Intraoral Ceramic Restoration Repair Techniques: Report of 3 Cases

SUMMARY
The authors' intention was to present ceramic restoration repair as a reliable, low-cost and low-risk procedure, by demonstrating 3 cases in the aesthetic zone. Intraoral ceramic repair was chosen for the small porcelain fracture of the maxillary left central incisor and for the large porcelain surface detachment of the maxillary left lateral incisor, since patients did not want to replace the fixed denture. The third case presented an easy way to correct orthodontic treatment relapse when ceramic restoration have already been placed. Gaps formed between maxillary left lateral incisor and canine were closed using the same adhesion protocol.

The sequence of treatment is demonstrated altering the basic repair protocol according to the needs of each case. The final outcome of the repair with composite resin was an aesthetic alternative and the patients were fully satisfied.

Keywords: Ceramic, repair; Adhesion; Silane; Sandblasting

Introduction
Ceramic restorations have been part of dental prosthetics for many years as they are characterized by superior aesthetics, functionality and biocompatibility. Feldspathic porcelain with a metallic framework, ultra-low fusing porcelains and reinforced ceramics evolved over decades. Metal-ceramic fixed restorations, probably the most frequently used, can survive up to 25 years. But the inherent brittleness of porcelain and the kind of cements used for insertion might result in fracture and consequently failure. Fractures are caused by trauma, acute accidents, chronic habits (bruxism), flaws and contamination in the original porcelain fabrication, or inadequate tooth thickness during tooth preparation. In these situations, ceramic restoration repair is a reliable, low-cost and low-risk procedure. Moreover, the same protocol can be used for interdental gap closure between already placed ceramic restorations.

Case Reports

Description of the Technique
- Treatment of ceramic and metal surface

Removal of the glazed ceramic layer is suggested in order to allow the exposure of the underlying ceramic layer, which is more reactive and has greater contact surface area. This can be made mechanically (roughening with diamond burs), chemically (sandblasting, acid etching), or with the combination of both.

Roughening with diamond burs should be performed at high-speed to avoid production of cracks and fissures in ceramic margins from the vibration of low-speed handpieces. Diamond bur roughening should be combined with other surface treatment methods in order to attain higher adhesion values.

Sandblasting is usually performed with a high-speed stream of purified aluminium oxide particles (30-250 μm) delivered by air pressure (2-3 bars or 30-42 psi) for approximately 15 seconds. Treatment of metal surface, if showing, is done by sandblasting, in order to improve retention by eliminating oxides and greasy materials and by increasing surface area. Particles could also be 30 μm silica coated (SiO₂). This results in deposition of a molecular coating of alumina coated with silicic acid on the alloy surface, providing a reliable mechanical retention and physicochemical bond between the alloy and the composite (CoJet-Sand, CoJet System, 3M-ESPE). Allow drying for 5 minutes and do not use a water-syringe.
because of possible water or oil contamination. Rubber dam isolation and high power suction systems prevent soft tissue injuries and control the emission and spread of the aluminium oxide particles over the operative area. Acid etching yields a clean surface and produces micro-retentions that increase bond strength of the etched substrate, as in composite resin adhesion protocol. Metal is cleaned but not affected in another way. The following acid formulations can be used:

- 37% phosphoric acid - it does not produce any type of alterations on the ceramic morphology, but it can be used to clean the ceramic surface after mechanical roughening. It is also used where tooth structure is associated, as a part of the standard adhesion protocol.

- Hydrofluoric acid - it creates surface irregularities acting on the silicon dioxide (SiO₂) of the porcelain vitreous phase. Concentration varies between 5-10% and etching time between 20 seconds-10 minutes, depending on ceramic type. Manufacturer's instructions are followed. Hydrofluoric acid however is very aggressive to soft tissues and care should be taken. No consensus has yet been reached regarding its use, as similar results are obtained with other surface treatment methods.

- 1.23% acidulated phosphate fluoride - its effect on ceramics is similar to that of hydrofluoric acid, requiring more time but without the aggressiveness towards soft tissues, attacking glass probably due to selective release of sodium ions, interrupting the silica network. Etching time varies from 5-15 minutes. The etched porcelain does not have a frosted appearance after etching, as with hydrofluoric acid.

