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Research Article

Bonding Strength of Cemented Glass Fiber Pins to Intra-Radicular Dentin with MDP Cements and MDP-Free Cements: 24 Hours Evaluation

Paulo Torban[1], Maria Catarina Almeida Lago[1], Cácio Lopes Mendes[1], Hermínia Anníbal[1], Cláudio Paulo Pereira de Assis[1], Leonardo José Rodrigues de Oliveira[1], Monica Soares de Albuquerque[1], Angela Josefa do Nascimento[1], Polyana Matos Alcântara[1], Eliane Alves Lima[1] and Rodivan Braz[2]*

[1]*Post-Graduation Student, Center of Research in Biomaterials (CPqB), Recife, Pernambuco, University of Pernambuco, Pernambuco, Brazil*

[2]*Adjunct Professor, Center of Research in Biomaterials (CPqB), University of Pernambuco, Pernambuco, Brazil*

***Corresponding Author:** Rodivan Braz, Adjunct Professor, Center of Research in Biomaterials (CPqB), University of Pernambuco, Pernambuco, Brazil.

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Abstract

Objective: Evaluating the bonding strength with push-out test in different root thirds of resin cements at fiberglass post with or without phosphate monomer (MDP).

Methods: 32 roots of bovine incisors were divided into 04 groups with following cements and adhesive systems: RelyX Ultimate + Single Bond Universal (G1); Clear Fill Luting AS + Single Bond Adhesive (G2); Clear Fill Luting AS Self Adhesive (G3); RelyX ARC + Scotch Multi-Purpose Bond (G4). After cementing of the post, the roots were stored in distilled water at 37°C for 24h, then sectioned into six slices of 01 mm of thickness and subjected to push-out test in universal testing machine.

Results: There was no statistic difference between the coronal thirds, except for the G4 ($p > 0.05$).

Conclusion: There was difference of decreasing bond strength in coronary thirds in the apical direction. There was no improvement in adhesion when added phosphate monomers.

Keywords: *Fiberglass Post; Bond Strength; Resin Cement*

Introduction

Endodontically treated teeth commonly present high loss of dental structure. Rely on the amount of lost coronary structure, it becomes necessary the use of an intraradicular retainer with the main purpose of promoting retention and stability of the direct and indirect restoration to dental tissue remain [1-5].

Restorative procedures of endodontically treated teeth has been the aim of many studies in order to know the method that becomes this complex (root, post and core, adhesive system, cement and crown) longer lasting and resistant to masticatory forces and stresses. Planning is primordial to the material selection, whose properties resemble to the root dentin properties, because this may favor the distribution of the transmitted stress to the root canal, as decreasing the risk of catastrophic fractures [6,7].

Fiberglass posts were introduced in Odontology at 1990 instead of others intraradicular posts [8]. Recent studies indicated posts to teeth that requires prosthetics treatment with intraradicular retainer due their advantages such as modulus of elasticity similar to dentin, high fracture strength and favorable esthetics [9-12].

Several studies evidenced that the failure in restorations with fiberglass post is regarding to quality of the adhesion between post/cement and cement/dentin interfaces [13]. Among the characteristics of fiberglass post, the adhesive system and type of resin cement may be an important factor of intraradicular retainer [14] by ability of dental reinforcing structure and avoid the friction between dentin surface and the post [9,15-18].

These functional acid monomers emerge at the adhesive dentistry in the beginning of 80's. They are composed for one or more polymerizable radicals (acrylate, methacrylate, methacrylamide, etc.) and for one or more acid radicals (carboxylic, phosphoric, phosphoric acid, and others). These radicals are separated for a spacer chain that can have different features as hydrophilicity and length. These monomers reduce the pH of the environment becoming acid while the applying of the materials (self-etching adhesives, resin cements and self-adhesive composite resins), promoting the demineralization of the substrate (usually enamel and dentin) and creating micro retention, which they are completed by resins. Thus, the micromechanics that are based the hybrid layer, it is similarly obtained to adhesives of humid technique, but without requirement of etching, washing and drying in separated steps. Beyond the traditional micromechanics bonding, the functional monomers also generate other mechanism of adhesion based on chemical interaction of calcium and hydroxyapatite in bonding surface. This chemical bonding is based on ionic bonding of phosphates anions and cations of metals, mainly with calcium [19,20].

