EFFECT OF ENDODONTIC SEALER AND RESIN LUTING STRATEGIES ON PULL-OUT BOND STRENGTH OF GLASS FIBER POSTS TO DENTIN

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ABSTRACT

The aim of this study was to evaluate the influence of eugenol-containing endodontic sealers and luting strategy on the pull-out bond strength of glass fiber posts to dentin. Sixty-four bovine incisors were randomly assigned into two groups of 32 specimens each for obturation procedure with gutta-percha only, or with Pulp Canal Sealer EWT. Subsequently, the roots were prepared for the fiber post Reforpost and all specimens of each endodontic sealing procedure were allocated to four groups (n=8), according to the strategies for post cementation: A) Single Bond 2 and RelyX ARC; B) All Bond 2 and C&B cement; C) All Bond 2 and RelyX ARC; D) Single Bond 2 and C&B Cement. The posts were cemented immediately after the endodontic treatment. The pull-out test was performed at a cross-head speed of 0.5 mm/min in a universal testing machine (EMIC). Data (Kgf) were submitted to a two-way ANOVA and Tukey test ($p \leq 0.05$). The eugenol-based sealer did not influence the pull-out bond strength of fiber posts regardless of the luting strategy. RelyX ARC showed higher bond strength than C&B Cement when used with Single Bond 2 adhesive system, when the eugenol-based sealer was present. All Bond 2, when associated to all cements studied, promoted similar bond strength, regardless of the eugenol-containing endodontic sealer. In conclusion, eugenol-containing sealer did not influence the pull-out bond strength values of the resin luting systems for glass fiber post cementation. The bond system and resin cement association from the same manufacturer had similar bond strength values for dentin.

Key words: dental cements, post and core technique, tensile strength.

EFEITO DO CIMENTO ENDODÔNTICO E DA ESTRATÉGIA DE CIMENTAÇÃO RESINOSA NA RESISTÊNCIA DE UNIÃO POR TRAÇÃO DE PINOS DE FIBRA DE VIDRO À DENTINA

RESUMO

O objetivo desse estudo foi avaliar a influência de cimentos endodônticos à base de eugenol e estratégia de cimentação resinosa na resistência à tração de pinos de fibra de vidro à dentina. Sessenta e quatro incisivos bovinos foram aleatoriamente divididos em dois grupos com 32 espécimes para cada procedimento de obturação, com o cimento à base de eugenol Pulp Canal Sealer EWT ou somente com guta percha pela técnica termoplastificada. Após, realizou-se o prepare do conduto radicular para o pino de fibra Reforpost e posteriormente, as amostras de cada procedimento obturador foram separadas em quarto grupos (n=8), considerando as estratégias para cimentação do pino: A) Adper Single Bond 2 e RelyX ARC; B) All Bond 2 e C&B cement; C) All Bond 2 e RelyX ARC; D) Adper Single Bond 2 e C&B Cement. Os pinos foram imediatamente cimentados após o tratamento endodôntico. Dessa maneira, o teste de pull-out foi realizado a uma velocidade de 0.5 mm/min em máquina de ensaio universal (EMIC DL2000). Os dados (Kgf) A análise estatística foi realizada pelos testes ANOVA de dois fatores e teste de Tukey ($p \leq 0.05$). O cimento endodôntico contend eugenol não influenciou a resistência de união à tração (pull-out) dos pinos de fibra, independente da estratégia de cimentação. O RelyX ARC ofereceu maior resistência de união do pino à dentina, comparado ao C&B Cement quanto utilizado com o Adper Single Bond 2, na presença do cimento endodôntico contendo eugenol. O All Bond 2 quando associado a todos os cimentos estudados promoveram uma resistência de união semelhante, independente do conteúdo de eugenol na cimentação endodôntica. Em conclusão, o cimento endodôntico à base de eugenol não influenciou na resistência à tração de pinos de fibra à dentina. A associação de sistema adesivo e cimento resinoso do mesmo fabricante apresentou valores de resistência de união semelhantes na cimentação de pinos de fibra.

