



The influence of 1% sodium hypochlorite in the bond strength between the radicular dentin and the fiber post using three cementing agents

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Abstract

Objective: To verify, *in vitro*, the influence of 1% NaOCl on the bond strength between intraradicular dentin and fiberglass post using three luting systems.

Methods: Sixty upper anterior teeth, endodontically treated, received a fiberglass post (White Post DC) and different luting systems: Relyx™ U200 (RU), Relyx ARC (RARC) and RelyX™ Luting 2 (RL). Before luting, samples were randomly divided into six groups: according to the irrigant, distilled water (DW) or 1% Sodium hypochlorite (NaOCl), and luting system: RU+DW, RU+NaOCl, RARC +DW, RARC+NaOCl, RL+DW, RL+NaOCl. After luting, roots were sectioned in three portions and subjected to "push out" test 0.5 mm/min in EMIC DL machine. Under stereoscopic microscope (25x), the type of fracture was evaluated.

Results: According to the ANOVA and Tukey post hoc test ($p < 0.05$), there was statistical significant difference in the interaction NaOCl/RARC. The RL had the lowest values of bond strength. The Relyx ARC showed greater bond strength in the cervical third. Most of fractures were in the interface adhesive bonding root/cement, followed by cement adhesive fractures in the interface and post.

Conclusion: 1% NaOCl reduced bond strength into the cervical third to RARC. The glass ionomer cement showed the lowest values of bond strength in the different dentin regions.

Key words: Post and Core Technique; Root canal therapy; Sodium hypochlorite

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Influência do hipoclorito de sódio a 1% na resistência adesiva entre dentina radicular e o pino de fibra de vidro utilizando três agentes cimentantes

Resumo

Objetivo: Este estudo objetivou avaliar, *in vitro*, a influência do Hipoclorito de Sódio (NaOCl) 1% na resistência adesiva (RA) entre dentina intraradicular, pino de fibra de vidro e três cimentos.

Métodos: Sessenta dentes unirradiculares, tratados endodonticamente, receberam um pino de fibra de vidro (White Post DC) cimentado com os cimentos: Relyx™ U200 (RU), Relyx ARC (RARC), RelyX™ Luting 2 (RL). Antes da cimentação, os dentes foram divididos em seis grupos ($n=10$) segundo o tratamento de superfície: água destilada (AD) ou NaOCl, e cimentos: RU+AD, RU+NaOCl, RARC+AD, RARC+NaOCl, RL+AD, RL+NaOCl. Nas três porções radiculares obtidas: cervical, médio e apical, foi realizado o teste de "push out" a 0,5 mm/min em uma máquina universal de ensaio LINHA DL EMIC DL 2000®, célula de carga de 50 Kgf. O tipo de falha foi avaliado em lupa estereoscópica 25X.

Resultados: A análise de variância (ANOVA) e teste de Tukey ($p < 0,05$) mostraram diferenças significativas no terço cervical (NaOCl e RARC) ($p < 0,05$). O RL apresentou menores valores de RA (AD/NaOCl). O RARC apresentou maior retenção no terço cervical (AD). A maioria das fraturas foi adesiva interface dentina/cimento, seguida das fraturas adesivas cimento/pino.

Conclusão: O NaOCl a 1% diminuiu a RA no terço cervical ao cimento RARC. Dentre os cimentos avaliados, o RelyX™ Luting 2 mostrou os menores valores de resistência ao cisalhamento nas diferentes regiões dentinárias.

Palavras-chave: Pinos de retenção dentária; Endodontia; Hipoclorito de sódio

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Introduction

Caries disease, abrasion, fracture and restorative procedures can weaken the tooth structure. Depending on the intensity of the lesion, the restorative procedure to be performed will be determined, which may be associated the endodontic treatment and intra-canal pins cementation to increase coronary retention [1,2,3].