Thus, this *in vitro* study aimed answer the following questions: Does the new MDP resin cements have superior bond strength in the cementation of fiberglass post to root dentin when compared to cement without MDP? Does the MDP association of the adhesive system with the MDP of resin cements potentiate the bond strength to the root dentin?

The null hypothesis of this study is the universal resin cement with MDP has no statistical difference in the bond strength to the root dentin in comparison to the resin cement without MDP.

Methods

The sample consisted of 32 bovine incisors, a number obtained from similar works previously performed, being randomly distributed in 4 groups (n = 8), G1 (adhesive system with MDP + resin cement without MDP); G2 (Adhesive system with MDP + resin cement with MDP); G3 (self-adhesive resin cement with MDP); and G4 (Adhesive system without MDP + resin cement without MDP - control group).

After the selection, the teeth were scrapped with periodontal curettes (Duflex - SS White) and submitted to prophylaxis with pumice stone. They were stored in 0.2% thymol solution at 4°C.

The crowns were sectioned with flexible double - sided diamond disc (KG Sorensen, Barueri, São Paulo, Brazil), perpendicularly to the long axis of the tooth, under irrigation, in order to standardize the samples with root length in 16 mm certified with a pachymeter Digital Isomet 1000 (Precision Saw, Buehler).

The channels were instrumented by the classical technique (manual-mechanics) using second Kerr-type files (Maillefer Instruments SA, Dentsply, Switzerland), the apical stop being obtained with file 80. The working length was established visually, 1mm of the total insertion length of a 15 Kerr file (Maillefer Instruments SA, Dentsply, Switzerland) when it appears in the apical foramen. Irrigation during preparation was performed with 1% sodium hypochlorite.

After instrumentation the roots were washed with physiological saline, the canals aspirated with metal suction cannulas and dried with absorbent paper cones number 80 (Dentsply, Maillefer, Petrópolis, Rio de Janeiro, Brazil). Sealing of the channels was performed using calcium hydroxide-based cement Sealer 26 (Dentsply, Maillefer, RJ, Brazil) using the lateral condensation technique using the main gutta-percha cones and accessories (Dentsply-Herpo, Petrópolis, RJ, Brazil). After cementation, the roots were stored under a temperature of 37°C, in a culture oven for 48 hours.

The channels were first uncoated and enlarged with Gates Glidden (Maillefer-Dentsply-Brazil) No. 4 and No. 5 drill bit at a depth of 12 mm, at low rotation and under constant irrigation with distilled water. After disintegration, the intraradicular preparation was finished with the drill provided by the manufacturer of the White Post DC pin No. 3 (FGM, Joinville, Brazil), corresponding to the diameter of the fiberglass post used in the depth of 12 mm, leaving 4 mm of sealing material. The preparation was also carried out in low rotation and constant irrigation with distilled water. After that, White Post DC # 3 post was introduced into the root canal at the established length to verify adaptation. The canals were cleaned with 1% sodium hypochlorite, washed with distilled water and dried with absorbent paper tips to effect post cementation, according to the different experimental groups.

After preparation, the roots were randomly distributed in 4 groups according to the inclusion of MDP in the formulation of the adhesive system and the resin cement:

- G1: White Fiberglass post was fixed with the Universal Single Bond System and RelyX Ultimate cement.
- G2: White Fiberglass post was fixed with Universal Single Bond System and Clearfil SA Luting cement.
- G3: White Fiberglass post was fixed with Clearfil SA Luting.
- G4 (control): White Post Fiberglass pin was fixed with Scotch Bond Multi-Purpose System and RelyX ARC cement.

All posts were cleaned with gauze moistened with 70° alcohol and dried with air jets. After this cleaning, in groups 3 and 4 Silane Prosil (FGM Joinville, SC, Brazil) was applied for 1 minute with the aid of disposable applicators (Microbrush) according to the manufacturer's recommendation. Groups 1 and 2 were treated with the Universal Single Bond (3M/ESPE, USA) applied with a Microbrush for 20s, and gently dried for 5s, photoactivated for 10s. This adhesive system has in its composition the silane, dispensing the application of this one separately. All roots were painted with black enamel so that the external light did not interfere with the polymerization.