Palavras-chave: cimentos dentais, técnica de pino e núcleo, resistência à tração.

INTRODUCTION

Endodontic therapy should not be considered as the final stage in dental treatment, since the form, function and esthetic appearance of the tooth must be restored[1]. In cases in which direct restoration alone is not indicated due to the great loss of tooth structure[2], intracanal retainers must be placed to increase the retention of the restoration[3-5].

Developments in adhesive dentistry have enabled the use of fiber-reinforced posts, which have a similar elastic modulus to dentin, thus reducing the risk of root fracture[6-10]. Moreover, fiber posts are considered to be a good alternative substitute to metallic posts and cores in the restoration of endodontically restored teeth, especially because of their natural translucency, excellent esthetic results and root reinforcement[11-13].

Fiber post retention is associated to the satisfactory degree of conversion of the bond system and resin cements inside the root canal, due to the attenuation of the light intensity that reaches all the root canal area[14]. In an attempt to overcome this problem, dual curing resin cements were developed to combine important properties of chemical and light curing to provide efficient conversion in deeper areas with reduced light penetration[15,16]. However, it is known that self-cured resins are not compatible with most conventional 2-step etch-and-rinse adhesive systems. This is due to the fact that the composition of these adhesive systems includes acidic monomers which, when in contact with these composites, react with tertiary amines and inhibit the activation of the polymerization reaction[17]. Such incompatibility also occurs with dual or chemically cured resin cements, and can be an important problem during fiber post cementation with current resin luting cements[18]. Hence, it is important to investigate the behavior of different adhesive systems/resin cement associations under root canal confinement, since clinicians use a large number of commercial brands and a standard luting protocol has not yet been established.

Furthermore, some endodontic sealers are also known to influence the resinous cementation strategy of fiber posts[19]. Eugenol-based endodontic sealers are reported to alter some composite properties, such as hardening and monomer conversion, since the presence of eugenol in the cement composition may inhibit polymerization of the resin cement and bond system, thus reducing tensile strength[20,21]. Moreover, the literature does not clarify whether this actually occurs, because some authors found no decrease in fiber post bond strength when a eugenol-containing sealer was used before the root canal preparation for post placement[13,22,23]. It should also be considered that the eugenol placed on the root canal walls after endodontic treatment may be removed during post preparation procedure and/or dentin acid etching in the total-etch bonding technique[20,21,24,25].

Thus, the aim of this study was to evaluate the influence of a eugenol-containing endodontic sealer and the resin luting strategy on the pull-out bond strength of glass fiber posts to root dentin. The hypothesis tested is that the eugenol-based sealer would decrease the bond strength of the resin luting cements to root dentin when using a glass fiber post. Also, self-cured resin cement is expected to yield lower post retention inside root canal.

MATERIAL AND METHODS

The materials used in this study are presented in Table 1.

Sixty-four bovine incisors were selected, cleaned and stored in a 0.5% chloramine T solution at 4°C for no

Table 1: Commercial brand, composition and manufacturer of the used materials.

Materials	Composition	Manufacturer
C&B cement	*Base (Batch #019078):* Bis - GMA, Ethoxylated Bis-GMA, Triethyleneglycol Dimethacrylate, fused silica, glass filler, sodium fluoride *Catalyst (Batch #019208):* Bis-GMA, Triethyleneglycol Dimethacrylate, fused silica	Bisco, Schaumburg, IL, USA
RelyX ARC (Batch #GU9JG)	*Paste A:* Silane treated ceramic, Bis-GMA, TEGDMA, camphoroquinone, silane treated silica, functionalized dimethacrylate polymer. Paste B: Silane treated ceramic, TEGDMA, Bis-GMA, silane treated sílica, functionalized dimethacrylate polymer (EYFH)	3M ESPE, St Paul, Minnesota, USA
All Bond 2	*Primer A (Batch #0500003574):* Na-N-tolyglycine glycidylmethacrylate (NTG-GMA), acetone, ethanol, water. *Primer B (Batch #0500003579):* BPDM, acetone, photoinitiator *D/E Resin (Batch #0500004549):* Bis-GMA, HEMA, UDMA, camphoroquinone, amine activator	Bisco, Schaumburg, IL, USA
Single Bond 2 (Batch #9XB)	Dimethacrylates, HEMA, Polyalkenoid acid copolymer, 5nm silane treated colloidal silica, ethanol, water, photoinitiator.	3M ESPE, St Paul, Minnesota, USA