The prefabricated fiber posts, for presenting several advantages from preservation of tooth structure by reducing the risk of root fracture [4,5], absence of corrosion, adhesive bonding, low cost, biocompatibility and better distribution of stress, become a satisfactory alternative to teeth with little remaining structure. The translucent fiber pins allow the light to be transmitted in the root canal, thereby increasing the degree of conversion of the dual cementing systems, with a consequent improvement in mechanical properties such as elastic modulus and hardness [6].

This type of cementation requires an elaborate technique and several steps, including cleaning the substrate to ensure adhesion through a hybrid layer of quality [5]. Dentinal tubules must be free of waste such as gutta-percha, endodontic sealer, dentin shavings and microorganisms and, therefore the irrigation with disinfectants must be used after clearing the canal, with sodium hypochlorite (NaOCl) being one of the agents most commonly used [7,8].

The literature presents several results regarding the influence of sodium hypochlorite on the bond strength of intra-radicular dentin, without a consensus on its actual interference [9,10]. Therefore, new studies extending this discussion become necessary, in order to verify the relation of this disinfectant solution on the bond strength between the intraradicular dentin and prefabricated posts.

Thus, the objective of this study was to evaluate and compare, *in vitro*, the influence of 1% NaOCl in shear strength by fiberglass post extrusion using different cementation systems: Relyx™U200, Relyx ARC and RelyX™Luting 2.

Methods

Sixty single-rooted intact upper teeth, extracted for periodontal reasons were used in this study. The teeth were acquired in the teeth bank of the Faculty of Dentistry at Escola Bahiana de Medicina e Saúde Pública and the School of Dentistry of the União Metropolitana de Educação e Cultura, clinics and private practices through the signing the Deed of Donation and Free and Clear Acceptance in accordance with the requirements of CNS Resolution 196/96, since this project was approved by the Ethics Committee in Research of Escola Bahiana de Medicina e Saúde Pública under the Protocol No. 74/2007. The teeth were stored in 0.2% thymol [11] until starting the experiment.

The samples were radiographed to check for possible cracks, internal resorption or obstructions within the root canal. The coronal portion of all teeth was removed (1 mm above the cement-enamel junction) using a bi-laminate diamond disk (# 7020 KG Sorensen Ind – São Paulo, Brazil) and, a single operator using the lateral condensation technique performed the endodontic treatment.

Sixty roots were randomly assigned into six groups (n=10), according to the disinfection and cementing protocols. Each group was divided into three (cervical, middle and apical thirds), resulting in 18 subgroups. Two irrigating solutions were used: Distilled water (AD) and 1% sodium hypochlorite (NaOCl). The cements used were: Relyx™U200 (RU), Relyx ARC (RARC) and RelyX™Luting 2 (RL) (Table 1).

The gutta-percha removal was performed using the drill string off weight (Dentsply-Maillefer – Petropolis RJ, Brazil) n. 2 and 3, followed by drills of White Post DC system (FGM – Joinville, SC, Brazil) numbers 0.5, 1, 2 and 3, so as to remain 3 mm apical filling [12]. Subsequently, each pin White Post DC number 3 was scored as the length of the corresponding root clearance and then positioned in preparation to confirm its insertion and removal passively.

Table 1. Cements' Composition

Material/Batch number	Chemical composition	Adhesive system classification	Polymerization method	Manufacturer
RelyX™ Luting 2 (KE7JU)	Paste A: Water, HEMA, fluoroaluminosilicate glass (FAS), reducing agents, titanium dioxide (TiO ₂), dispersing agent Paste B: BisGMA, HEMA, water, oxidizing agent – potassium persulfate, Polyacid methacrylate, Cargo Zr-Si, solubility modifiers	–	Chemical	3M-ESPE
Relyx™ ARC (FJGA) / Adper™ Single bond2 (6HM)	Adper™ Single bond2: Bis-GMA and Hema diurethane dimethacrylate copolymer of polyalkenoic acid, camphorquinone, water, ethanol and glycerol 1.3 dimethacrylate Paste A: Bis-GMA, TEGDMA, zirconia silica, and photoinitiator system. Paste B: Bis-GMA, TEGDMA, zirconia silica and benzoyl peroxide.	2 steps	Dual	3M-ESPE
RelyX™ U200 (244203)	Powder: glass particle, silica, initiator, calcium hydroxide and pigments Liquid: Ether phosphoric methacrylate, dimethacrylate, ethyl, stabilizer and initiator.	–	Dual	3M-ESPE