All roots of groups 1, 2 and 4, after root canal preparation, were conditioned by the application of 37% phosphoric acid by 15%, washed with water and dried with absorbent paper tips. Adhesive systems and cementitious agents were handled according to manufacturers' guidelines. The cement was applied to the post and inserted into the root canal. The posts inserted were kept under slight digital pressure for the removal of excesses. The photoactivation was performed through an Optilight LED light unit (Gnatus, Brazil), placing the device tip in the occlusal-apical direction. After cementation, the roots were stored in vials coated with dark adhesive tape (to isolate ambient light for 24 hours in order to avoid interference in the polymerization process of the cements). They were labeled, stoved at 37°C and 100% relative humidity.

G1: The Universal Single Bond adhesive was applied with a Microbrush for 20s. Remove the excess root canal with a paper cone and dry with a light stream of air for 5 seconds. The base paste and the catalyst of the RelyX Ultimate cement were mixed in one blending pad for 20 seconds. After the manipulation, it was inserted into the channel through a Kerr file number 50 (Dentsply - Maillefer) and onto the treated surface of the post. It was then inserted with moderate pressure and held in place. Photoactivated for 40 seconds in the occlusal-apical direction.

G2: The Universal Single Bond adhesive was applied with a Microbrush for 20 seconds. After removed the excess root canal with a paper cone and applied a light stream of air for 5 seconds. The base paste and the Clearfil SA Luting cement catalyst were mixed in one blending pad for 20 seconds. After the manipulation, it was inserted into the channel through a Kerr file number 50 (Dentsply - Maillefer) and onto the treated surface of the pin. Soon after the post was inserted with moderate pressure and held in position. Photoactivated for 40 seconds in the occlusal-apical direction.

G3: Clearfil SA Luting cement was supplied in one block for mixing and manipulated for 10 seconds. The cement was inserted into the channel through a Kerr file number 50 and applied to treat the fiberglass post surface. The post was then inserted with moderate pressure and held in position. Photoactivated for 40 seconds in the occlusal-apical direction.

G4: Scotch bond Multi-Purpose, the primer was applied to the dentin walls of the root canal with a Microbrush, and after 20 seconds, bond was applied. The excesses were removed with paper cone and a light jet of air for 5 seconds and then photoactivated for 20s. The RelyX ARC cement (pulp A and pulp B) was provided in a block for mixing and manipulated for 10 seconds. The cement was applied inside the channel through a Kerr file No. 50 and the fiberglass post surface was treated. The post was then inserted with moderate pressure and held in position. Photoactivated for 40 seconds in the occlusal-apical direction.

The roots with the cemented posts were included in PVC tubes (Tigre SA São Paulo - Brazil.) Placed perpendicular to the base of these tubes with the aid of the eyeliner B2 (Bioart, São Carlos, SP, Brazil) therefore the posts remained fixed. The roots were fixed using a chemically activated acrylic resin (Jet-Classic - Campo Lindo Paulista- Brazil). After 24h, the portions of the cemented roots were sectioned horizontally in a cutting machine (BUEHLER, São Paulo, SP), two 1 mm thick slices were obtained from each third of the root (cervical, middle and apical) in a precision cutting machine (ELQUIP, São Carlos, SP). The first slice of 1.0 mm of the cervical border was discarded in all the roots and then, the slices of each third were made. The slices were identified with blue, red and black pens, according to the corresponding thirds. The markings also served to identify the cervical portion of the slice. After the cuts, the specimens were gauged with a pachymeter to verify the correct thickness.

After sectioning, each root slice was placed in the center of a 3mm aperture steel support, coupled to a universal test machine (Kratos, São Paulo, Brazil), with the coronary facing down. A 1 mm diameter stainless steel rod, only in contact with the central area of the post. A velocity of 0.5 mm/min was applied until the total displacement of the root canal post. The force required for the displacement was obtained in Kilogram/force and converted to Megapascal (Mpa).