more than a week. Roots of similar size and shape were sectioned off 1 mm under the cement enamel junction using a double-face diamond saw (K.G. Sorensen, SP, Brazil). Then the cervical root third was ground using 320 and 600 grit silicon carbide (SiC) abrasive paper (Carbimet Disc Set, Buehler, Lake Bluff, IL, USA) to the final root length of 16mm. After grinding, the coronal diameters of root canals were measured with a digital caliper (Starret 727, Starret, Itu, Brazil) and specimens with diameter larger than 1.5 (diameter of the post) were discarded. Root canals were instrumented to a working length at 15 mm (1 mm short of the apex).

The instrumented samples were then randomly assigned to two groups of 32 specimens each for the obturation procedure. Group 1 root canals were obturated with gutta-percha and a eugenol-containing sealer, Pulp Canal Sealer EWT (Kerr Dental, Orange, CA, USA) and group 2 root canals were filled only with heat plasticized gutta-percha cones without endodontic sealer. The excess gutta-percha filling was removed with a heated vertical condenser and vertical condensation was performed. A Gates-Glidden drill #5 was used to remove the gutta-percha at the length of 12 mm (remaining endodontic filling of 3 mm), which corresponds to the standardized length of the post inside the root canal.

After preparation, specimens were embedded in a PVC cylinder (height: 25 mm, diameter: 10 mm) filled with chemically cured acrylic resin (Dencrilay, Dencril, Vaieiras, SP, Brazil). For specimen inclusion in the acrylic resin, the preparation bur of the post system was placed inside the prepared root canal, and the entire set was placed parallel to the PVC pipe and perpendicular to the ground, with a parallelometer. The most coronal portion of the root was 3 mm up to the acrylic resin inside the PVC cylinder.

Roots were prepared with #3 burs of the glass fiber post system Reforpost (Angelus, Londrina, PR, Brazil) with 1.5 mm diameter. Subsequently, specimens from each endodontic sealing procedure (with and without eugenol-containing sealer) were allocated to four groups (n=8), considering the strategies for post cementation: A) posts fixed with the 2-step light-cured adhesive system Adper Single Bond 2 (3M ESPE, St Paul, Minnesota, USA) and the dual-cured cement RelyX ARC (3M ESPE, St Paul, Minnesota, USA); B) posts fixed with the 3-step light-cured adhesive system All Bond 2 (Bisco, Schaumburg, IL, USA) and the self-cured cement C&B Cement (Bisco, Schaumburg, IL, USA.); C) posts fixed with All Bond 2 and RelyX ARC; D) posts fixed with Adper Single Bond 2 and C&B Cement. All bond systems were applied with a microbrush according to the manufacturer's recommendation and resin luting cements were mixed according the manufacturer´s instructions and placed into the root canal with a lentulo spiral drill. The light curing source used was a quartz tungsten halogen light Degulux (Degussa, Germany/500 mW/cm^2) in a continuous mode at 10 seconds for the bonding systems and 40 seconds for the dual-cured cement. Before cementation, silane treatment (Prosil, FGM, Joenvile, Brazil) was performed, by applying the coupling agent on the surfaces of each fiber post and leaving to dry for 1 minute. After that, the posts were cemented immediately after the endodontic treatment.

Pull-out test

For the pull-out test, a polystyrene cylinder was built at the coronary portion of the fiber post, with a stainless steel wire strap at the top. Specimens were attached to the lower portion of a universal testing machine (Emic DL 5000, São José dos Pinhais, PR, Brazil) and the wire strap at the top of the specimen was directly connected to the upper part of the system, which was in contact with the load cell (Fig. 1). The pull-out test was performed at a cross-head speed of 0.5 mm/min. The data obtained (Kgf) were submitted to a two-way ANOVA and the post-hoc Tukey's tests at 5 % significance.