The pins were cut 2 mm beyond the dial with diamond tip # 3195F (KG Sorensen Ind – São Paulo, Brazil).

For fixing the pin to the tooth, the cementing systems were handled according to the instructions provided by the manufacturer. The pins were cleaned with gauze soaked in 70° alcohol, silanized with silane (3M ESPE – Sumaré, SP, Brazil) for 60 seconds and dried with air jets for 5 seconds.

Prior to cementing, the canals, depending on the group, were irrigated with distilled water or 1% NaOCl for 30 seconds and dried with absorbent papers (Dentsply-Maillefer, Petrópolis, RJ, Brazil). For Relyx U200 (3M ESPE) cement group, the cement capsule was activated in Softly mechanical mixer (GNATUS – Ribeirão Preto, SP, Brazil) for 12 seconds. The canal was completely filled with cement, the pin inserted and light cured for 40 seconds with an emitting-diode light ULTRA BLUE IS (DMC-600mW/cm², São Carlos, SP, Brazil). A radiometer of accuracy Demetron L.E.D. Radiometer (Kerr Corp. – Orange, California, USA) was used in every 10 samples and the average light intensity of 500 mW/cm² was recorded.

In Relyx ARC (3M ESPE – Sumaré, SP, Brazil) group, the post space was conditioned with 37% phosphoric acid COND AC 37 (FGM – Joinville, Santa Catarina, Brazil) for 15 seconds, rinsed thoroughly and dried with absorbent paper. Single Bond 2 (3M ESPE – Sumaré, SP, Brazil) was applied with a thin disposable brush Cavibrush (FGM, Joinville, Santa Catarina, Brazil) and the excess removed with absorbent paper points and then light cured for 40 seconds. Resin-based cement was disposed, base paste and catalyst, on a glass plate in equal parts, mixed and taken into the canal with a #50 lentulo drill (Maillefer-Dentsply – Petrópolis, RJ, Brazil). Subsequently, the pin was inserted in the canal and pushed down to the preset limit and light cured for 40 seconds.

The Relyx Luting 2 cement (3M ESPE – Sumaré, SP, Brazil) was disposed in a glass plate, the base paste and catalyst in equal parts, mixed and inserted it the canal with a #50 Lentulo drill (Maillefer-Dentsply – Petrópolis, RJ, Brazil). The pin was inserted in the canal and pushed down to the preset limit and awaited the polymerization time recommended by the manufacturer (3 minutes).

After cementing the pins, the roots of all groups were kept in distilled water with the relative humidity at a temperature of 37°C for 24 hours.

To obtain the samples, the first millimeter of the cervical region was sectioned and disposed. The roots were sectioned transversely into three slices of 3.0 mm and so-called: cervical, medium and apical thirds. The sections were sawed in polishing AROPOL 2V (Arotec, São Paulo, Brazil) using silicon carbide sandpaper in decreasing grits (600, 800 and 1000) until the surfaces were flattened, reducing the thickness to 2.8 mm conferred by a 500-144B digital caliper (Mitutoyo, Japan).

The samples were placed in a steel device and subjected to shear test by “push out” extrusion at the universal testing machine LINHA DL (EMIC DL 2000[®], São José dos

Pinhais, Paraná, Brazil), with 50 kgf load cell. A metal rod with an active tip of 1.0 mm diameter was fixed in the nip of the machine and positioned at the center of the fiberglass pin. The “push-out” test is performed at an average speed of 0.5 mm/min until fracture (Figures 1 and 2).

