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COMPARATIVE ANALYSIS OF DIFFERENT INSTRUMENTATION TYPES AND ADHESIVE SYSTEMS IN FIBERGLASS PIN RETENTION IN FLATTENED CHANNELS

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ABSTRACT

The objective of this work was to compare the adhesive strength of the prefabricated fiberglass pin in flat channels by means of the tensile removal force. For this, 48 extracted human inferior incisors were selected and randomly divided into four experimental groups of 12 samples each. All teeth were sectioned horizontally, leaving 2 millimeters of dental remnant, so that an average length of 16 millimeters was obtained. The endodontic treatment was performed with the PROTAPER NEXT and iRACE rotary systems and with the RECIPROC and WAVE ONE reciprocating systems up to the diameter of 0.40 and filled with gutta percha cones according to the technique used for each group. For the clearance and preparation of the root canal for cementation of the pins, 5 mm of obturator material was left in the apical third. The cementation of the fiberglass pins was performed according to the adhesive agent. The specimen was placed in the universal test machine and the axial tensile loading at the speed of 0.5 mm/min was applied. Then, the data were analyzed by means of the analysis of variance ANOVA double factor at the 5% level and the unit analyzed was in Kgf. The results showed differences between the strength means in the different groups, where the self-etching adhesive Ambar Universal showed superiority compared to the conventional Ambar adhesive. There was no statistically significant difference between the automated systems, however, the Wave One group presented a higher degree of adhesiveness when compared to the iRace group.

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INTRODUCTION

Rehabilitation of teeth treated endodontically with great loss of coronary structure requires, in most cases, a prosthetic rehabilitation for the success of endodontictreatment,thus minimizing microinfiltration and recontamination of the root canal system. An alternative to an immediate sealing of the channels, protecting them from possible micro infiltrations, are the prefabricated fiberglass pins, which provide retention and resistance to restorations. Its use has become frequent in dental offices, as they offer several advantages: favorable mechanical properties, such as modulus of elasticity similar to dentin and resilience, which ends up considerably decreasing the chances of root fracture (Braz *et al*., 2011), besides improvement in aesthetics (Bulucu, 2010). However, the support of prefabricated pins to intrarradicular dentin through adhesive systems is still somewhat complex. Dentin a dine is based on micromechanical retention devices (Carvalho, 2009).

Thus, it would be due to a sum padding achieved by the formation of resin *tags* within the dentinal tubules, the formation of the hybrid layer and the surface's adhering by the intimate contact of the adhesive with the dentin structure (Casselli, 2007). However, the performance of the adhesive technique in root canals is compromised due to the low humidity control, accessibility during the handling of materials, the difficulty of light curing of the adhesive system, and the highly unfavorable configuration factor of the cavity (Consani, 2007). In the case of an adhesive system that requires prior conditioning, the adhesion can be impaired by the water that migrates to the interface between adhesive and composite, trapped in bubbles, which can act as stress creators, which may result in the detachment of the interface between resin and dentin [(6)]. Clinically, this incompatibility may occur during the cementation of fiber pins in the root canal. The appearance and development of new adhesive agents are totally modifying dental practice, changing some concepts and enabling the realization of aesthetic indirect restorations with greater practicality. The challenge has been the search for a material with adhesive capacity that can overcome the structural differences of biocompatibility and masticatory resistance and with mechanical properties similar to those of the dental structure, resistance to degradation in the oral environment and ability to adhering to the pin and intraradicular dentin. Recently, the Ambar universal adhesive system was developed. The use of this adhesive makes it unnecessary to use acid and (or) primer, as it does not require any pretreatment of dentin. However, the new adhesives need to be evaluated in so that their actual performance can be measured. This work aimed to evaluate the support of fiberglass pins cemented with different adhesive systems in flattened channels and prepared with different techniques.

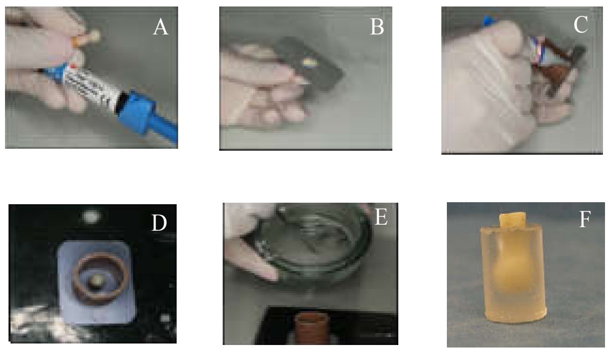
MATERIALS AND METHODS

SELECTION OF SAMPLES: For the development of the present study, 48 human lower incisor teeth were selected. Inclusion criteria were: healthy tooth, apex and complete root formation, single canal and without calcification. The teeth had a similar root diameter in the middle third and external diameter from 4.0 to 5.0 mm in the mesiodistal direction and from 5.0 to 6.5 mm in the buccolingual direction and were chosen in order to facilitate the preparation of the canal for the cementation of the pins. The samples were stored in0.1% yummy solution and then mantid to hydrated with saline solution until the time of use.