Metal surface treatment

Besides sandblasting, metal primer must be applied on the showing metal surface in order to bond the resin onto the metal. If metal is high-noble or noble, bond strengths can be enhanced by tin plating the exposed metal. If the metal is determined to be base metal, tin plating is not necessary. The type of metal primer is specified by the type of alloy and its ingredients.

Silanization

Ceramic primers containing silane are applied prior to the adhesive agent and used in order to improve the chemical bond between porcelain and composite resin. Silane consists of a carbon chain that presents a SiO₂ group in a functional end. As a result, the functional end is joined with the porcelain, thus maintaining the carbon chain free for bonding to the resin. Silanization should be used in conjunction with other surface treatments (roughening with diamond burs, sandblasting, acid etching) and the resin adhesive system. There are no reports of disadvantages in the use of silane agents except for the short shelf life, being 12-18 months.

Application of unfilled resin

If the patient has the fractured piece of porcelain, it can be re-bonded to the crown after using the etchant, silane and unfilled resin on the piece too.

Application of opaquer

Resin composites systems which offer opaque and translucent resins should preferably be used to re-establish aesthetics after ceramic repair. Flowable resin in opaque shade seems to be very practical.

Application of composite resin shades according to manufacturer's recommendations, occlusal adjustment and polish.

Case 1 (Incisal and Cervical Porcelain Fracture)

A 47-year-old male patient with a 4-unit metal-ceramic fixed partial denture presented with a fracture on the incisal edge and cervical margin of the maxillary left central incisor and on the joint between the maxillary left central incisor and maxillary right central incisor palatally (Fig.1). Intraoral ceramic restoration repair was selected as the treatment of choice. Cotton rolls were used for isolation and roughening of the ceramic surface was done with high speed bur. 10% hydrofluoric acid was applied for 2 min on the ceramic and metal surface, followed by thorough rinsing for 30s and drying (Fig. 2), application of metal primer for 1 min, silanization by silane application for 1 min, and application of unfilled resin and polymerization with a LED curing unit (Elipar S10, 3M-ESPE). Flowable opaquer was applied in 2 thin layers (Fig. 3) following by incremental placement of dentin and enamel A3 composite resin shades (Fig. 4). Occlusal adjustment was made and finishing and polishing were done with the appropriate tips (Fig. 5).

Figure 1. Initial aspect of the small fracture in the distal angle of the maxillary left central incisor

Figure 2. Etching with 10% hydrofluoric acid
Case Report 2: Large Porcelain Surface Detachment

A 50-year old female patient with a 6-unit metal-ceramic fixed partial denture presented with total buccal surface detachment of maxillary left lateral incisor (Fig. 6). Intraoral ceramic restoration repair was selected as the treatment of choice. Light cured rubber dam and lip retractor were used for isolation. 10% hydrofluoric acid was applied for 2 min on the ceramic and metal surface (Fig. 7), followed by thorough rinsing for 30s and drying. Sandblasting with 30μm silica oxide particles (CoJet Sand, 3M-ESPE) for 15s using a chairside air-abrasion device (CoJet System, 3M-ESPE) was done (Fig. 8). Metal primer was applied for 1min, followed by silanization by silane application for 1 min and application of unfilled resin and polymerization with a LED curing unit (Elipar S10, 3M-ESPE). Opaquer was applied in 2 thin layers (Fig. 9) following by incremental placement of dentin and enamel A3 composite resin shades. Occlusal adjustment was made and finishing and polishing were done with the appropriate tips (Fig. 10).
Case Report 3: Gap Closure between Porcelain Restorations

A 42-year old male patient underwent orthodontic treatment and placed all-ceramic crowns in maxillary teeth. But orthodontic treatment relapsed and a small gap was formed between the maxillary left lateral incisor and canine (Fig. 11). Intraoral composite resin addition on ceramic was selected as the treatment of choice for the repair. Ceramic surface was roughened with high speed diamond bur (Fig. 12). Light cured rubber dam and lip retractor were used for isolation. 10% hydrofluoric acid was applied for 2 min on the ceramic surface (Fig. 13), followed by thorough rinsing for 30s and drying. Silanization was achieved through silane application for 1 min and application of unfilled resin followed, polymerized with a LED curing unit (Elipar S10, 3M-ESPE). A1 shade of composite resin was placed incrementally (Fig. 14) until the desired shape of incisor and canine was formed and polymerized with a LED curing unit (Elipar S10, 3M-ESPE). Occlusal adjustment was made and finishing and polishing were done with the appropriate tips (Fig. 15).
Discussion