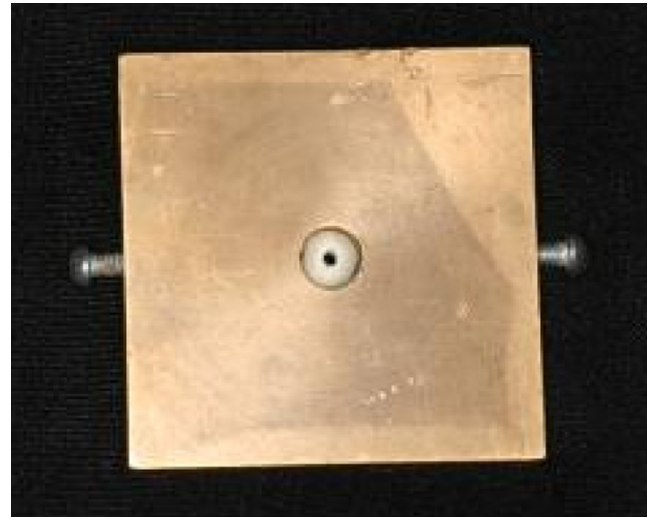


Figure 1. Samples positioned on the steel device

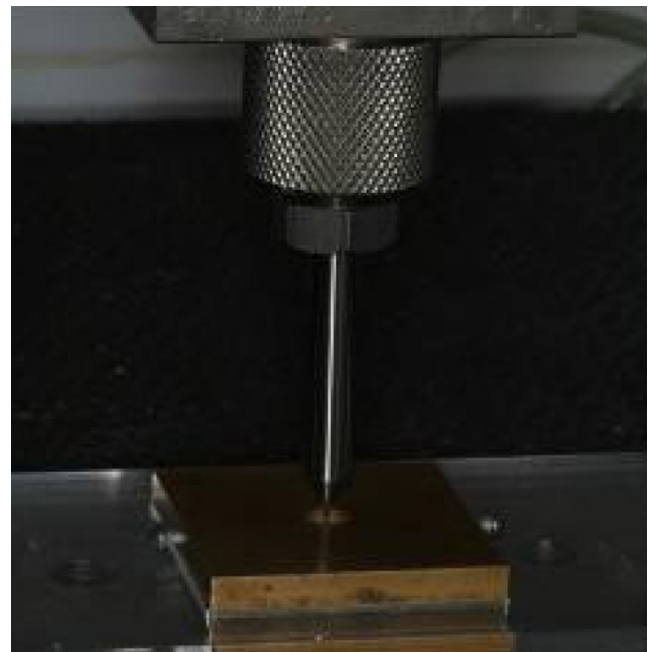


Figure 2. Sample subjected to shear test by “push out” in EMIC DL LINE Testing Machine

After the fracture test, samples were examined by using a stereoscopic magnifying glass with 25× magnification (LAMBDA LEE No. 2 005 007 – ATTO INSTRUMENTS CO/HONG KONG) to determine the type of fracture. Failures were classified as: adhesive, when the fracture

was in the union cement/pin (CR-P) interface; adhesive on cement and root dentin (CR-DR) interface; mixed, when the fracture occurred partially in the cement and pin interface and, partly in cement and root dentin interface; or cohesive, when fracture was in the cement (CR), pin (P) and root dentin (RD) [13,14].

The values of shear strength were subjected to analysis of variance (ANOVA) and Tukey's post hoc test for multiple comparisons of means at 5% significance.

Results

The analysis of variance showed statistically significant differences in the experimental conditions, type of cement and cement interaction, irrigating sustenance and dentin third ($p < 0.01$) (Table 2).

