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# Influence of Bio-C and AH Plus sealers on bond strength determined by push-out of a fiberglass post installed with self-adhesive sealer

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***ABSTRACT***

*Given the limitations of the intrarradicular adhesion procedure and the significant challenge of achieving effective bonding, it is essential to assess the potential impact of various endodontic sealers on the bond strength between fiberglass posts and root dentin.* ***Aim:*** *The aim of this study was to evaluate the bond strength of fiberglass posts to the root dentin of teeth filled with different endodontic sealers.* ***Material and Methods:*** *Forty-five single-rooted teeth were instrumented, filled using the single-cone technique, and divided into three groups according to the selected sealer (n=15): Bio-C sealer (GBC), AH Plus (GAH), and control group without sealer (GC). The post was installed using RelyX U200 self-adhesive resin sealer. Specimens were cut into a cervical, middle and apical thirds, to analyze one slice per third. Bond strength was evaluated using a push-out extrusion test. The failure modes in each third were observed under the microscope, and classified as adhesive, cohesive or mixed.* ***Results:*** *It was found a difference between groups in the cervical and apical thirds, with GAH having stronger adhesion in the cervical third than GBC (p=0.0015), although there was no difference with GC. In the apical third, GAH had higher adhesion values than GBC (p=0.0014) and GC (p=0.0005). In the middle third, there was no difference between groups (p=0.1386). The same sealer in the different thirds only differed significantly in the GBC group, where bond strength was higher in the middle and apical thirds, with a significant difference from the cervical third (p<0.05). There was no difference between failure types in any of the groups (p>0.05).* ***Conclusion:*** *The predominant failure between dentin and sealer was adhesive. It was concluded that the use of AH Plus endodontic sealer resulted in less impairment of the bond strength of resin cemented fiberglass posts compared to bioceramic sealer.*

***Keywords:*** *dentin sealers - endodontics - root canal filling materials - resin cements - post and core technique*

## Influência dos selantes Bio-C e AH Plus na resistência de união de rententores de fibra de vidro através do teste de push-out usando um selante autoadesivo

***RESUMO***

*Dadas as limitações do procedimento de adesão intrarradicular e o significativo desafio de alcançar uma adesão eficaz, é essencial avaliar o impacto potencial de diversos cimentos endodônticos na resistência de união entre pinos de fibra de vidro e a dentina radicular.* ***Objetivo:*** *O objetivo deste estudo foi avaliar a resistência de união do pino de fibra de vidro à dentina radicular em dentes obturados com dois cimentos endodônticos, por meio do teste push-out.* ***Material e Métodos:*** *Foram instrumentados 45 dentes unirradiculares, obturados pela técnica do cone único, divididos em três grupos de acordo com o cimento selecionado (n=15), Bio-C Sealer (GBC), AH Plus (GAH) e o grupo controle, sem cimento (GC). O espaço do canal radicular cimentado com o pino+ cimento resinoso autoadesivo RelyX U200, seccionados, uma fatia em cada terço, em terços cervical, médio e apical. A resistência de união foi avaliada por meio do teste por extrusão push-out e os modos de falha observados em microscópio, sendo classificados em adesiva, coesiva e mista nos terços cervical, médio e apical.* ***Resultados:*** *Os resultados mostraram diferença entre os grupos no terço cervical e apical, no qual o GAH teve maior adesão que o GBC no terço cervical (p=0.0015), sem diferença do GC. E no terço apical o GAH teve maiores valores de adesão que o GBC (p=0.0014) e GC (p=0.0005). No terço médio não houve diferença entre os grupos (p=0.1386). Comparando o mesmo cimento em terços diferentes, houve diferença significante somente no grupo GBC que apresentou maior resistência de união no terço médio e apical com diferença significante em relação ao terço cervical (p<0.05). Não houve diferença entre os tipos de falhas em todos os grupos avaliados (p>0.05) e foi observado um predomínio de falha adesiva entre dentina e cimento.* ***Conclusão:*** *Concluiu-se que, o uso do cimento endodôntico AH Plus propiciou menos interferência na resistência de união de pinos de fibra de vidro cimentados com o cimento resinoso quando comparado ao cimento biocerâmico.*

***Palavras-chave:*** *adesivos dentários - endodontia - materiais para obturação de canal radicular - cimentos resinosos - pinos de retenção dentária*

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## INTRODUCTION

The clinical and biological success of endodontic treatment depends on a sequence of procedures, including root canal disinfection and obturation, sealing access to the cavity, and amount of remaining dentin[1]. Endodontic sealer is used for root canal obturation to promote the interface between dentin and gutta-percha[2]. The obturation phase is challenging due to the difficult adhesion between the proposed obturation materials and the walls of the root canals.

