Short Communication

Resin Microtensile Bond Strength to Feldspathic Ceramic: Hydrofluoric Acid Etching vs Tribochemical Silica Coating

Fernanda Pelógia, DDS, MS[a]/Luiz Felipe Valandro, DDS, MS, PhD[b]/Vinicius Brigagão, DDS, MS[c]/
Maximiliano Piero Neisser, PhD[d]/Marco A. Bottino, PhD[e]

This study aimed to compare the microtensile bond strength of resin cement to alumina-reinforced feldspathic ceramic submitted to acid etching or chairside tribochemical silica coating. Ten blocks of Vitadur-α were randomly divided into 2 groups according to conditioning method: *(1)* etching with 9.6% hydrofluoric acid or *(2)* chairside tribochemical silica coating. Each ceramic block was luted to the corresponding resin composite block with the resin cement (Panavia F). Next, bar specimens were produced for microtensile testing. No significant difference was observed between the 2 experimental groups (Student *t* test, $P > .05$). Both surface treatments showed similar microtensile bond strength values. *Int J Prosthodont 2007;20:532–534.*

Clinical performance of glass all-ceramic restorations (inlays, onlays, or laminate veneers) depends on the bond of the resin cements to the restorative materials and hard tissues.[1,2] Surface conditioning should be used to enhance the bond to surface ceramic.

Acid-sensitive ceramics or glass ceramics (feldspar, leucite, and lithium disilicate ceramics) undergo surface conditioning with hydrofluoric (HF) acid, yielding a micromorphologic pattern that contributes to micromechanical bonding. Further, silane application may promote chemical bonding between ceramic and resin materials because of its bifunctional characteristics.[3] However, the hazardous and caustic effects on soft tissues and the danger for clinical use of HF acid gels are well known.

Tribochemical silica coating via airborne particle abrasion of silica oxide particles combined with silanization has been introduced for the conditioning of surface ceramic.[3,4] After air abrasion, a coating of silica oxide embeds the surface. Consequently, the application of silane coupling agent bonds not only to the silicated surface, but also to the resin cement.[3–5] This conditioning method has been used to achieve better bonding to acid-resistant ceramics, but can also be applied to the surface of alumina-reinforced feldspathic ceramics that are composed of 50% glass and 50% crystalline phase (aluminum oxide). These materials are used to make all-ceramic restorations.

The aim of this study was to compare the microtensile bond strength (μTBS) of a resin cement to alumina-reinforced feldspathic ceramic submitted to acid etching or chairside tribochemical silica coating. The null hypothesis was that the 2 conditioning methods provide similar bond strength.

[a]*Graduate Student in Prosthodontics, São Jose dos Campos Dental School, São Paulo State University, Brazil.*
[b]*Associate Professor, Federal University of Santa Maria, Department of Restorative Dentistry, Santa Maria, Brazil.*
[c]*Graduate Student in Dentistry, Dental School, University of Taubaté, Brazil.*
[d]*Associate Professor and Researcher, MS Graduate Program, Dental School, University of Taubaté, Brazil.*
[e]*Professor and Chair, São Paulo State University, Department of Dental Materials and Prosthodontics, São Jose dos Campos Dental School, Sao Jose dos Campos, Brazil.*

Correspondence to: *Dr Luiz Felipe Valandro, Federal University of Santa Maria, School of Dentistry, Department of Restorative Dentistry, Division of Prosthodontics, Rua Marechal Floriano, 1184, 97015-372, Santa Maria, Brazil. E-mail: lfvalandro@hotmail.com*

Figs 1a and 1b Representative micrographs (×5,000) of ceramic surfaces conditioned by 1 of 2 methods. **(a)** Surface conditioned with HF acid etching; the silica oxides were attacked and dropped from the surface, yielding the micromorphologic patterns for microretentive bond to resin cement. The *arrow* indicates strong and deep conditioning. (**b)** Surface abraded with silica oxide particles. The *arrows* indicate the sandblasted silica oxide fixed to the surface.

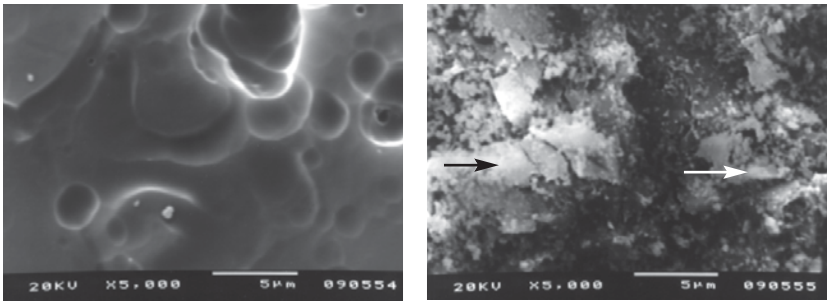

Table 1 Surface Conditioning Methods

Group	Conditioning method
1	Etching with 9.6% HF acid* for 1 min + rinsing and drying + silane† application for 5 min
2	Chairside tribochemical silica coating with 30-µm silica oxide‡ + silane† application for 5 min

*Conditioner, Dentsply.
†ESPE-Sil, 3M ESPE.
‡Micro-Etcher, Danville; perpendicular to the surface at a distance of 10 mm for 20 s at a pressure of 2.8 bar; followed by CoJet-Sand, 3M ESPE.

Table 2 Mean Values (SDs) of the Microtensile Bond Strength Results*

Group	σ (MPa)
1	17.9 (2.9)
2	15.5 (2.4)

*No significant differences were found ($P > .05$).