Table 2. Analysis of Variance of Shear Strength (MPa)

Effect	Num DF	Den DF	Value F	Pr > F
Treatment	1	48	2.85	2.85
Cement	2	48	93.21	<.0001 **
Treatment* Cement	2	48	3.16	0.0513
Third	2	96	1.34	0.2660
Treatment* Third	2	96	1.31	0.2748
Cement* Third	4	96	2.37	0.0575
Cement* Treatment* Third	4	96	4.12	0.0040 **

* ???; ** $p < 0.01$.

Then, isolate evaluations were performed considering the irrigating substances, cements and dentin thirds. Regarding irrigating substances, there was significant statistical difference ($p < 0.01$) in the values of shear strength for groups which post spaces were irrigated with 1% NaOCl in the cervical third and used the Relyx ARC cement (Table 3).

The analysis of cementing agents indicated that Relyx Luting 2 cement showed the lowest bond strength values in the three thirds when the post spaces were irrigated either with distilled water or 1% NaOCl. There was no statistically significant difference between the U200 and Relyx ARC when 1% sodium hypochlorite was used ($p < 0.01$). However, when the cervical third was irrigated with distilled water, the cement Relyx ARC (39.95 MPa) showed statistically higher values compared with the Relyx U200 (23.87 MPa). The results may be evaluated in Table 4.

With respect to the dentinal thirds and irrigating solutions, statistically significant differences between the three thirds were observed only for Relyx ARC cement when the irrigating solution used was distilled water ($p < 0.05$). For other cements there were no statistically significant differences, regardless of dentin third and irrigating solution (Table 4).

Besides the evaluation of the bond strength between intra-radicular dentin and fiberglass pin, complementary fracture-type analysis occurred at the tooth/pin/cement interface. Results are shown in Table 5.

Table 3. Means and standard deviations of push out test (MPa) of different cementing systems in dentin region deviations

Cement	Distilled water			1% NaClO		
	Cervical	Middle	Apical	Cervical	Middle	Apical
U200	23.87(7.91) ^b	25.33(10.80) ^a	30.27(8.01) ^a	25.96(5.83) ^a	23.41(8.93) ^a	27.05(9.87) ^a
Relyx ARC	39.95(10.10) ^a	34.34(8.77) ^a	29.23(4.59) ^a	25.97(7.57) ^a	24.97(11.04) ^a	29.47(9.96) ^a
RelyxLuting 2	6.46 (3.06) ^c	5.80(4.02) ^b	7.06(3.65) ^b	6.92(2.98) ^b	7.71(2.74) ^b	8.11(3.46) ^b

* Means comparison in the vertical direction. Means followed by different lowercase letters differ among each other ($p < 0.05$)

Table 4. Means and standard deviations (MPa) of dentin regions within the cementing systems and irrigating substances

Third	Distilled water			1% NaClO		
	U200	Relyx ARC	Relyx Luting 2	U200	Relyx ARC	Relyx Luting 2
Cervical	23.87(7.91) ^a	39.95(10.10) ^a	6.46(3.06) ^a	25.96(5.83) ^a	25.97(7.57) ^a	6.92(2.98) ^a
Middle	25.33(10.80) ^a	34.34(8.77) ^{ab}	5.80(4.02) ^a	23.41(8.93) ^a	24.97(11.04) ^a	7.71(2.74) ^a
Apical	30.27(8.01) ^a	29.23(4.59) ^b	7.06(3.65) ^a	27.05(9.87) ^a	29.47(9.96) ^a	8.11(3.46) ^a

Means comparison in the vertical direction. Means followed by different lowercase letters differ among each other ($p < 0.05$).

Table 5. Percentage (%) of fracture types by study group

Fracture type	Cementation systems and irrigating substances					
	RU+AD	RU+NaClO	RARC+AD	RARC+NaClO	RL+AD	RL+NaClO
Adhesive C-DR	28.57	38.1	14.3	76.19	47.62	33.33
Adhesive C-P	23.81	38.1	19.05	4.76	19.05	66.67
Cohesive DR	19.05	14.3	47.62	9.52	4.76	0
Mixed	28.57	9.5	19.05	9.52	28.57	0

Discussion

Microbial control in the root canal is a prerequisite for successful endodontic treatment. Irrigating solutions should be antimicrobial, but not toxic, and should not interfere with the substrate in which they operate [15].