AH Plus endodontic sealer is considered the gold standard due to its excellent intratubular penetration properties, sealing capacity and non-interference of the endodontic sealer with the resin adhesive[1]. On the other hand, bioactive endodontic sealers have been developed to improve the quality of root canal obturation[3], and bioceramic sealers such as Bio-C are becoming increasingly popular due to their ability to bond with the dentin surface and form hydroxyapatite[4].

Fiberglass posts have similar physical properties to dentin, including modulus of elasticity, compressive strength, flexural strength and coefficient of thermal expansion, and provide advantages such as esthetics and biocompatibility[5]. Fiberglass posts can be cemented with conventional or self-adhesive resin sealers. The latter do not require pretreatment of the tooth surface, so the technique is simpler, thereby reducing sealing procedure time and risk of failure in the clinical steps[6]. The main cause of clinical failure of a fiberglass post is debonding at the dentin-sealer interface because of the degradation of the resin sealer-dentin bond over time[7].

Various techniques have been reported in the literature to evaluate the bond strength of materials, including the conventional pull-out and push-out tests. Push-out tests provide better simulation of clinical conditions[4], and enable evaluation of the effectiveness of adhesion in different regions of the canal, identifying precisely where the failures occur[8].

Given the limitations of the intraradicular adhesion procedure and the great challenge of achieving effective adhesion, it is important to evaluate the possible influence of different endodontic sealers on the bond strength of fiberglass posts to root dentin. Since there are few publications on the adhesion of bioceramic sealers, it was decided to compare them to AH Plus sealer, which is widely discussed in the literature due to its excellent properties.

The aim of this study was therefore to evaluate the bond strength between the fiberglass post cemented with self-adhesive resin sealer and the root dentin in teeth filled either with the bioceramic sealer Bio-C Sealer (Angelus, Londrina, Brazil) or with AH Plus (Dentsply Sirona, North Carolina, USA), using the push-out test. The null hypothesis tested was that the two sealers are similar both in terms of bond strength between the fiberglass post and the root dentin, and in terms of failure mode.

## MATERIAIS AND METHOD

### Tooth selection and sample preparation

This study was approved by the Ethics Committee for Human Research of the São Leopoldo Mandic Research Institute (Approval number: 3.645.466).

Forty-five single-rooted human teeth provided by the institutional Tooth Bank were divided into three groups. The sample size of 15 specimens per group, calculated by the Biostat 5.0 program, allowed a test power of 80% with a type I error probability of 0.05 and an effect size of 0.18.

The inclusion criteria were teeth with a single round canal of similar shape, size and diameter, with fully developed roots, with root curvatures of up to 15° according to Schneider[9] and an initial foramen diameter corresponding to a Kerr file #15. The round shape of the canals was verified radiographically, evaluating the symmetry between the vestibulolingual and mesiodistal distances. Exclusion criteria were teeth with calcifications, fissures, pathologic root resorption (internal, external or apical), root caries, previous endodontic treatment and root cracks visible under a surgical microscope with 10x magnification. The coronal section of each tooth was removed under water cooling with a double-sided diamond disk placed below the cementoenamel junction. The root portion was standardized to an average length of 15 mm in the apical-cervical direction, measured with a conventional ruler and checked with a digital caliper. After preparation, the roots were immersed in distilled water and stored in an oven at 37 °C for rehydration until the tests were performed.

### Endodontic treatment and division into experimental groups

For root canal instrumentation, the working length was determined 1 mm short from the foramen, as a with a #15 Kerr file tip was observed in the foramen under microscope at 12.5x magnification. All canals were prepared using a Logic 40./05 system (Bassi/Easy Equipamentos, Belo Horizonte, Brazil) driven by a Bassi iRoot Pro motor at 950 rpm and torque 4 N. After instrumentation, ultrasonically activated irrigation was performed to remove the smear layer, using an Irrisonic insert at 10% power and 30,000 Hz frequency, inserted 2 mm from the working length. Three 20-second cycles were performed with 2.5% NaOCl (5 mL), 17% EDTA (ethylenediaminetetraacetic acid) (5 mL), and 2.5% NaOCl (5 mL). The canals were irrigated with 5 mL of distilled water to remove the solutions. Finally, they were dried with an Ultradent suction cannula and capillary tip attached to a high-powered aspirator and 40-gage suction paper tips.

A special random distribution program (http://www.random.org) was used to randomize the teeth into three groups (n=15) according to the endodontic sealer to be used. The protocol followed is shown in the flow chart in Fig. 1.

