Effects of Photodynamic Therapy on the Adhesive Interface of Fiber Posts Cementation Protocols

Anna Thereza Peroba Rezende Ramos, DDS, MSc, Lauriê Garcia Belizário, DDS, MSc, Ana Carolina Venção, DDS, MSc, PhD, Keren Cristina Fagundes Jordão-Basso, DDS, MSc, PhD, Alessandra Nara de Souza Rastelli, DDS, MSc, Marcelo Ferrarezi de Andrade, DDS, MSc, PhD, and Milton Carlos Kuga, DDS, MSc, PhD

Abstract

Introduction: The aim of this study was to evaluate the effects of photodynamic therapy (PDT) on the bond strength and dentinal penetrability of cementation protocols using conventional resin cement (Relyx ARC; 3M ESPE, St Paul, MN) or self-adhesive (Relyx U200, 3M ESPE) after the glass fiber post cementation. **Methods:** Forty human canine roots were endodontically treated and prepared for a fiber post. The roots were divided into 4 groups according to the cementation protocol and PDT use: conventional cement (CC), Relyx ARC; self-adhesive cement (SAC), Relyx U200 cement; PDT/CC, PDT + Relyx ARC; and PDT/SAC, PDT + Relyx U200. After cementation of the fiber posts, the roots were cross sectioned, and then specimens from the cervical, middle, and apical thirds of the prosthetic space were obtained. The specimens were submitted to the pushout test and dentinal penetration evaluation of the cementation protocol using laser confocal microscopy. **Results:** PDT/CC presented the lowest bond strength to root dentin in the cervical third ($P < .05$). In the middle and apical thirds, all groups presented a similar bond strength ($P > .05$). PDT/CC presented the lowest dentinal penetration of the adhesive system in the cervical and apical thirds ($P < .05$). **Conclusions:** PDT presented negative effects on the bond strength to dentin in the cervical third after cementation using Relyx ARC and on the dentinal penetrability of the etch-and-rinse adhesive system in the cervical and apical thirds of the prosthetic space. *(J Endod 2018;44:173–178)*

Key Words

Bond strength, fiber posts, photodynamic therapy, push-out bond strength, self-adhesive cement

Significance

Microbial contamination is a common clinical situation during post space preparation that compromises the success of endodontic treatment. Antisepsis protocols have been recommended; however, it is still unclear whether these protocols affect post adhesion.

Intracanal preparation of the prosthetic space for a fiber post requires a partial removal of root canal obturation. During this procedure, local contamination may occur, which compromises the success of endodontic and/or restorative treatments (1, 2). Sodium hypochlorite and chlorhexidine digluconate have been recommended for prosthetic space irrigation, but they have shown negative effects on the bond strength of the resin cements to root dentin (3–5).

Free radicals participate in the polymerization process of resinous compounds inducing chemical reactions in the methacrylate structure (6). Thus, the degree of conversion and the adhesion of resinous materials to the dentin are compromised by the substances that interact with these free radicals, such as sodium hypochlorite, which degrades in sodium hydroxide and hypochlorous acid and, consequently, leads to singlet oxygen formation (7–9). Moreover, the presence of oxygen can also work as a barrier in the adhesive interface, which hampers hybrid layer formation in dentin (10).

Because sodium hypochlorite may cause undesirable effects, other alternatives have been sought to perform prosthetic space antisepsis. Henceforth, photodynamic therapy (PDT) with specific photosensitizers, such as 0.005% or 0.01% methylene blue, has been an interesting option (11) because of its satisfactory antimicrobial activity in contaminated root canals (12).

The mechanism of action of PDT occurs when a photosensitizing substance absorbs the photons from the irradiation source and their electrons enter an excitation state. Then, the energy is transferred to a specific substrate, forming reactive oxygen species (ROS) (mainly singlet oxygen), which irreversibly oxidize the cellular components causing bacterial death (11, 13, 14). However, it is still unknown whether the free radicals from the ROS release affect the adhesive interface between the dentin and fiber post cement after different cementation protocols, similar to the decontamination protocols using sodium hypochlorite.

Therefore, the aim of this study was to evaluate the effects of PDT using 0.005% methylene blue in the intracanal prosthetic space on the bond strength and intradentinal penetrability using conventional (Relyx ARC; 3M ESPE, St Paul, MN) or self-adhesive (Relyx U200, 3M ESPE) resin cements in different root thirds after the fiber post cemen-

Department of Restorative Dentistry, São Paulo State University (Unesp), Araraquara, São Paulo, Brazil

Address requests for reprints to Dr Anna Thereza Peroba Rezende Ramos, Department of Restorative Dentistry, Araraquara Dental School, São Paulo State University, Humaitá Street, 1680, Araraquara, SP 14801-903, Brazil. E-mail address: annatherezaramos@hotmail.com

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TABLE 1. Materials, Manufacturers, Origin, and Chemical Composition of Materials and Groups

Material	Composition	Groups
Relyx ARC (3M ESPE, St Paul, MN)	Paste A: BisGMA, TEGDMA, zirconia silica, pigments, amine, and photoinitiator system Paste B: BisGMA, TEGDMA, zirconia silica, benzoyl peroxide	Groups 1 and 3
Relyx U200 (3M ESPE)	Base paste: glass powder treated silane, 2-propenoic acid, 2-metil 1,1′-[1-(hydroxymetil)-1,2- ethanodlyl] ester, triethylene dimethylacrylate with silane, glass fiber, sodium persulfate, and t-butyl per-3,5,5–trimethylhexanoate Catalyst paste: silane-treated glass powder, substituted dimethacrylate, silanated silica, sodium p-toluene sulfonate, 1-benzyl-5-phenyl-baric acid, calcium salts, 1,12-dodecane dimethacrylate, calcium hydroxide and titanium dioxide	Groups 2 and 4
Adper Scotchbond Multipurpose (3M ESPE)	Primer: 2-hydroxyethyl methacrylate in aqueous solution (HEMA) and polyalkenoic acid copolymer Adhesive: bisphenol diglycidyl dimethacrylate solution (Bis-GMA), 2-hydroxyethyl methacrylate (HEMA), and Camphorquinone	Groups 1 and 3

tation protocols. The null hypothesis was that PDT does not affect the adhesion and the dentinal penetration of fiber post cements.

