Provisional Repair of a Zirconia Fixed Partial Denture with Fibre-Reinforced Restorative Composite: A Clinical Report

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ABSTRACT

Although all-ceramic restorations have become popular, they present some biomechanical problems. Some technical failures can be repaired intraorally to help maintain the longevity of the restoration. This clinical report describes an intraoral method for repairing a fractured 4-unit posterior zirconia-based ceramic fixed partial denture using fibre-reinforced composite material.

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The popularity of all-ceramic dental restorations has increased in recent years because of their esthetic appearance and metal-free structure.[1] Although these restorations provide adequate resistance to occlusal forces when used for a single crown or short-span fixed partial denture (FPD), their use for long-span FPDs is limited.[2]

All-ceramic systems must meet the biomechanical and longevity requirements associated with metal–ceramic restorations,[3–5] while providing enhanced esthetics.[6] Since the late 1990s, several clinical studies have evaluated all-ceramic systems for anterior and posterior FPDs.[7–11]

Zirconia, a high-strength ceramic, was recently introduced for dental use as a core material in conventional and resin-bonded FPDs and crowns.[12–14] Zirconia is highly rated in terms of esthetics and has several other advantages, including biocompatibility as it is metal free[15–17] and has a low degree of bacterial adhesion,[18,19] high flexural strength and acceptable optical properties, such as adaptation to the basic shades.[20]

Traditional cementation can be used if abutments for the FPD provide enough retention, and cementation is recommended to ensure better retention and marginal adaptation. Resin cement is preferred for luting such restorations, as zirconia is non-etchable. Cementation with resin cements that contain 10-methacryloyloxydecyl dihydrogen phosphate monomers or a silica-coating technique, such as CoJet (3M ESPE, Seefeld, Germany), is recommended.[21] In tribochemical silica coating, the ceramic surface is abraded with airborne particles of aluminium oxide modified with silica; the blasting pressure embeds silica particles in the ceramic surface.[22] Thus, tribochemical silica coating combines micromechanical retention produced by airborne-particle abrasion and chemical bonding with silanization of the silicated ceramic surface particles.[23]

Despite these advantages, the only data on the success of zirconia FPDs are short term. Furthermore, careful patient selection and operating technique appear to be paramount for success. Longer-span FPDs are considered experimental and have been evaluated only in vitro.[24]

Although zirconia has high fracture strength, fractures may still occur after cementation of the restoration. If the fractured restoration is fulfilling its requirements and replacement is not feasible, repair is indicated.[25] Intraoral repair, if possible, is the first choice.

This clinical report describes an intraoral method to repair a fractured zirconia ceramic FPD.

Case Description and Results

A 46-year-old woman was referred to our clinic with a fractured 4-unit posterior zirconia-based FPD. The retainers were the canine and first maxillary molar. Clinical and radiographic examination revealed the fractured area between the 2 premolar pontics (**Fig. 1**). The prosthesis had been fabricated only one month earlier. Marginal adaptation, occlusion, periodontal health, colour matching and proximal contacts of the prosthesis were all within normal limits. The patient's only complaint was some roughness in the mouth and she wanted an immediate solution. Because of lack of time, possible trauma to the restored tooth and the difficulty of removing the restoration, an intraoral repair was indicated, even though this type of repair is still experimental. Replacing the FPD was an alternative treatment option if the repair was unsuccessful.

The treatment plan included preparing the cavity, etching, sandblasting, silanizing and applying dual-adhesive resin cement and glass-fibre-reinforced composite.

A rubber dam was used to protect the oral mucosa from the adverse effects of etching compound and tribochemical coating. The dam was tied with silk suture material under the pontics of the bridge. The cavity was prepared with a 30-μm fine-diamond rotary cutting instrument under running water. A small cylindrical cavity (about 1 mm deep) was made within a larger cylindrical cavity (about 2 mm deep) to promote mechanical retention (**Fig. 2**). To promote satisfactory adhesion, the cavity was acid-etched with 6% hydrofluoric acid gel (Porcelain Bonding Kit, Sultan, Germany) for 5 minutes (**Fig. 3**), then washed with water, air dried and sandblasted with 30-μm silicated aluminum oxide (Al_2O_3) particles (CoJet System, 3M ESPE) (**Fig. 4**). Silane coupling agent (ESPE-Sil, 3M ESPE) was then applied to the surface of the cavity and allowed to air dry for 5 minutes. Bonding agent (Single Bond 2, 3M ESPE) was applied to promote chemical retention.

After surface treatment of the cavity, dual-adhesive resin cement (Rely X ARC, 3M ESPE) was applied to the fractured area. The length of the cavity was determined using a piece of dental floss, then a piece of unidirectional

resin-impregnated 1.2-mm diameter glass-fibre bundle (EverStickC&B, StickTech, Turku, Finland) was cut to this length (**Fig. 5**). The fibre bundle was prepared for bonding by first wetting the bonding surface with a bonding agent (Stick Resin, StickTech). The bundle was pressed into the cavity with a hand instrument to ensure good contact between the cavity and the fibres. The fibres were then light polymerized for 20 seconds (**Fig. 6**) and covered with packable posterior composite restorative material (SureFil, Dentsply, De Trey, Konstanz, Germany). The whole area was light polymerized for 40 seconds (**Fig. 7**). Occlusal contact points were adjusted with a fine diamond rotary cutting instrument (no. 8835KR; Komet Medical, Gebr. Brasseler, Germany) under running water and polished with composite polishing disks (Sof-Lex, 3M Dental Products, St. Paul, Minn.) (**Fig. 8**).