The groups were established as follows:

- Control group (GC): no endodontic sealer.
- Bio-C Sealer group (GBC): Bio-C Sealer, an endodontic sealer based on calcium silicate, which comes in a "ready-to-use" syringe.
- AH Plus group (GAH), AH Plus, an epoxy resin-based endodontic sealer in paste/paste presentation, which was mixed with a flexible spatula No. 24, so that the portions were the same for all samples.

The root canals were obturated with a single 40/05 guttaperchacone, 1 mm from the foramen. The sealers were placed in the canal with the gutta-percha cones and the thermoplastic tip and cold vertical compaction was performed. The teethwere then sealed with a temporary filling material (Coltosol, Coltene, Lezennes, France) and stored in an oven at 37 °C and 100% relative humidity for one week. The teeth were then sealed with a temporary filling material (Coltosol, Coltene, Lezennes, France) and stored in an oven at 37 °C and 100% relative humidity for one week.

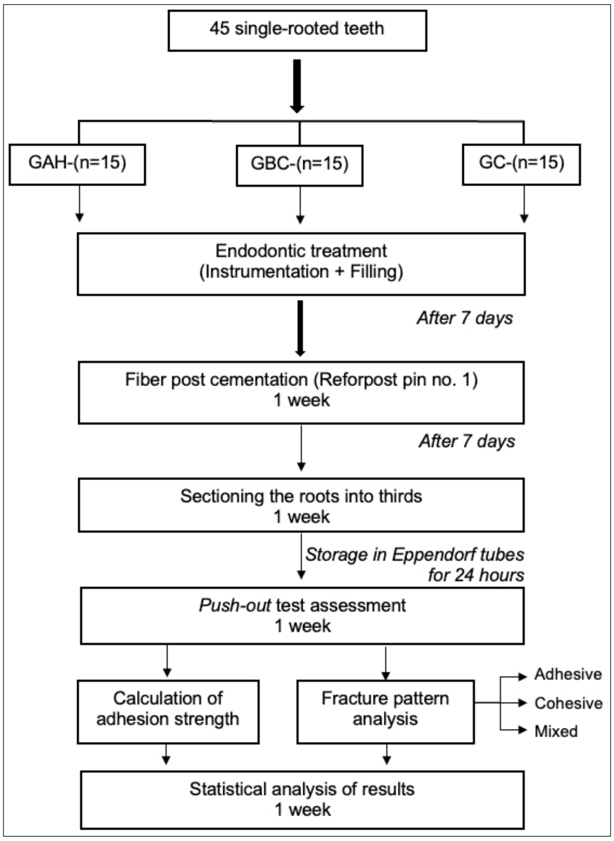


*Fig. 1: Flow chart of the protocol followed in the experimental phase of this study.*

**Preparation of the intra-radicular prosthetic space**

Seven days after root canal obturation, the specimens were prepared for the insertion of fiberglass posts. The canals were partially exposed with Gates-Glidden #4 drills (Dentsply Sirona, Charlotte, USA) until an intraradicular length of 10 mm was reached. The preparation was then refined with Largo #3 burs (Dentsply Sirona) at low speed, following the fiber post manufacturer's instructions (Reforpost #1 post, Angelus, Londrina, Brazil) (Fig. 2).

After preparation for the post, the canals were irrigated with 1 mL of saline to remove debris and residual filling material, and then dried with absorbent paper points. The posts were immersed in 70% alcohol for one minute to remove oil and debris. The surfaces were treated with 37% phosphoric acid for 15 seconds, washed, and silanized for one minute, as recommended by the manufacturer, and then dried with a gentle stream of air.

The fiberglass posts were cemented with RelyX U200 self-adhesive resin sealer (3M do Brasil, Sumaré, Brazil), prepared according to the manufacturer's recommendations and inserted into the canal with a needle-shaped injection tip on a Maquira syringe. Immediately afterwards, the post was inserted into the root canal and the excess was removed with a microbrush. The cervical area of the roots was