Materials and Methods

Twelve blocks ($6 \times 6 \times 4$ mm^3) of an alumina-reinforced feldspathic ceramic (Vitadur-α, Vita Zahnfabrik) were fabricated according to the manufacturer's instructions. The surfaces were ground finished to 1,200-grit silicone carbide abrasive. Ten blocks were duplicated in hybrid composite (W3D Master, Wilcos) and ultrasonically cleaned in distilled water for 3 minutes. They were then randomly divided into 2 groups (n = 5) according to surface conditioning method (Table 1), and one surface (6×6 mm) of each block was conditioned.

Each ceramic block was luted to the corresponding resin composite block with the resin cement (Panavia F, Kuraray) according to the manufacturer's recommendation under vertical load (750 g) for 10 minutes. During this period, excess material was removed and each surface was light polymerized for 40 seconds (XL 3000, 3M ESPE; light output: 500 mW/cm^2). Oxygen blocking agent (Oxyguard, Kuraray) was applied to all cementation surfaces. The blocks were washed and rinsed with water, and the light polymerization was again carried out for 40 seconds on the interface zones. The specimens were stored in distilled water at 37°C for 24 hours.

Production of Untrimmed Beam Specimens

The blocks were bonded with cyanoacrylate glue (Super Bonder Gel, Loctite) to a metal base that was coupled to a cutting machine. The blocks were positioned perpendicular to the diamond disk. Slices were obtained using a slow-speed diamond disk (no. 34570, Microdont) under water cooling. The peripheral slices (0.5 mm) were eliminated in case the results could be influenced by either an excess or insufficient amount of resin cement or the irregularities at the interface.

Thereafter, 4 sections (0.8 ± 0.1 mm in thickness) were obtained. Each section was rotated 90 degrees, fixed again to the metallic base, and sectioned (0.8 ± 0.1 mm in thickness). Thus, 16 untrimmed beam specimens (adhered area: approximately 0.6 mm^2; length: approximately 8 mm) were obtained from each block.

Microtensile Bond Strength Test

The ends of each bar specimen were fixed with cyanoacrylate adhesive in an adapted device. µTBS was then determined using a universal testing machine (EMIC DL-1000, EMIC) (1 mm/min^{-1}). The bond strength σ (MPa) was calculated according to the formula $\sigma = L / A$, where L is the load for rupture of specimen (N) and A is the interfacial area (mm^2) (measured with a digital caliper before testing). The mean bond strength values from specimens of each block (n = 5) were analyzed using the Student *t* test ($\alpha = .05$).

Microscopic Analysis

Fractured surfaces were observed using a light microscope (Zeiss MC 80 DX, Zeiss; ×50 to ×100 magnification) to determine the type of failure (Fig 1).

Micromorphologic analysis

Additional ceramic specimens (1 specimen per group) were submitted to the 2 conditioning methods. The specimens were not silanized. They were analyzed using scanning electron microscopy (JEOL–JSM–T330A, Jeol) to observe the topographic patterns achieved by the treatment methods.

Results

No significant difference was observed between the 2 experimental groups ($P > .05$) (Table 2). The null hypothesis was accepted. Examination of the fractured surfaces under optical microscope revealed that all failures occurred at the adhesive zone[6] at the resin cement–ceramic interface.

Conclusions

µTBS to alumina-reinforced feldspathic ceramic showed similar values after HF acid etching plus silane or tribochemical silica coating.

References

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Literature Abstract

The efficacy of posterior three-unit zirconium oxide–based ceramic fixed partial dental prostheses: A prospective clinical pilot study

This prospective pilot study evaluated the efficacy of zirconia-based posterior 3-unit fixed partial dentures (FPDs). Sixteen patients were chosen based on defined inclusion criteria to have 20 FPDs replacing the second premolar or first molar. Abutments were prepared in a standardized manner. Fabrication of provisional restorations, impression taking, and frameworks were standardized as well. Two evaluators independently evaluated the fracture resistance, marginal integrity, and marginal discoloration. The assessments were repeated at 2 weeks and 6, 12, 18, 24, and 36 months. Parameters were evaluated using modified Ryge clinical criteria. Alpha and Bravo scores were defined as success while Charlie and Delta were considered as failure. Five abutments became nonvital prior to the definitive cementation. Seven abutments had postoperative sensitivity that subsided 3 months after cementation, except for one that required a root canal treatment through the retainer. In terms of fracture resistance, 15 FPDs were rated Alpha and 5 were rated as Bravo. For the marginal integrity and marginal discoloration, all restorations were rated as Alpha except for one rated as Bravo in term of marginal integrity. This study is unique in that it is one of few that addresses the success of 3-unit all-ceramic FPDs; nonetheless, it is limited by the relatively small sample size, absence of control, and short-term evaluation (18 to 36 months). Considering the alternative options of metal-ceramic FPDs or dental implants, the tooth vitality or postoperative sensitivity associated with tooth preparation for all-ceramic restorations, the requirements for connector dimension (9 mm), and the absence of long-term results (5 years or more), clinicians are cautioned to approach this treatment option with care.

Ariel JR, Gerard JC, Narong P, et al. *J Prosthet Dent* 2006;96:237–244. **References:** 30. **Reprints:** Dr JR Ariel, University of Washington, Dental School, 1959 NE Pacific St., BOX 357456, Seattle, WA 98195-7456. Fax: 206 543 7783—*Majd Al Mardini, Hamilton, Canada.*