Fracture can extend to ceramic only with or without metal showing, or include metal framework. The simplest repair is if the fracture is limited in the porcelain. If tooth structure is revealed, the process should be slightly altered, as clinical usage of hydrofluoric acid on dentine should be avoided25. Likewise, a stable and durable bond to ceramics that contain minimal or even no silica, such as aluminium or zirconium oxide ceramics, requires other surface pre-treatment techniques or modified luting cements7, although it seems that silane coating or silanization improve the longevity of repaired zirconia crowns1. With similar procedures, fractures in all-ceramic and in Cerec restorations can be fixed, but since there are no clinical trials of these restorations of more than 5 years3,29, it is questionable whether a repair or a replacement should be decided. Generally the basic protocol steps should be individualized to meet the needs of each special repair case, as demonstrated in the cases described.

Within the limitation of the studies, it seems that acid etching and silanization create high bond strengths between feldspathic porcelain and resin composite cement11,24. Surface conditioning with hydrofluoric acid and silanization or silane coating with the use of CoJet and silanization, used as different options in the 2 cases described, exhibited no differences in shear bond strength12. On the contrary, Ozcan et al17 showed that the repair method based on silane coating and silanization was superior to other repair strategies without silane coating application. Combination of silane primer and unfilled resin, shows the greatest magnitude of bond strength in comparison with silane only, or unfilled resin only6. Others, however, state that use of adhesive resin does not improve resin adhesion to etched and silanized ceramic after long term thermocycling and water storage19. Research shows that sandblasting with aluminium oxide particles is a better method of preparing the surface than roughening with diamond burs30, but some state that it is not superior to other kits without it10. Acid etching time and type of bonding agent influence bond strength, and self-etching bonding agents should be avoided2. Acid etching, sandblasting with aluminium oxide or silica coated particles, show no differences in fracture loads on repaired surfaces; however, addition of a layer of glass fibre-reinforced composite increased the load level16. CoJet system sandblasting offers the highest bond strength values for the metal substrate, in comparison to bonding agents4. However, it is also stated that micro-mechanical cohesion is not enough and that macro-mechanical retention should be prepared where possible10. Bond strengths between composite and porcelain resulting from silanization seem to increase over time, as an effect of water storage (Berry et al. 1999) and pre-polymerized resin structures obtain higher shear bond strength values, compared to in situ resin polymerization26.

Intraoral ceramic repairs present a variety of difficulties and possible failures. The most important issue is to explain to the patient the cause of the initial restoration failure, to proceed in possible changes and include the challenge of anticipating longevity of the repair. The adhesive protocol needs to be abided by the practitioner and physical and mechanical behaviour of the very different materials used should be associated. Metameric effect between dental porcelain and resin composite8 and colour stability of repairing materials over time23, should also be considered but hybrid resin composites are best chosen for the repair procedure, as they are best suited due to their physical, mechanical and optical properties. Additionally, soft tissues should be protected by the use of high-speed burs and acid etchants in the operation field21. Moreover, function and thermal changes are detrimental to all bonded restorations22.

Conclusion

When attempting to repair a fractured ceramic restoration, it is important to determine the reason for failure and eliminate it, or else the repair will probably fair no better than the original restoration. The patient has to be informed for the possible risks and alternative solutions. Repairing ceramic restoration fractures with composite resins has some major advantages, as it preserves the main body of the restoration and avoids extra unnecessary cut of the tooth, making the treatment inexpensive and easy when no replacement or fabrication of an over-casting is possible. Dental practitioners should be familiar with the technique, as it can be used in aesthetic restorations as shown, but keeping in mind the fact that all clinical procedures have advantages and disadvantages.
References