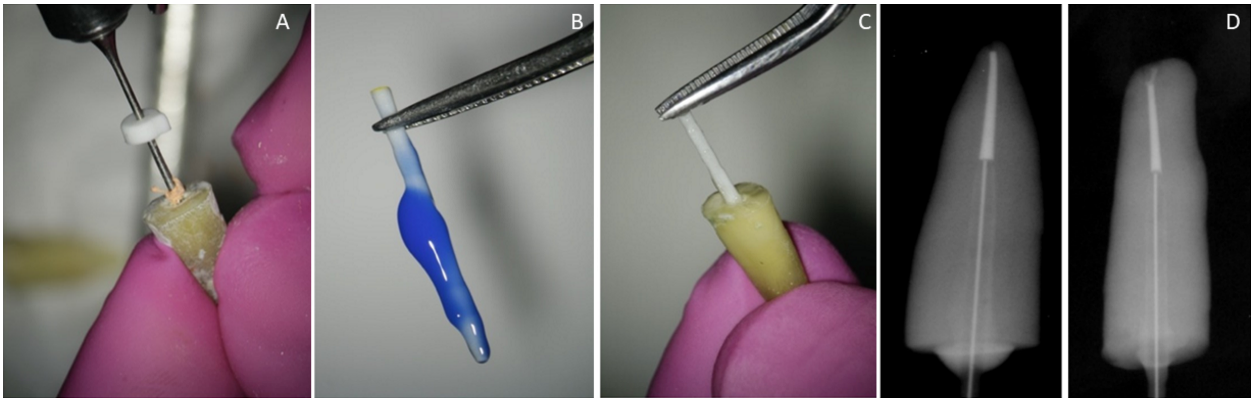


*Fig. 2: Illustrative sequence of fiber post cementation and radiographic confirmation of adaptation*

photoactivated for 60 seconds at a power of 1,200 milliwatts/cm$^2$ using a Radii-Cal photopolymerizer (Mosharraf & Zare[10]). After sealing the fiber posts, their fit was confirmed radiographically. The samples were stored in an environment at 100% humidity and temperature 37°C for seven days prior to testing.

The cemented root canal space was divided into cervical, middle and apical thirds. The roots were attached to a glass plate with sticky red wax. An IsoMet 1000 slicer (Buehler, Illinois, USA) with a 4”x12x1⁄2 EXTEC disk (Vilas-Boas et al.[1]) was used to cut 1.5 mm slices perpendicular to the long axis. The central slice of each third of the post space was selected and stored in an Eppendorf tube with distilled water for 24 hours.

**Mechanical extrusion shear test (push-out)**

For the mechanical push-out test, each sample was positioned on a stainless-steel metal base on a universal testing machine (EMIC DL 2000, Instron Brasil Equipamentos Científicos Ltda, São José dos Pinhais, Brazil), equipped with a force of 2000 kgf. The disks were arranged so that the smaller base was facing upwards and the cervical side was in contact with the base. The force was applied from apical to coronal. A metal rod with a diameter of 1.0 mm and an active tip was attached to the clamp of the machine (Fig. 3) and positioned in the center of the fiber post.

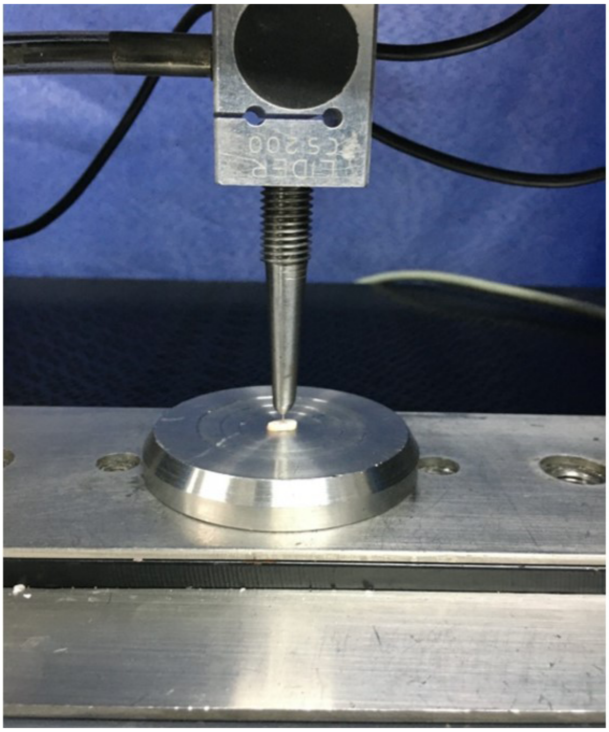

*Fig. 3: Representative image of the slices adapted to the universal testing machine for the mechanical extrusion shear test (push-out).*

The resistance test was performed at a rate of 1.0 mm/min until the pin and seal assembly was displaced or the specimen broke. The values were determined in Newtons, and the adhesive force of each disk was calculated by dividing the breaking force by the cross-sectional area in MPa. The adhesion area was calculated using the following formula: $A = \pi(R + r) [h2 + (R – r)2]0.5$, where $\pi$ is the fixed constant 3.14, R is the radius of the cemented post on the coronal side, r is the radius of the cemented post on the apical side and h is the thickness of the disk. The values obtained were tabulated and subjected to statistical analysis.