In this study, the influence of the 1% sodium hypochlorite in the bond strength between intraradicular dentin and fiberglass pins was evaluated using three cements. The choice of NaOCl as irrigating solution is due to the fact that its mechanism of action promotes changes in cell metabolism by oxidative action with irreversible enzyme inhibition in bacteria and also because it is widely used in clinical practice [7,16].

The statistical results of this study showed a decrease in bond strength due to the use of 1% sodium hypochlorite only in the cervical third when Relyx ARC cement was used. This may be due to the large dentinal permeability in this region that allows the permanence of residual sodium hypochlorite within the dentinal tubules and, as a result, the incomplete polymerization of the resin monomers at adhesive/dentin interface [16]. This fact, associated with the acidic conditioning required in cementing system Relyx ARC, which causes demineralization of the collagen matrix [17], may have contributed to the decreased bond strength in this region.

These results differed from the study of Muniz and Mathias [12], since these authors found that surfaces treated with 5.25% sodium hypochlorite favored the retention of pins as compared to distilled water, which was corroborated by Varela et al. [18] and Hayashi et al. [16].

It is known that the antibacterial characteristic of NaOCl does not vary widely in their different concentrations [19], making unnecessary the use of substances with high concentration. Furthermore, the concentration of NaOCl and time of its application can influence the removal of the organic matrix in the dentinal surface [20] and act negatively on the bond strength, since the removal of the organic matrix can prevent the creation of a resistant hybrid layer [21].

In this study, three cementing systems, Relyx U200, Relyx ARC and Relyx Luting2 were evaluated. The Relyx Luting 2 cement presented the lowest bond strength values in dentin regions compared to resin cements with both irrigating substances. These results are in agreement with Bonfante et al. [13]. The low bond strength values, attributed to glass ionomer cements, can be assigned to the chemical bond to dentin of this material, which has great potential for failures due to low values of tensile strength [22].

It is likely that, the positive results of Relyx ARC resin cement are due to surface conditioning with phosphoric acid 37%, which promotes removal of the "smear layer" and demineralization of the collagen matrix [23]. Previous studies confirm these findings when the values of bond strength of cementing systems of separately acidic conditioning are larger than those of self-adhesive cementing systems [23].

In the present study, we also found that the cementing system Relyx ARC showed the highest values in the cervical

portion with distilled water. Mallmann et al. [14] found similar results. This can be explained by the high density of resin "tags" in the cervical third of the root canal promoting higher rate of bond strength in this region [24].

The reduction in bond strength in the root canal can be affected by many conditions, from the materials used in endodontics to the high C factor (factor of cavity configuration) [13,14,23]. It was found, in this work, that most of the fractures were adhesive at the root dentin and cement interface, followed by adhesive fractures at the cement and pin interface. These results are in agreement with the findings of Bonfante et al. [13] and Kececi et al. [25]. Possibly, the silanization has promoted greater adherence in pin and cement interface [13].

Questions related to hypochlorite concentration and adhesiveness demonstrate that additional studies are needed so that they can corroborate these results.

Conclusions

Within the limitations of this study it can be concluded:

1. 1% Sodium hypochlorite decreases the bond strength in the cervical third of the Relyx ARC cement;
2. Relyx Luting 2 Cement showed the lowest values of shear strength in all different dentinal regions;
3. The root dentin region influenced bond strength of cements and, the cervical third showed the highest retention of Relyx ARC cement when the canal was irrigated with distilled water;
4. No cohesive failures were identified on the pin and cement interface; however it was found predominance of adhesive failures at the root dentin and cement interface, followed by adhesive failures at the cement and pin interface.

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