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Evaluation of different surface treatments on fiber post cemented with a self-adhesive system

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ABSTRACT

Surface treatment of fiber-reinforced posts can increase adhesion, especially on the post/resin cement interface. The purpose of this in vitro study was to evaluate the effect of different surface treatments on fiber post cemented with a self-adhesive system. Sixty fiberglass epoxy resin posts were cleaned, dried and divided into 6 groups (n = 10): Control (no surface treatment), silane (silane coupling agent was applied homogeneously on surface), 24% hydrogen peroxide (H_2O_2) (immersion during 1 min), blasting (blasting with aluminum oxide for 30 s), NH_3 plasma (plasma treatment for 3 min) and HMDSO plasma (plasma treatment for 15 min). After the treatments, posts were inserted into a silicon matrix that was filled with the resin cement RelyX U200. Afterwards, the post/cement specimens were cut perpendicularly to the long axis of the posts into six 1.0 mm thick discs and submitted to a push-out bond strength (POBS) test. Failure pattern was classified in 5 types: type I: cohesive in post; type II: cohesive in cement; type III: cohesive post and cement; type IV: adhesive post/cement; and type V: mixed (association between cohesive and adhesive). Data were analyzed by one-way ANOVA and Tukey HSD post hoc test ($\alpha = 0.05$). Silane (15.94 ± 6.5), blasting (13.13 ± 3.6), NH_3 plasma (14.44 ± 4.0) and HMDSO plasma (13.23 ± 5.3) showed higher POBS when compared to control ($p < 0.05$) and similar among them. H_2O_2 (9.40 ± 4.0) treatment showed POBS values statistically similar to control (9.65 ± 3.6). Failures were predominantly cohesive post and cement, type III, in all groups. In conclusion, surface treatments influenced in the adhesion of fiberglass post with the self-adhesive cement RelyX U200. Silane, blasting with aluminum oxide and plasmas (NH_3 and HMDSO) showed results superior to 24% hydrogen peroxide.

1. Introduction

For the restoration of endodontically treated teeth, the use of fiber posts luted with resin cement and combined with composite core build-up materials is becoming very frequent [1].

Self-adhesive cement was developed a decade ago, with the purpose of simplifying the cementation process by assembling all the components into a single product. This combination has resulted in a material that self-adheres to dentin, does not require pretreatment of the surface of the tooth, is simple to implement, and which application can be performed in a single step. Given that the removal of the smear layer is not recommended with most self-adhesive cements, there is increased tolerance to moisture and the release of fluoride ions [2–5].

An important aspect of adhesive procedure for fiber post cementation is that two interfaces are involved, namely, resin cement/root dentin and fiber post/resin cement. The adhesion in both interfaces is crucial for the long-term success of restoration and to the endodontic treatment [6]. Regarding the first interface (root dentine/resin cement), it has been widely investigated using conventional and self-adhesive cements [5,7,8].

Several surface post modifications, including chemical and mechanical treatments, have been proposed to improve adhesion in the fiber post/resin cement interface [9]. Surface treatments include sandblasting using Al_2O_3 particles [10], etching with acidic solution [10,11], hydrogen peroxide [12], silane coupling agents [10,11,13], plasma irradiation [11,14], Er:YAG laser irradiation [15], and ultraviolet irradiation [6].

Concerning the association between fiber posts and the self-adhesive resin cement, fewer studies evaluated this interaction [6,11,16,17]. Regarding RelyX U200, Reza et al. [6] evaluated the influence of ultraviolet irradiation on fiber post surface. The influence of conventional (silane, peroxide and blasting) and plasma treatments on adhesion of fiber post to this resin cement is unknown. This way, the aim of the present study was to evaluate the effect of different surface treatments on fiber post cemented with a self-adhesive system. The null hypothesis tested was that surface treatments, including sandblasting treatment using Al_2O_3 particles, hydrogen peroxide, silane coupling

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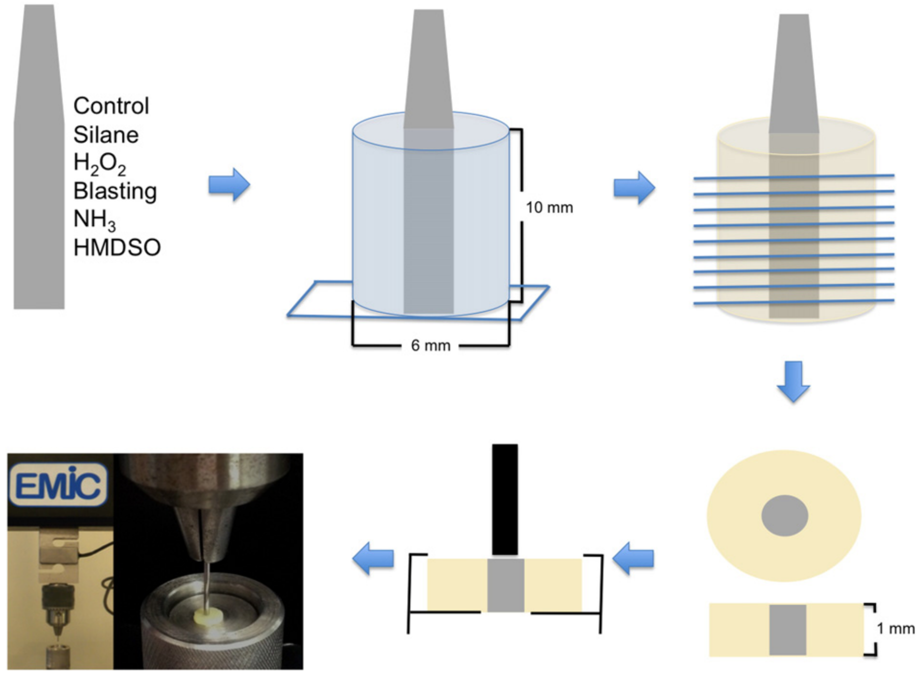