After push-out, the specimens were analyzed at 12.5x magnification in a DF Vasconcelos microscope to identify failure mode, which was classified as adhesive failure between dentin and sealer, cohesive failure in dentin, or mixed failure (Fig. 4).

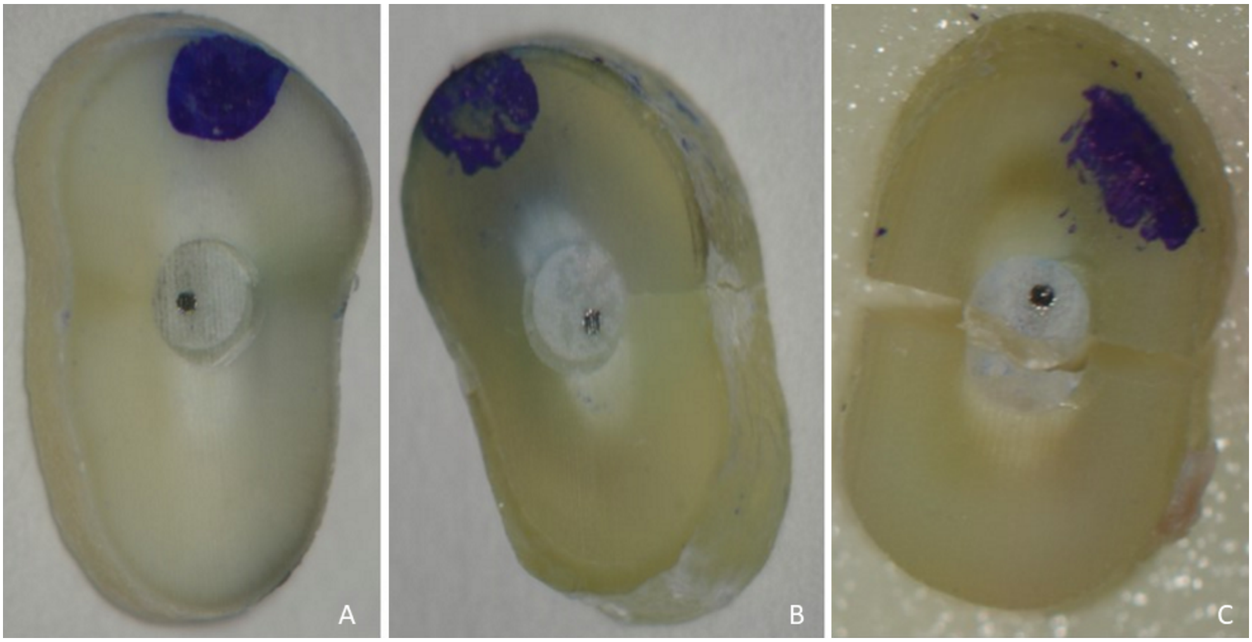

*Fig. 4: Representative image of slices showing the types of gaps presented after the push-out test.*

## RESULTS

The results were analyzed using the Biostat 5.0 program. The D'Agostino normality test showed non-normal behavior. The non-parametric Kruskal-Wallis (Student-Newman-Keuls) test was applied with a significance level of 1%.

Table 1 shows the medians and standard deviations of the push-out bond strength values according to endodontic sealer used. Fig. 5 shows the arithmetic means in a column diagram. In the cervical third, the highest bond strength occurred with the AH Plus sealer, with a significant difference only to Bioceramic sealer (p=0.0015). In the middle third, there was no significant difference to any studied groups (p=0.1386). In the apical third, the highest bond strength occurred with AH Plus sealer, with a significant difference to Bioceramic sealer (p=0.0014) and control (p=0.0005) (Table 1 and Fig. 5).

Comparing the same sealer in different thirds, there was significant difference only to Bioceramic sealer, which presented higher bond strength in the middle and apical thirds, with a significant difference in relation to the cervical third (p<0.05). The other comparisons did not present statistically significant differences (p>0.05) (Table 1 and Fig. 5).

Regarding failure types, no differences were observed among the endodontic sealers BC (Bioceramic Sealer), AH (AH Plus Sealer), and C

**Table 1. Medians, interquartile deviations and statistical analysis of the bond strength (MPa) of the endodontic sealers BC (Bioceramic Sealer), AH (AH Plus Sealer) and C (control group) in the Cervical (C), Middle (M) and Apical (A) thirds.**

| | BC | AH | C | (p) |
|---|---|---|---|---|
| **C** | 1.70 (1.90)$^{a1}$ | 3.95 (3.04)$^{a2}$ | 2.30 (2.62)$^{a1,2}$ | **<0.05** |
| **M** | 3.34 (2.38)$^{b1}$ | 4.29 (3.63)$^{a1}$ | 4.83 (3.54)$^{a1}$ | **>0.05** |
| **A** | 4.11 (1.97)$^{b1}$ | 5.90 (3.12)$^{a2}$ | 2.93 (2.46)$^{a1}$ | **<0.01** |
| **(p)** | **<0.05** | **>0.05** | **>0.05** | |

Different letters in the vertical direction and different numbers in the horizontal direction denote statistically significant differences.

