Effect of Silica Coating on Flexural Strength of Fiber Posts

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Purpose: Fiber-reinforced composite (FRC) posts can be air-abraded to obtain good attachment to the resin cement. This study tested the effect of silica coating on the flexural strength of carbon, opaque, and translucent quartz FRC posts. **Materials and Methods:** Six experimental groups of FRC posts (n = 10 per group) were tested, either as received from the manufacturer or after chairside silica coating (30-μm CoJet-Sand). **Results:** There was no significant difference in the flexural strength of nonconditioned (504 to 525 MPa) and silica-coated (514 to 565 MPa) specimens ($P >$ .05) (analysis of variance). The type of post did have a significant effect on flexural strength ($P <$ .05). **Conclusion:** Chairside silica coating did not affect the flexural strength of both carbon and quartz FRC posts. *Int J Prosthodont 2006;19:74–76.*

Restorations of endodontically treated teeth frequently require anchorage with root posts. Recent studies suggest that the elastic modulus (E) of the posts should be similar to that of root dentin to reduce the risk of root fracture.[1] As an alternative to metallic posts, fiber-reinforced composite (FRC) posts were introduced because their biomechanical properties are often similar to those of dentin. Bonding such posts to the root using dentin adhesive systems is difficult owing to the high configuration factor and the morphology of dentin substrate.[2] In vivo studies have confirmed some failures at the adhesive-fiber interface.[3] This problem was partly solved by air-abrading the posts with 30-μm silica particles (silica coating) followed by silanization, which yields to a potential of micromechanical and chemical bonding of the luting cement to the FRC posts or other substrates.[4,5] Air-abrasion methods work as a function of pressure and duration and thus may weaken the posts. Since maintenance of the original flexural strength of the FRC posts is fundamental for long-term clinical success, the objective of this study was to test the effect of silica coating on the flexural strength of carbon, opaque, and translucent quartz FRC posts.

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Materials and Methods

Six groups, each containing 10 FRC posts (n = 60; n = 10 per group), were formed for the experiment (Table 1). In the control group, FRC posts as received from the manufacturer, without additional conditioning, were subjected to 3 point-bending tests (crosshead speed: 1 mm/min-1) in a universal testing machine. The experimental method employed tribochemical silica coating, in which the specimens were conditioned using the intraoral air abrasion device (Micro-Etcher, Danville) at 2.8 bar pressure from a distance of approximately 10 mm for about 15 seconds with 30-μm silicon oxide (CoJet-Sand, 3M/ESPE) while rotating the post manually until its surface appeared matte under visual inspection.

Table 1 Characteristics of FRC Posts Used for the Experiments

Root post systems* and experimental groups (n = 10)	Fiber/resin matrix	Diameter of post	Fiber thickness
C-Post[1†]	Carbon/epoxy resin	1.4 mm	~5 μm
Group 1: nonconditioned			
Group 4: silica coated			
AEstheti-Plus[2‡]	Opaque quartz/epoxy resin	1.4 mm	~10 μm
Group 2: nonconditioned			
Group 5: silica coated			
Light-Post[3§]	Translucent quartz/epoxy resin	1.4 mm	~10 μm
Group 3: nonconditioned			
Group 6: silica coated			

*All manufactured by Bisco.
†Batch #: 0200002557; ‡Batch #: 010000430; §Batch #: 0200005764.

Table 2 Flexural Strength (MPa) of the FRC Posts With and Without Surface Conditioning

Group	σ (SD)*
1	504^b (10.4)
2	565^a (18.9)
3	525^b (19.3)
4	514^b (35.1)
5	561^a (18.5)
6	514^b (12.3)

*The same superscripted letters indicate no significant differences ($P > .05$).
SD = standard deviation.

Flexural strength values (σ) were calculated with the formula $\sigma = 8FL/\pi d3$, where F is the force applied (Kgft), L is the length of the cylindric portion of the post (span = 6 mm), π is 3.14, and d (mm) is the average diameter of the post (1.4 mm). The data were converted from Kgft/mm to MPa (N/mm^2). Statistical analysis was performed using Statistix 8.0 for Windows (Analytical Software). The data were analyzed using 2-way analysis of variance (ANOVA) and the Tukey test ($\alpha = .05$).

