Intra-oral repair technique for ceramic fracture using direct resin composite

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ABSTRACT
Background One of the most common clinical failures of ceramic reconstructions is the fracture or chipping of the veneering ceramic creating a great discomfort for the patient. If the prosthesis presents ideal adaptation and satisfactory aesthetics, a viable and practical solution for such failures is the intra-oral repair using direct resin composite. In order to achieve successful repair, it is essential to perform adhesion protocols meticulously on the exposed surfaces after fracture.

Case report This case report presents step-by-step the procedures for the intra-oral repair of metal-ceramic prosthesis with minor cohesive fracture in the veneering ceramic, employing resin composite, emphasizing the stages of surface condition methods applied on feldspathic porcelain.

Introduction
In bilayered dental prostheses, such as metal-ceramic fixed dental prosthesis (FDP), on occasion, the veneering ceramic can fracture under clinical function as a result of the presence of premature contacts, trauma, parafunctional habits, inadequate tooth preparation and/or failures during laboratory processing (1, 2). Fractures in ceramic are closely related to the fragile nature of the feldspathic porcelain and to conventional layering techniques, since defects such as pores and voids are almost unavoidable during the layering process (3). Fracture in veneering ceramic may eventually culminate in an aesthetic and/or functional problem for the patient and, as a consequence, replacement of the fractured FDP is indicated (4).

The removal of FDP is often performed using drills, ultrasonic or mechanical devices (5). It is often indicated when marginal leakage, decay or aesthetic problems are present. When none of these symptoms are present, removal of the FDPs could lead to clinical complications such as fractures of the veneering ceramic, deformation of the metal and iatrogenic fracture of the sound tooth tissues that can seriously compromise the longevity of the tooth (6, 7). Moreover, replacement of FDPs is generally a complex and expensive procedure, leading to a considerable increase in chairside time, which is not always well accepted by the patient (6).

In order to minimize such iatrogenic complications during removal of the FDP, when the failure is small or medium size, and does not involve the functional areas, intra-oral repair technique using resin composite could be indicated. This treatment modality is viable, economical, conservative, and may be performed in a single clinical session without requiring the removal of the prosthesis, but requires meticulous conditioning of the substrate ceramic material (4, 7).

Intra-oral repair technique
The intra-oral repair has been described as a clinical strategy to restore part of a failed or fractured restoration whether directly or indirectly (8). The restorative material will come into direct contact with the remaining portion of the old restoration and will become part of it, restoring function and aesthetics (9). Currently, the most commonly used material for this purpose is the resin composite, especially in clinical situations where aesthetics is important.

Resin composite intra-oral repairs present similarity to the optical properties of natural teeth, solving the aesthetic problems caused by fracture or chipping (6). In addition, these fractures occur often supra-gingivally, thus helping the clinical procedure of intra-oral repair (8, 9). The success and longevity of restorative procedures with resin composite depends highly on the knowledge and application of adhesive techniques. When applied correctly, resin composite intra-oral repairs present acceptable success rates, increasing the longevity of the failed restoration (8).
Adhesion to glassy matrix ceramics

The success of an intra-oral repair of metal-ceramic FDP depends on the integrity of the adhesion between the glassy matrix ceramic substrate and the resin composite. When the fracture does not involve metal exposure, adhesion is more predictable. This is due to the fact that glassy matrix ceramics, as feldspathic porcelain, contain silica that could be etched. Chemical etching agents such as hydrofluoric acid can dissolve the glassy matrix selectively, leading to a physical change on the ceramic surface, capable of promoting adhesion and interlocking of resin composite to the porous ceramic surface (10).

The adhesion between glassy matrix ceramics and resin composite is achieved through two mechanisms, namely, micromechanical interaction by etching with...
hydrofluoric acid and/or air-abrasion and chemical adhesion with the use of silane coupling agents. It is not possible to achieve high bond strength values to glassy ceramics without the use of these two methods (11). The etching time recommended for feldspathic porcelain is about 3 minutes with 9.6% hydrofluoric acid, which creates sufficient porosity to allow the silane coupling agent and the adhesive resin to penetrate the pores, increasing the bond strength of the resin composite (12).