Fig. 1. The setup of push-out bond strength steps.

agent and ammonia (NH_3) and hexamethyldisiloxane (HMDSO) plasmas had no influence in the bond strength of fiber posts to the self-adhesive resin cement RelyX U200.

2. Materials and methods

2.1. Push-out bond strength analysis

2.1.1. Sample preparation

Sixty fiber epoxy resin posts (White Post DC3, FGM, Joinville, SC, Brazil) of 2 mm in diameter and 20 mm in length were used. Posts were submitted to an ultrasonic bath for 10 min in 70% alcohol so that any superficial contaminant would be removed. Afterwards, the posts were divided into 6 groups (n = 10) according to the surface treatment:

Control group: no surface treatment was applied to the fiber posts.

Silane group: a thin layer of silane (Prosil, FGM, Joinville, SC, Brazil) was applied homogeneously on fiber post surface using a microapplicator (Cavibrush, FGM, Joinville, SC, Brazil), waiting 1 min. Then, the surface was dried with air jet for 5 s.

H_2O_2 group: fiber posts were immersed in 24% hydrogen peroxide at room temperature for 1 min, rinsed with 10 mL of distilled water and dried with air jet.

Blasting group: fiber posts were sandblasted with 50 μm aluminum oxide particles (Microetcher II; Danville Engineering, San Ramon, CA, USA) for 30 s at a distance of 20 mm perpendicular to the post surface at the pressure of 0.4 MPa. Afterwards, the fiber posts were rinsed with 10 mL of distilled water and dried with air jet.

HMDSO and NH_3 groups: plasma treatment was performed on the cathode of a diode glow-discharge plasma reactor operating at 13.56 MHz. The vacuum chamber was pumped down to 0.1 Pa, and monomer vapor or gas was allowed to fill the reactor up to 15 Pa. Surfaces were then modified using (i) HMDSO (Sigma Chemicals by Tedia, Rio de Janeiro, Brazil) for 15 min and (ii) NH_3 (Sigma Chemicals by Tedia, Rio de Janeiro, Brazil) for 3 min. Both surface modifications were accomplished at −280 V self-bias voltage (VB). At the end of the process, radiofrequency was turned off and the system allowed to cool down before exposure of the samples to air.

After the treatments, the cylindrical portion of fiber posts for each group were inserted into a silicone matrix (10 mm height and 6 mm of internal diameter), positioned upon a transparent adhesive tape, with their upper cylindrical faces positioned in the center of the matrix (n = 10). Then, the silicon matrix was fully filled with the resin cement (RelyX U200, 3M ESPE, St. Paul, MN, USA) in order to build up a core around the fiber post. The resin cement was cured for 40 s with an irradiance of 500 mW/cm^2 (Optilight LD MAX, Gnatus, Ribeirão Preto, SP, Brazil) in four positions spaced of 90° in the silicone matrix diameter and through the top of the fiber posts.

2.1.2. Push-out bond strength test

After the matrix was removed, the resin cement-fiber post blocks were cut perpendicularly to the long axis of the posts into 1.0 mm thick discs using a diamond saw under water cooling (Isomet 1000, Buëhler, Lake Bluff, IL, USA). The first and the last slice of each block were discarded. A total of four discs were analyzed per sample, totaling 40 discs per group. The exact thickness of each disc was checked with a digital caliper (MPI/E-101, Mitutoyo, Tokyo, Japan).

Table 1
Treatments on fiber post surface.

Groups	Treatment
Control	Control - no surface treatment
Silane	Silane coupling agent was applied homogeneously on surface
H_2O_2	24% hydrogen peroxide for 1 min
Blasting	Blasting with aluminum oxide for 30 s
NH_3	NH_3 plasma treatment for 3 min
HMDSO	HMDSO plasma treatment for 15 min

Table 2
Mean, median and standard deviation values (MPa) of the different groups.

Groups	Mean	Median	Std. deviation
Control	9.648415^b	8.589172	3.6378658
Silane	15.935862^a	14.267902	6.5315797
H_2O_2	9.400132^b	8.190005	3.9823654
Blasting	13.133998^a	13.295602	3.5748676
NH_3	14.441980^a	14.518392	4.0386371
HMDSO	13.235348^a	11.455415	5.2826789

^{a,b}Different letters indicate statistically significant differences (Tukey HSD test; $p < 0.05$).