The compressive strength was evaluated using ANOVA test and TUKEY post-test, taking into consideration the following factors: material and root third. The Levene and Kolmogorov-Smirnov tests ($\alpha = 0.05$) were performed to verify the normality and homogeneity of the data. All tests were performed with the help of SPSS 17.0 for Windows, adopting a significance level of 0.05.

Results

Table 1-4 present the descriptive measures of the data and according to the results it is possible to verify that for the three regions of the dentin, groups 1 (Rely x Ultimate + Single Bond Universal) and 4 (Rely X Arc + Scotch Bond Multi-Purpose) obtained the highest averages. According to the box plot presented in figure 1 to 4, it is possible to observe difference in the distribution of the data between the dentin areas.

Group	Third	N	Avarage	Standard deviation
Rely X Ultimate + Single Bond Universal	Cervical	16	5.98	2.30
	Medium	16	4.36	1.67
	Apical	16	3.45	0.77

Table 1: *Descriptive statistics of strength (Mpa) between different regions of intraradicular dentin by group.*

Group	Third	N	Avarage	Standard deviation
Clear Fill Sa Lutting Universal	Cervical	16	2.04	0.70
	Medium	16	1.58	0.37
	Apical	16	1.32	0.24

Table 2: *Descriptive statistics of strength (Mpa) between different regions of intraradicular dentin by group.*

	Third	N	Avarage	Standard Deviation
Clear Fill Sa Lutting Universal Autoadesivo	Cervical	16	1.83	0.69
	Medium	16	1.36	0.36
	Apical	16	1.02	0.20

Table 3: *Descriptive statistics of strength (Mpa) between different regions of intraradicular dentin by group.*

Group	Third	N	Avarage	Standard Deviation
Rely X Arc + Scoth Bond Multi Purpose	Cervical	16	5.16	3.06
	Medium	16	4.91	2.81
	Apical	16	4.35	2.49

Table 4: *Descriptive statistics of strength (Mpa) between different regions of intraradicular dentin by group.*

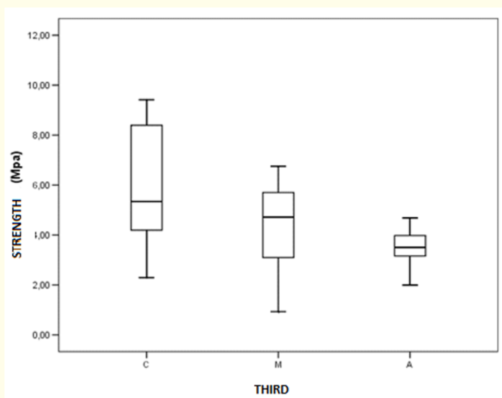

Figure 1: *Boxplot plot of strength between different regions of Group 1 intraradicular dentin.*

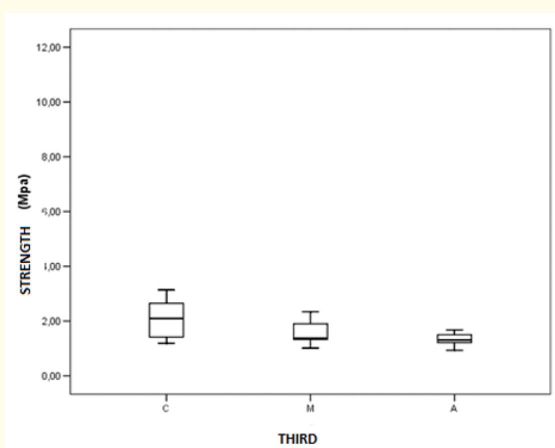

Figure 2: *Boxplot of the force between the different regions of Group 2 intraradicular dentin.*