PREPARATION OF SAMPLES: After hydration, the specimens were fixed in a small walrus and followed by horizontal sectioning of the crowns, with the use of a carborundum disc mounted on a chuck fitted to the straight part of the dental micromotor, respecting the limit of 2 mm of the remaining coronary portion, measured with the aid of a compass, so that an average length of16 mm was obtained.

ENDODONTIC TREATMENT: The endodontic treatment was performed with the continuous and reciprocating rotational systems of Nickel-Titanium PROTAPER NEXT (PTN), iRACE (iR), RECIPROC (REC) and WAVE ONE (WO) according to each group. Instrumentation with the PTN System (group $G_{1)}$ was performed with rotational files X1, X2, X3 and X4, associated with manual files. Initially,irrigation was performed with hypochlorite at 2.5% and the root canals were operated with the manual file K15, followed by instrumentation with x1 and x2 files and the completion ofsand procedure with rotational files X3 and X4 (40/06). For instrumentation with the iR group (group G_2), catheterization was also performed with the manual file K15, and then the rotational instrumentation with the files R1 (15.06), R2 (25.04), R3 (30.04), and complemented with bio race BR4 (35/04) and BR5 (40/04) files.The PTN and iR files performed continuous rotational movement with the entrance and exit of each file by brushing the root canal. Preliminary explored with the K15 file, the root canals of the following group were instrumented with the file R40 (40/06) (group G_3), an instrument integral to the REC system. To perform the instrumentation with the WO file (group $G_{4)}$, similarly, the same pattern of catheterization was followed with the use of the K15 manualized, soon after, the instrumentation with the Large 40/08 file. The REC andWO files worked in reciprocating motion, and three pecking movements were performed, with advance, recoil and slight apical pressure for each third of the root canal. After these movements, the instruments were removed and their blades were cleaned. All channels were finished with manual file #40 up to the working length established at 16mm,aiming at refinement and irrigated with 5 mL of NaOCl at 2.5% after the application of each instrument, through the use ofa30G needle (NaviTip, Ultradent, South Jordan, Utah, Usa). After the biomechanical preparation of the root canals, they were irrigated with 17% EDTA solution, and stirred with ultrasound insert for 1 min, to remove the dentin mud. Final irrigation of root canals was performed with 10 ml of NaOCl at 2.5% and they were dried with absorbent paper tips. The specimens wereobtained with specific gutta cones-percha for each instrumentation system and with endodontic cement AH Plus. The excess of the filling mass of the cervical part was cut with the aid of Touch's Heat 26 (5004; Kerr, Orange, California, United States), and the crowns were sealed with a small portion of filtek Z350 XT – 3M composite resin.

MAKING SPECIMENS FOR TRACTION: For the preparation of the specimens, a part of approximately 3 mm of Filtek Z350 composite resin was added to the apical third. Soon after, a radiographic film was positioned in the amelo-cementary union, which contained a perforation in the central region with 5 mm in diameter. The root fell 2 mm below the amelo-cementary junction, and was fixed in this position with cyanoacrylato. A PVC ring (Tigre S/A Brazil) was positioned around the root, so that it remained in the center of the ring, which was fixed to the film with cyanoacrylate at its base. The root and film assembly were embedded on a perforated table, and then the acrylic resin was leaked and, after being fastened, it was removed from the PVC ring attached to it (Figure 1).



Source: Own Authorship.

Figure 1. A. Resina composed in the apical third; B: radiographicelicula in the amelo-cementary union; C: aPVC nel positioned around the root and fixed to the film withcyanoacrylato; D: contogether rootand filmembedded on a perforated table; E: acrylicresina; F: Corpo proof.

DIVISION OF GROUPS: Each group (n= 12) was divided into 2 sub-groups with6 samples each, according to the instrumentation system and the adhesive agent used. The following organization chart explains the formation and constitutionof the groups and subgroups mentioned (Chart 1).