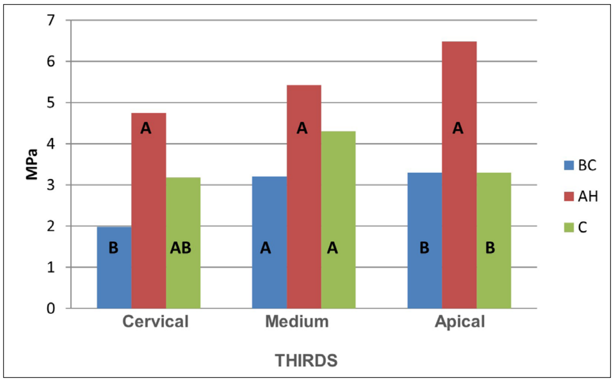

*Fig. 5: Arithmetic means of the bond strength (MPa) of the endodontic BC (Bioceramic), AH (AH Plus Sealer) and C (control group) in the Cervical (C), Middle (M) and Apical (A) thirds. Legend: BC: Bioceramic Sealer, AH: AH Plus Sealer and C: control group.*
*Different letters denote statistically significant differences.*

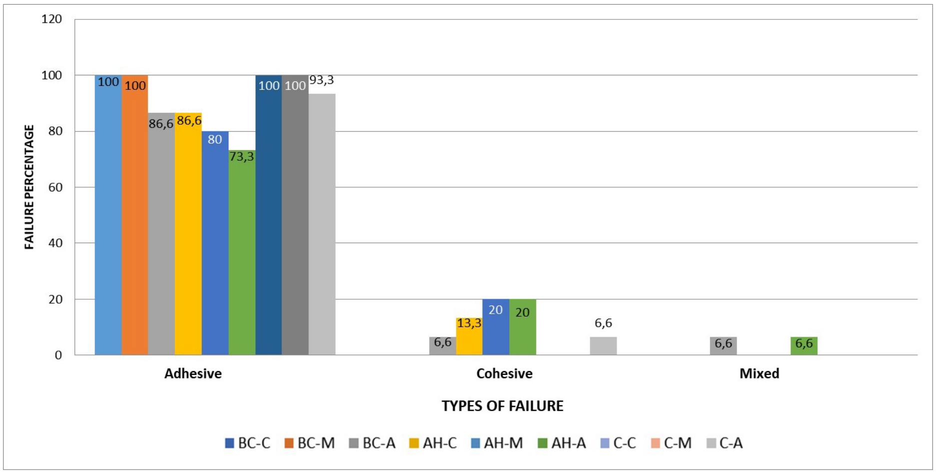


*Fig. 6: Percentage of fracture types presented by endodontic BC (Bioceramic), AH (AH Plus) and C (control group) in the Cervical (C), Middle (M) and Apical (A) thirds.*
*Legend: BC-C: bioceramic cervical third; BC-M: bioceramic middle third; BC-A: bioceramic apical third; AH-C: AH Plus cervical third; AH-M: AH Plus middle third; AH-A: AH Plus apical third; C-C: control cervical third; C-M: control middle third; C-A: control apical third.*

**Table 2. Medians, interquartile deviations and statistical analysis of the types of failure presented by the endodontic sealers BC (Bioceramic Sealer), AH (AH Plus Sealer) and C (control group) in the Cervical (C), Middle (M) and Apical (A) thirds.**

| | BC | AH | C | (p) |
|---|---|---|---|---|
| **C** | 1.00 (0.00)A | 1.00 (0.00)A | 1.00 (0.00)A | **>0.05** |
| **M** | 1.00 (0.00)A | 1.00 (0.00)A | 1.00 (0.00)A | **>0.05** |
| **A** | 1.00 (0.00)A | 1.00 (0.50)A | 1.00 (0.00)A | **>0.05** |
| **(p)** | **>0.05** | **>0.05** | **>0.05** | |

Failure type scores: Adhesive 1; Cohesive: 2 and Mixed: 3. Equal letters and numbers in the vertical and horizontal directions denote absence of statistically significant differences.

(control group) in the cervical, middle, and apical thirds (Fig. 6 and Table 2).