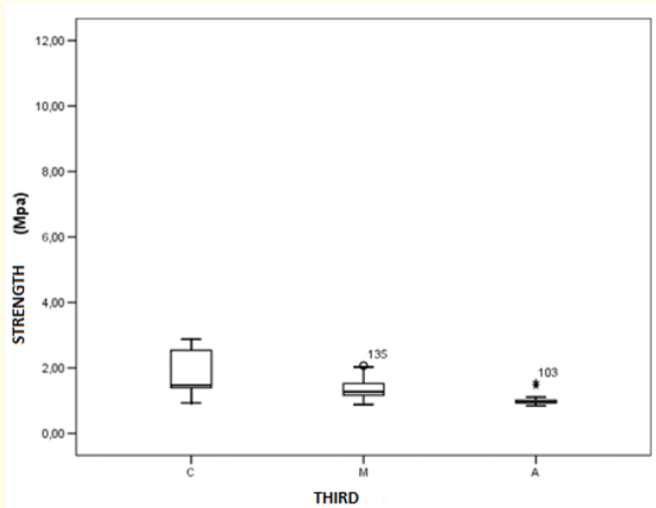

Figure 3: *Boxplot of the force between the different regions of Group 3 intraradicular dentin.*

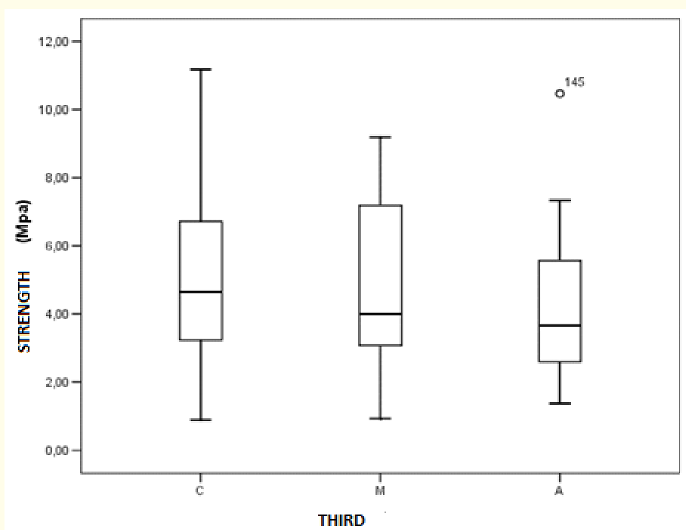

Figure 4: *Boxplot of the force between the different regions of intraradicular dentin in group 4.*

Discussion

To evaluate the posts adhesive resistance to the root canal, the push-out test has traditionally been used, since it is based on shear of the interface between dentin-cement and post-cement, being a valid and reliable technique to measure the force of union of fiber posts to root dentin [17]. In this study, the push-out was used because it also allows the evaluation of the different root thirds and, according to the literature, is less prone to premature failure of the samples.

Prior to the cementation of the fiberglass posts, they were cleaned with alcohol 70° for the purpose of surface cleaning and soon after drying with air jets, the posts were silanized. The silane is a bifunctional molecule capable of potentiating the chemical bond between the post and resin components, matrix and charge (Vano., *et al.* 2006). Fiberglass posts are composed of quartz, which is also found in the composition of ceramics indicated for metal-free restorations that requires surface treatment, such as feldspathic ceramics, which are silanized because the adhesive force between the resin and the porcelain was relatively higher in the samples in which the silane was used (Lacy., *et al.* 1988). Thus, its application aimed at a greater union between the fiberglass post and the resin cement inside the root canal.

The presence of MDP in the resin cement was not enough to influence positively the bond strength of fiberglass post to root dentin. Because of that, the null hypothesis, H0, was accepted. The G3 is related to the resin cement Clearfil SA Luting, with the monomer in its formulation, which does not require acid conditioning or adhesive system, being therefore self-adhesive, which presented the least satisfactory results in relation to other cements and in all thirds root.

The suggested hypothesis that the MDP of the adhesive systems would not be able to increase the bond strength was denied. The G1 used RelyX Ultimate Universal resin cement without MDP and the Universal Single Bond adhesive with MDP. It presented superior results to the other groups (G2 and G3), being comparable only to the control group (G4).

Conclusion

MDP-containing resin cements do not present adhesive bond strength results on fiberglass posts to dentin, superior to cement without the same monomer.

The association of the MDP of the adhesive system with the MDP of the resin cements is not able to potentiate the bond strength to the root dentin.

There is a decrease in the bond strength of the cementation of fiberglass posts in the cervical-apical direction.

Conflict of Interests

The authors declared that there are no conflicts of interests.

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