspiration and photo-polymerized for 20 s.

13. Apply resin composite incrementally (8).

Each increment should be photo-polymerized to reduce the final polymerization shrinkage (Figure 13). Remove rubber-dam and control occlusion.

Make sure there are no premature contacts left.

Finish and polish the composite surface using rubber tips or disks with polishing pastes (Figures 14, 15).

Conclusion

When intra-oral repair is properly indicated and performed using adhesive technologies and resin composite, aesthetic and functional problems caused by ceramic fracture could be quickly solved chairside, preventing replacement of the prosthesis.

However, clinical success and longevity of intra-oral repair, is dictated by the clinical protocol starting from suitable rubber dam application, employment of correct sequence of surface conditioning for each substrate and meticulous finishing and polishing procedures.

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