Clinical evaluations were performed every 3 months to evaluate the repaired restoration in terms of function, fractures and esthetics. After 12 months of follow up, no clinical complications were observed.

Discussion

Although 3-unit zirconia FPDs have been reported to have high fracture resistance, the use of this material for longer-span FPDs is limited. Fractures may result from trauma, inadequate occlusal adjustment, parafunctional habits such as bruxism, inadequate tooth reduction during dental preparation, inappropriate design or failure of the cementation.[26]

The structure of a zirconia framework is also important in terms of strength of the restoration. A framework design allowing uniform thickness and support of veneering porcelain has been shown to optimize the strength of zirconia.[27] A minimum connector cross-section area of 9 mm² and a retainer thickness of 0.6 mm have been recommended for 3-unit FPDs.[28] Longer-span FPDs are experimental and have been evaluated only in vitro.[29] Long-term clinical data on the success of all-ceramic FPDs are rare. The primary mode of failure is fracture, usually in the area between the retainer and pontic, emanating from the gingival surface of the connectors under high tensile stress, resulting in catastrophic loss.[22]

Fracture of the zirconia FPD reported here occurred between the connector areas of the 2 pontics where high tensile stress occurred during mastication. The failure, therefore, likely occurred because the thickness of the connector between the pontics was inadequate to bear the necessary occlusal load.

When repairing an FPD, optimum adhesion between the repair materials and the prosthesis surfaces must be achieved.[30] In our case, mechanical retention was promoted by drilling a small cylindrical cavity within a larger cylindrical cavity. A 30-μm medium diamond rotary cutting instrument was used for preparation under
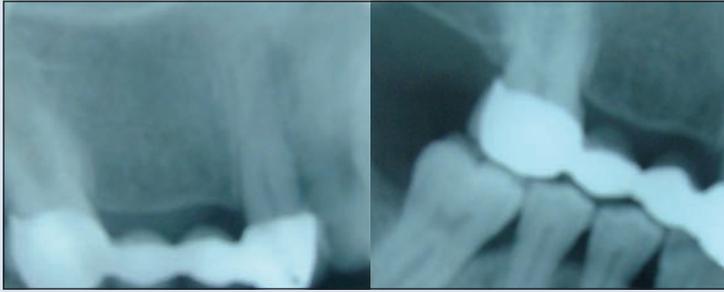
Figure 1: Radiographic view of the fractured bridge.

Figure 2: Clinical view of the fractured bridge showing the prepared cavity.

Figure 3: Acid etching material coating the cavity.

Figure 4: Application of the tribochemical coating.

Figure 5: Placement of the glass-fibre bundle.

Figure 6: Light polymerized glass-fibre-reinforced composite.

Figure 7: Composite application.

Figure 8: Final view of the restoration.

running water because 50-μm or coarser diamond rotary cutting instruments with dry cooling have been shown to generate radial surface cracks, which compromise the strength of the zirconia core.[31]

It has been reported that roughening the surface of exposed metal or ceramics, using a combination of sandblasting and hydrofluoric acid gives the best results.[25] High-alumina or zirconia ceramics cannot be roughened by etching as these materials do not contain a silicon dioxide (silica) phase.[23] Ozcan and Vallittu[23] reported that, while acid etching demonstrated better results for glass ceramics, it did not improve the bond strength of the luting cement to high-alumina ceramics or zirconium oxide ceramic. In practice, etching might only be useful for removing smears from the ceramic.[32]

Although intraoral sandblasters have been designed to be used with Al_2O_3, we used aluminium oxide coated

SiO_x particles instead of Al_2O_3, together with silane application.[33] A previous study evaluating surface conditioning methods found that silica coating with silanization increases bond strength significantly for all high-strength ceramics compared with airborne particle abrasion with 110-μm Al_2O_3 and silanization.[34]

Tribochemical silica coating followed by silanization increases the silica content of the ceramic surface, evidently enhancing the bond between the ceramic surfaces and the luting agent. Because the silica layer is well attached to the ceramic surface, silanes enhance the resin bond.[23] Shen and others[35] also reported that the use of silane in conjunction with resin-based bonding agents on ceramic has resulted in a significant increase in bond strength and promotes mechanical retention.

After the etching and abrasion process, a silane coupling agent was applied to the surface cavity to improve

the bonding strength of the resin-based material which was applied to the cavity. Because of its fluid nature, the dual-adhesive resin cement flowed through the fracture area, filling the space between the fractured pieces. Mechanical support for the repair was achieved by using unidirectional glass-fibre material. The strength of the repair depends on the quantity of glass fibre, the direction of the fibres and their attachment to the ceramic.

Repaired restorations should be resistant to fatigue. In our case, adding fibre-reinforced composites under the composite resin increased fatigue resistance of the repair.[36] In addition, the upper part of the cavity was filled with fibre-reinforced composite and a posterior composite material to ensure wear resistance.

We have presented a technique for provisional repair of fractured all-ceramic restorations. In some cases, it may be desirable to repair a fractured fixed prosthesis rather than removing it because of cost, lack of time, possible trauma to the restored tooth and the difficulty of removing the restoration. The effectiveness of available adhesive systems and the durability of glass-fibre-reinforced composites can be useful for the provisional repair of uncomplicated cases of fractured restorations. ✦

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