The silane coupling agents are hybrid inorganic-organic bifunctional molecules that promote chemical adhesion between organic and inorganic structures. This mechanism of action occurs by silanol group bonds to the vitreous matrix of the ceramic and organofunctional group bonds to the organic matrix of the resin material employed (13). In addition, the silane coupling agents favour the wettability and surface energy of the ceramic surface, increasing the contact area with resin composite, thereby obtaining a durable adhesion between the ceramic and the intra-oral repair composite.

**Case report**

A female patient (35 years old) sought dental treatment as her anterior tooth was broken and she was uncomfortable with her aesthetics. In the clinical examination, it was observed that a metal-ceramic FDP had been cemented on the abutments four years before and a small chipping was present on the labial surface of the central incisor, at the incisal edge (Figures 1 and 2). The FDP presented adequate aesthetics and proper adaptation to the abutments that were well fitted to the dental implants.

Due to the small size of the chipping, without exposure of the metallic framework, an intra-oral repair option was considered since the repair of the FDP can preclude further problems (6). Before performing the repair, the occlusion of the patient was checked and made sure that premature contacts were not present. Chippings at the incisal edge are often related to occlusal problems, such as premature contacts and occlusal interferences (3, 14).

For shade determination, small increments of resin composite (Empress Direct, Ivoclar Vivadent, Schaan, Liechtenstein) were placed on the fractured area and photo-polymerized. Absolute isolation was carried out to protect the soft tissues from the hazardous effects of the hydrofluoric acid and to prevent saliva contamination and oral humidity during adhesive procedures (12, 14) (Figure 3). The area to be repaired was cleaned with rubber cups and fluoride-free paste.
to remove the pellicle or other contaminants from the ceramic surface for better adhesion of the resin composite.

Initially, a light bevel was prepared in the remaining ceramic with a fine grit diamond bur (Figure 4). At this stage, abundant cooling was performed in order to avoid ceramic heating and possible formation and propagation of cracks. The presence of the bevel provides a better marginal adaptation and creates a smooth transition between the ceramic and the resin composite. Moreover, after the bevel preparation, the removal of the glaze increases the surface area, allowing the silane agent to react with the glass matrix of the ceramic, increasing the siloxane bonds (13).

Prior to acid etching, the remaining ceramic surface was protected with glycerine gel. As chipping did not present an exposure of the metallic infrastructure, the adhesion technique only for feldspathic porcelain was employed (12). The bevel and fractured area were etched with 9.6% hydrofluoric acid for 3 min (Figure 5).

Before applying the silane coupling agent, the etched area was washed under copious water for 3 min. A neutralizing agent (IPS Neutralizing Powder, Ivoclar Vivadent) was applied on the etched area, kept for 1 min, washed once more and then dried. One layer of silane coupling agent (Monobond Plus, Ivoclar Vivadent) was applied to the etched ceramic surface (Figure 6), waited for its reaction for 20 s and the solvent was dried with oil-free air.

Adhesive resin (Excite F, Ivoclar Vivadent) was scrubbed on the ceramic surface with a clean microbrush for 20 s. The adhesive layer was air-thinned by aspiration and photo-polymerized for 20 s (Bluephase N, Ivoclar Vivadent: light output: 1200 mw/cm²) (Figure 7). Adhesive increases the wettability of the resin composite on the etched ceramic surface (12). The intra-oral repair was finalized using resin composite (Empress Direct, Ivoclar Vivadent, Shade A2) employing the incremental technique. Each increment was placed with the aid of a metallic spatula (Figure 8) and photopolymerized for 20 s. Incremental application of resin composite helps to control the polymerization shrinkage, increasing the longevity of the repair. The resin composite surface was finished with rubber tips (OptraPol, Ivoclar Vivadent) and polishing paste (Universal Polishing Paste, Ivoclar Vivadent) (Figure 9, 10).

Conclusion
For the success and longevity of intra-oral repair of veneering ceramic with direct resin composite, it is essential to establish a strong and stable adhesion between the resin composite and the remaining surface. Adhesion to glassy matrix ceramics, such as feldspathic porcelain, is durable when the adhesive protocol is properly followed.

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