## DISCUSSION

The null hypothesis regarding bond strength was rejected because the different endodontic sealers influenced the bond strength of the fiberglass post to the root dentin in the cervical and apical thirds of the post. The null hypothesis regarding failure type was accepted because there was no difference between the tested groups. In the present study, the control group was treated only with gutta-percha, without endodontic sealer, as frequently reported in the literature [1,4,8,11,12], so that the endodontic sealer was the only variable between the control group and the experimental groups.

Fiberglass posts are often used in the rehabilitation of endodontically treated teeth. The main factors that affect the retention of posts are dimensions (length, diameter), shape (conical, cylindrical), type of surface (fluted, threaded or smooth), intracanal space preparation, type of sealer, and the skill of the practitioner[11]. The procedures in this study were performed by a single experienced operator. Reforpost fiber post No. 1 (Angelus) is made of fiberglass, pigmented epoxy resin and a stainless steel filament, has a parallel shape with apical taper and serrated surface. It was selected because it contains a steel filament which enables radiographic visualization to verify post positioning in the intraradicular space.

The intraradicular length used was 10 mm, respecting the 5 mm wide space of the canal obturation, as reported by Baena et al.[13], Vilas-Boas et al.[1] and Chen et al.[14].

The push-out (or extrusion shear test) was used in this study because it provides great precision in the measurement of sealer resistance, evenly distributed stress, and low variability in the mechanical test, thereby enabling evaluation of the differences in bond strength between the root thirds. It is therefore recommended for determining the bond strength of fiberglass posts to intraradicular dentin[10,11,15].

The irrigation solution used is one of the factors that may affect the adhesion of the fiberglass post to the root dentin. Chemical adjuvants in the irrigating solution, such as NaOCl and EDTA in different concentrations, are commonly used and widely accepted for removing organic and inorganic residues from the root canals. While the halogenated solution promotes the dissolution of organic tissue, the chelating agent acts on the inorganic portion of the smear layer[10,15,16]. Thus, to simulate the clinical mode, we used 2.5% NaOCl and 17% EDTA as rinsing solutions.

The relationship between the adhesion of fiberglass posts and the type of endodontic sealer used in root canal filling has been extensively discussed in the literature because some endodontic sealers can have negative effects on resin sealer polymerization, thereby compromising the longevity of restorations held in place by intraradicular posts[1,2,4,8,10,11,17].

Vilas-Boas et al. found no difference in the bond strength of the fiber post when different sealers were tested[1]. However, the present study found in the apical third of the post space, bond strength was lower in the control group than in the AH Plus group, suggesting that the AH Plus sealer does not impair post adhesion, and may promote better retention. This may be due to the presence of residual resin from the AH Plus endodontic sealer on the canal walls, which could foster interaction with the resin sealer, as shown by Mosharraf & Zare[10].

Bioceramic endodontic sealers based on calcium silicate are recognized for their biocompatibility and ease of use due to their premixed form[14]. In this study, sealers were used with a gutta-percha cone to standardize methodology. There are few studies on the adhesion of fiber posts with bioceramic sealers, which have only been introduced recently. There is no consensus on the timing for post space preparation after obturation. Rosa et al.[17] found no effect of timing on post adhesion, in agreement with Menezes et al.[18] and Vilas-Boas et al.[1]. However, other studies, such as Yuanli et al.[2], noted lower adhesion with immediate cementation. The current study prepared the posts after seven days, following Ozcan et al.[8] and Bengoa et al.[12], to ensure complete curing.

Resin cements are used for cementing fiberglass posts, and the literature contains numerous studies evaluating their effects on the bond strength of fiberglass posts. They can be divided into conventional cements (which were preceded by adhesive systems) and self-adhesive cements. Bengoa et al.[12], Yuanli et al.[2], and the current study used the self-adhesive sealer U200 to install fiberglass posts, but other studies such as Dibaji et al.[4] and Vilas-Boas et al.[1] used conventional sealers. In contrast to the adhesion mechanism of conventional resin sealers, self-adhesive ones do not form a pronounced hybrid layer or a resin tag. There is surface interaction with the dental substrate due to the chemical interaction with the calcium of the hydroxyapatite[7,13]. Although self-adhesive sealers have been reported to have lower adhesion values than conventional ones by Chávez-Lozada, Urquia-Morales[6], they were proposed by Sarkis-Onofre et al.[19] in a systematic review for better retention of fiberglass posts in root canals. They are easy to handle, have dimensionally stable mechanical retention properties, have better physical properties than conventional ones, are moisture tolerant, have good compressive strength and microhardness, and are less sensitive to technique due to their one-step nature, as they do not require pretreatment with bonding agents on the tooth surface, which makes their clinical application attractive[7]. The self-adhesive sealer RelyX U200 was chosen for fiber post adhesion in this study.