RESULTS

The two-way ANOVA test applied did not show a significant effect between the factors studied (endodontic sealer x luting strategy); however, there was difference for the luting strategy factor, requiring Tukey test application. Means and standard deviation obtained for the experimental groups in the tensile strength test are presented in Table 2.

The endodontic sealer used did not influence the pull-out bond strength of fiber posts regardless of the resin luting strategy. RelyX ARC showed higher bond strength than C&B Cement when used with Single Bond 2 bond system, when the endodontic sealer was presentThus in the absence of Pulp Canal Sealer EWT, RelyX ARC presented higher pull-out bond strength when used with Single Bond 2 and the association of C&B cement with this light-cured

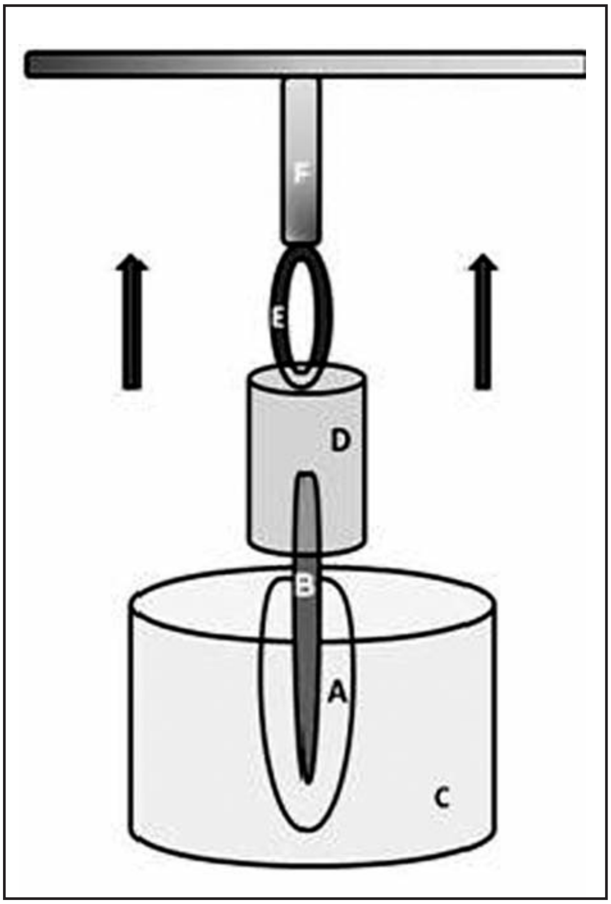

Fig. 1: Pull-out testing configuration. (A) bovine root specimen; (B) glass fiber post cemented; (C) PVC tube filled with acrylic resin; (D) polystyrene cylinder used to attach the fiber post; (E) stainless steel wire strap attached to the upper portion of the universal testing machine; (F) upper portion of the system, connected to the load cell.

adhesive. All Bond 2 promoted similar bond strength as when all resin cements were used, regardless of the eugenol-containing endodontic sealer.

Table 2: Pull-out bond strength of fiber posts in the groups tested.

Resin luting systems	Endodontic sealer	No Endodontic sealer
Single Bond 2/RelyX ARC	37.4 (12.8) A	45.5 (9.2) A
All Bond 2/C&B cement	27.1 (8.3) ABC	38.9 (7.1) AB
All Bond 2/RelyX ARC	33.4 (11.4) AB	29.2 (13.4) BC
Single Bond 2/C&B cement	21.3 (6.3) C	23.5 (4.8) C

Different letters in the columns means statistical difference
( )- Standard deviation

DISCUSSION

Unsuitability or absence of restorations after a root canal obturation procedure are relevant factors that may determine the failure of an endodontic treatment. In cases of great amount of tooth structure loss, glass fiber post cementation can increase restoration retention and establish satisfactory tooth rehabilitation[26].