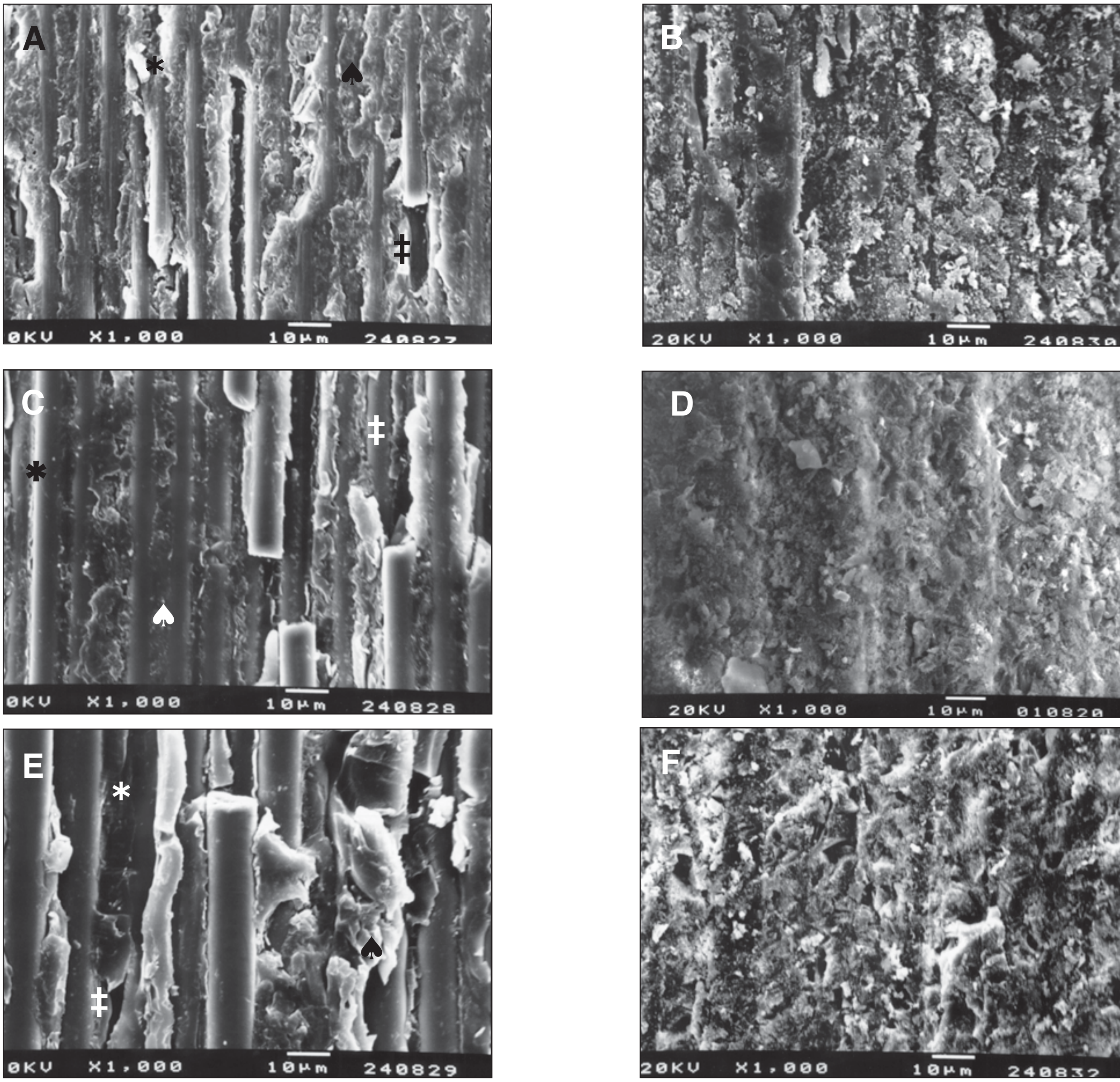
Two FRC post surfaces, one from the nonconditioned group and the other from the conditioned group, were further evaluated to observe topographic changes under scanning electron microscope (SEM) (Jeol JSM T330A) (×1,000 magnification).

Results

The flexural strength data (mean ± standard deviation) for the experimental groups are summarized in Table 2. Two-way ANOVA showed no significant differences in flexural strength between the nonconditioned (504 to 525 MPa) and silica-coated (514 to 565 MPa) specimens ($P > .05$). The post type demonstrated significant effect on the flexural strength ($P < .05$). The highest flexural strengths were found on both nonconditioned (565 MPa) and silica-coated (561 MPa) opaque quartz FRC posts (Aestheti-Plus) and the lowest on carbon posts (504 to 514 MPa for nonconditioned and silica-coated samples, respectively). SEM analysis at ×1,000 magnification, which complemented the flexural strength tests, revealed that exposed fiber/matrix surfaces before surface conditioning were evenly covered with abundant silica particles after silica coating (Fig 1).

Conclusion

1. Chairside silica coating did not impair the flexural strength of either carbon or quartz FRC posts.
2. No significant difference was found in flexural strength between translucent quartz FRC posts and carbon FRC posts. The opaque quartz FRC posts tested in this study exhibited higher flexural strength than did the translucent FRC posts.



Figs 1a to 1f SEM photographs of nonconditioned C-Post, AEstheti-Plus, Light-Post (A, C, E, respectively). The same post surfaces (B, D, F, respectively) were evenly covered with abundant silica particles after chairside silica coating. Asterisk = fiber; ♠ = matrix resin; ‡ = empty space.

References

1. Martinez-Insua A, da Silva L, Rilo B, Santana U. Comparison of the fracture resistances of pulpless teeth restored with a cast post and core or carbon-fiber post with a composite core. J Prosthet Dent 1998;80:527–532.
2. Bouillaguet S, Troesch S, Wataha JC, Krejci I, Meyer JM, Pashley DH. Microtensile bond strength between adhesive cements and root canal dentin. Dent Mater 2003;19:199–205.
3. Malferrari S, Monaco C, Scotti R. Clinical evaluation of teeth restored with quartz fiber-reinforced epoxy resin posts. Int J Prosthodont 2003;16:39–34.
4. Özcan M, Pfeiffer P, Nergiz I. A brief history and current status of metal/ceramic surface conditioning concepts for resin bonding in dentistry. Quintessence Int 1998;29:713–724.
5. Valandro LF, Andreatta Filho OD, Valera MC, Araújo MAM. The effect of adhesive systems on the pull-out strength of a fiber glass-reinforced composite post system in bovine teeth. J Adhesive Dent (in press, 2006).