Materials and Methods

The study was approved by the Research Ethics Committee of Araraquara School of Dentistry (São Paulo State University-Unesp) (1.603.859). Forty human canines with a similar root anatomy and the absence of structural alterations were selected and kept in 0.1% thymol solution at 4°C.

The dental crowns were removed about 15 mm from the root apex. Then, chemical-mechanical preparation and root canal obturation were performed according to Aranda-Garcia et al (15). After vertical condensation obturation, the cervical opening was sealed using temporary cement (Coltosol; Coltene, Rio de Janeiro, Brazil), and the roots were stored under 100% relative humidity at 37°C for 7 days.

The preparation of the intracanal prosthetic space was performed using a #2 bur (White Post DC System; FGM, Joinville, SC, Brazil) with an 11-mm length. Then, it was irrigated using 10 mL distilled water and dried with absorbent paper points. The specimens were randomly divided into 4 groups ($n = 10$) according to the cementation protocol and PDT application in the prosthetic space: conventional cement (CC), Relyx ARC; self-adhesive cement (SAC), Relyx U200; PDT/CC, PDT + Relyx ARC; and PDT/SAC, PDT + Relyx U200.

The fiber post surface was cleansed using 95% ethanol and etched with 37% phosphoric acid (Power Etching; BM4, Palhoça, SC, Brazil) for 1 minute, and then silane (Prosil, FGM) and dentin adhesive (Adper Scotchbond Multiuso Plus, 3M ESPE) were applied throughout its length. Afterward, the whole set was light cured for 60 seconds (Bluephase; Ivoclar Vivadent, Barueri, SP, Brazil).

PDT was performed in the PDT/CC and PDT/SAC groups. Initially, the prosthetic space was filled with 1000 μL 0.005% methylene blue (Chimiolux; DMC, São Carlos, SP, Brazil), and the root cervical face was covered with laminated paper and left untouched for 5 minutes. After that, an optical fiber (Twin Flex Evolution; MMO Opto-Electronic Equipment, São Carlos, SP, Brazil) was inserted into the entire prosthetic space in a static position, and the prosthetic space was irradiated for 30 seconds using a laser emission source (Twin Flex Evolution) with an output power of 30 J/cm^2.

Afterward, methylene blue was aspirated, and the prosthetic space was irrigated with 3 mL saline solution and dried with absorbent paper points. Before fiber post cementation, 0.01% (by mass) Rhodamine B isothiocyanate was added to the primer of the adhesive system (Adper Scotchbond Multiuso Plus) and used in the CC and PDT/CC groups. Rhodamine B isothiocyanate was also added to the cements and used in the SAC and PDT/SAC groups. All specimens were subjected to laser confocal microscopic evaluation.

Specimens in the CC and PDT/CC groups were acid etched (Power Etching) for 15 seconds, irrigated with distilled water for 30 seconds, and dried with absorbent paper points. The adhesive system (Adper Scotchbond Multiuso Plus) was applied throughout the prosthetic space and light cured for 20 seconds (Bluephase).

The cements were handled according to the manufacturers' recommendations and are described in Table 1. Immediately after the cementation of #2 (FGM) fiber posts, the roots were vertically centralized inside a polyvinyl chloride matrix (16.5 diameter × 15.0-mm length) and checked using a parallelogram (BioArt B2, São Carlos, SP, Brazil). The matrices were filled with polyester resin (Maxi Rubber, Diadema, SP, Brazil), leaving 1.0 mm of the root cervical outside the inclusion. The whole set was left undisturbed for 24 hours. Then, the

TABLE 2. Mean and Standard Deviation of Bond Strength (in MPa) in the Root Thirds of the Prosthetic Space according to Photodynamic Therapy (PDT) Use in the Prosthetic Space

Groups	Cervical	Middle	Apical
Group 1: Relyx ARC	4.21 ± 1.06^a	3.56 ± 1.13^a	3.96 ± 1.96^a
Group 2: Relyx U200	6.09 ± 1.66^a	4.38 ± 2.22^a	3.51 ± 1.54^a
Group 3: PDT + Relyx ARC	2.45 ± 0.78^b	3.27 ± 1.56^a	3.65 ± 1.52^a
Group 4: PDT + Relyx U200	4.55 ± 1.57^a	4.71 ± 1.06^a	4.66 ± 1.37^a

Different superscript letters in the same column indicate significant differences ($P < .05$).

TABLE 3. Mean and Standard Deviation of the Penetration (%) of Fiber Post Cement in Root Dentin in All Thirds of the Prosthetic Space according to the Cementation Protocol and Photodynamic Therapy (PDT) Use

Groups	Cervical	Middle	Apical
Group 1: Relyx ARC	34.85 ± 6.60^a	39.14 ± 19.80^a	16.01 ± 1.46^a
Group 2: Relyx U200	42.89 ± 12.44^a	49.29 ± 19.33^a	19.56 ± 5.18^a
Group 3: PDT + Relyx ARC	11.82 ± 3.02^b	26.52 ± 16.08^a	6.36 ± 3.18^b
Group 4: PDT + Relyx U200	41.28 ± 16.10^a	41.76 ± 23.78^a	18.19 ± 3.21^a

Different superscript letters in the same column indicate significant differences ($P < .05$).