Although there is no consensus on the best method for removing debris from the root canal post space, treating dentin with NaOCl and EDTA may enhance bond strength between resin sealer and dentin. Baena et al.[13] found that bond strength increased when dentin was treated with phosphoric or polyacrylic acid before sealing. Phosphoric acid removes the smear layer and demineralizes the dentin, enhancing resin infiltration and micromechanical interlocking. Polyacrylic acid partially removes the smear layer and creates a surface that enhances chemical interaction with resin sealers. However, conditioning with 17% EDTA showed no adhesion benefit, in agreement with Moura et al.[16], who found no influence of EDTA on RelyX U200 adhesion. EDTA, a chelating agent, lowers calcium levels and does not enhance micromechanical bonding. Studies by Martinho et al.[20] and Chen et al.[14] found ultrasound activation ineffective in improving smear layer removal and bond strength. Ferreira et al.[15] highlighted the importance of cleaning dentin walls under microscopy for better adhesion. Given the controversy, the current study chose not to pretreat the dentin, using only a saline solution rinse, as the self-adhesive sealer does not require pretreatment.

Some studies compare fiber post adhesion by root third regions[2,4,8,12,21], as was done in the current study. We observed greatest adhesion in the apical third, followed by the middle and cervical thirds for both sealers evaluated, although the difference was significant only in the Bioceramic group. This agrees with Jha & Jha[21], who attributed the difference to stronger reamer wear in the apical thirds than in the cervical thirds during canal preparation for the post. This may eliminate sealer residues in the dentin and facilitate interaction with the sealing agent.

Boing et al.[22] linked the effectiveness of RelyX U200 sealer to its reaction with hydroxyapatite, noting that adhesion was better in the apical third due to more available calcium and increased contact with canal walls supporting both chemical and mechanical retention. In the current study, the lower adhesion in the cervical third with bioceramic sealer (GBC) compared to AH Plus (GAH) may result from the manufacturer's recommended insertion method, as gutta-percha cones may reduce sealer penetration into tubules and thus, also adhesion.

In contrast, studies such as Menezes et al.[18] and Soares et al.[23] detected greatest adhesion in the cervical third, followed by the middle and apical thirds. This was explained by the fact that there are more dentinal tubules and larger diameters in the cervical third than in the others. In addition, light attenuation by the fiber post decreases with increasing root depth.

In the literature, the lowest values are reported in the apical region, which is associated with the difficulty of the adhesion protocol (several steps for dentin hybridization and the type of resin sealer used), the presence of gutta-percha and sealer residues, and the lack of light that fully reaches the interior of the root canals, which affects the adequate resin sealer curing[20].

Sometimes there is no significant difference between the thirds evaluated, as reported by Ozcan et al.[8] and Baena et al.[13]. These results are confirmed by Pereira et al.[24], who found that the region of the post space did not influence the dual resin sealer conversion. In other words, this homogeneous behavior is explained by the dual curing of the sealer, which enables polymerization where the light does not reach.

This study found that endodontic sealer type influences post adhesion in the cervical and apical thirds, with AH Plus showing stronger adhesion than bioceramic sealer. These findings agree with Vilas-Boas et al.[1], Dibaji et al.[4], and Bengoa et al.[12]. However, Ozcan et al.[8], Rosa et al.[17], and Reyhani et al.[11] found no adhesion differences with calcium silicate or MTA-based sealers, possibly due to the resin component in MTA Fillapex. Yuanli et al.[2] also found no difference between AH Plus and bioceramic sealers with immediate post cementation. No significant differences were found in middle third adhesion, in agreement with Bengoa et al.[12], though this study attributes it to the non-conical Reforpost design rather than to canal morphology.

Failure mode analysis showed no differences between sealers, with prevalent adhesive failures between dentin and sealer, explained by the high C-factor and reduced light intensity in root dentin[17].

The study found differences in bond strength between root dentin and fiberglass posts when self-adhesive resin sealer was used. Bioceramic sealer may compromise post adhesion. Most research, including this study, involves in vitro methods, presenting limitations. Further research is recommended due to the clinical relevance of the issue and potential for treatment failure.

## CONCLUSION

The results suggest that the bond strength of fiberglass posts cemented with U200 self-adhesive resin sealer is affected less by AH Plus than by than the bioceramic sealer. The most common type of failure was adhesive type at the interface between the sealer and the root dentin, regardless of the endodontic sealer used.

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**CONFLICT OF INTERESTS**

The authors declare no potential conflicts of interest regarding the research, authorship, and/or publication of this article.

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