Some authors[19-21] say that residual eugenol could inhibit the setting of resin cement, decreasing bond quality responsible for the adequate fiber post retention. Therefore, the tested hypothesis was rejected, since the eugenol sealer did not affect the post bond strength and the self-cured cement showed similar or lower bond strength values compared to the dual-cured cement. The primary expectation was that the non-eugenol-containing sealer groups would have higher mean tensile bond strengths compared to eugenol-containing groups. The results showed no difference between the two groups in this study regarding the eugenol content. These findings are in agreement with the results obtained by many authors[13,21,23,24], who, even assessing tensile strength a week later, noted that the endodontic sealer did not influence post retention. It may be explained due to the removal of the residual eugenol by the mechanical preparation of the root canal and/or by the cleaning promoted by the phosphoric acid in bonding procedure[22,25]. Cleaning the bonding substrate may be the most critical factor in achieving success with resin cements, which was carried out in this work[22]. These results indicate that the post retainer may be cemented immediately after filling, regardless of the endodontic sealer, thus preventing coronary microleakage[26-28] and favoring the root canal treatment prognosis.

On the other hand, it is recommended that the same brand adhesive system and luting cement should be used in order to avoid incompatibility[17].With no eugenol-based endodontic sealer, it was shown that Single Bond 2 should not be indicated for use with self-cured cements, due to the lower tensile bond strength values found, compared to the others post fixing strategies. However, when eugenol was present in the endodontic sealer, RelyX ARC promoted higher bond strength values compared to the self-cured cement, probably because of the photocuring characteristic of the dual-cured cement. Regardless of the endodontic sealer, Single bond 2 promoted lower bond strength values when used with the self-cured cement, possibly because of polyalkenoid acid copolymer and other acidic monomer content that could be responsible for the reduction in the degree of conversion of the resin cement due to incompatibility[17]. There are differences in pH values between the bonding systems (Single bond 2 - pH 4.6 and All bond 2 - pH 6.1), which may be responsible for the low degree of conversion of self-cured resinous materials such as resin cements[29]. However, the curing depth of the resin luting cement inside the root canal may not be satisfactory due to the acidic monomers, which may affect the hardening reaction of dual and self-cured cements, preventing the initiation of the oxide-reduction reaction that occurs between the tertiary amine and the benzoyl peroxide[17].

There was no statistical difference in pull-out bond strength between resin luting strategies Single Bond2/RelyX ARC and All Bond 2/C & B cement. These similar bond strength values may be explained by chemical compatibility from each manufacturer[17]. Both the acidic monomers polymerized poorly in the presence of the redox system – peroxide-amine – and the tertiary amines neutralized by these monomers lost their reduction ability[18]. This may explain the lower bond strength values when a 2-step adhesive was used in combination with self-cured resin cement. The redox reaction products may be deposited as globular structures within some of the air bubbles found along the composite/adhesive interface. These bubbles may represent an ultra-structural manifestation of the electron transfer complex between acid monomers and the binary redox initiators that prevent the generation of free radicals in chemically activated compounds[17]. The lack of free radicals in the resinous cement mass that was not activated by light may be assigned to deficient polymerization, which may explain the tensile strength values obtained by the Single Bond 2/RelyX ARC system.

For the All Bond 2/RelyX ARC group, the chemical incompatibility between the brands of different materials was probably more evident when no endodontic sealer was present, with lower bond strength values compared to Single Bond 2/RelyX ARC group. It may have occurred due to the fact that NTG-GMA monomers of All Bond 2 Adhesive systems may interfere with the curing reaction of the resin cement which does not have this monomer content, affecting the pull-out bond strength of the entire system to root dentin.

Although some *in vitro* studies exist, final conclusions regarding glass fiber systems will depend on the outcomes of clinical trials. Long-term clinical studies and investigations of retention ability of glass fiber dowels in the intra-oral environment can best evaluate the quality and durability of these restorations.

CONCLUSIONS

Eugenol-containing endodontic sealer did not influence the pull-out bond strength values of the resin luting systems for fiber post cementation.

Bond system and resin cement association from the same manufacturer presented similar bond strength values.

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