Quadro 1. Gp_1S_1 = PTN+ PFV e Ambar; Gp_1S_2 = PTN+ PFV e Ambar Universal; Gp_2S_3 = iR+ PFV e Ambar; Gp_2S_4 = iR+ PFV e Ambar Universal; Gp_3S_5 = REC+ PFV e Ambar; Gp_3S_6 = REC+ PFV e Ambar Universal; Gp_4S_7 = WO+ PFV e Ambar; Gp_4S_8 = WO+ PFV e Ambar Universal

Group Subgroup	PTN	iR	REC	WO
Gp_1S_1	Ambar			
Gp_1S_2	Universal amber			
Gp_2S_3		Ambar		
Gp_2S_4		Universal amber		
Gp_3S_5			Ambar	
Gp_3S_6			Universal amber	
Gp_4S_7				Ambar
Gp_4S_8				Universal amber

Source: Own authorship.

CEMENTATION OF FIBERGLASS PINS: The specimens were prepared leaving in the apical part 4mm of the shutter material. Para tanto, a drill with dimensions corresponding to the dc 0.5 fiberglass pin (White post- FGM) was used, in such a way that the fiber pins were adjusted on the walls of the root canal, providing a thin layer of resin cement. Next, the test of the adaptation of the pins in all specimens that constitute the experimental groups was processed, withthe subsequent preparation of the dental substrate for cementation. Before the cementation of the fiberglass pins, they were salinized. For this procedure, 37% phosphoric acid was conditioned for 20 seconds for cleaning. After washing with water and drying, silane was applied, with the aid of a micro *brush*. After one minute, the surface of the pin was dried for 5 seconds with jets of air.

CEMENTATION OF FIBER PINS WITH ADHESIVE AMBAR: Phosphoric acid 37% was applied for 15 seconds throughout the root canal, with the aid of a *microbrush,* according to the manufacturer. After this time, all acid was removed inside the root canal with water jets and then the channels were dried with absorbent paper tips of compatible diameter. Soon after, two layers of the adhesive were applied with the aid of a *microbrush* brush, and a light air jet was applied to promote the spreading of the film of this product inside the root canal. Next, photoactivation was performed for 60 seconds (Emitter D - Schuster, Santa Maria, RS), with a power of 1250 mW/cm². After applying the adhesive agent to the root canal, two equal parts of the base paste and catalyst of Alkema CORE were mixed in glass plate and taken to the root canal with the aid of a lentil drill. The pins were cemented and light polymerized for 40 seconds, with a light source positioned vertically.

CEMENTATION OF FIBER PINS WITH ADHESIVE UNIVERSAL AMBAR: The techniques applied in the use of this self-adhesive cement were further simplified because they did not require the use of phosphoric acid for the cementation of the pins. Two layers of the adhesive were applied with the aid of a *micro rush brush,* followed by the use of a light air jet to promote the spreading of the film of this product inside the root canal. And then, the photoactivation was done for 60 seconds. On a glass plate, equal parts of the base paste and catalyst of Allcem CORE cement were dispensed with, manipulated according to the manufacturer's guidance. The cement was taken to the root canal with the aid of a lentulus drill, and the pins were cemented and light cured for 40 seconds. After cementation, the samples were packed for 45 days in a greenhouse, in order to maintain the relative humidity of the internal environmentand simulate the oral cavity.

TENSILE RESISTANCE TEST: Inside a plastic cylinder, a cylinder was made on the coronary portion of the fiberglass pin, with self-curing acrylic resin, on which a metal handle was positioned at the top (Figure 2).

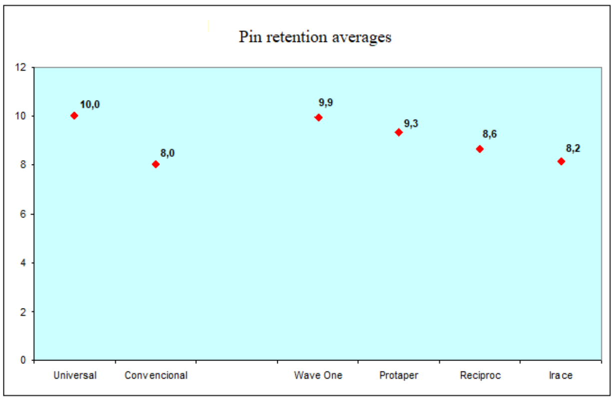
Figure 2. Test body. Souce: Own authorship

The test body was positioned in the universal-EMIC test machine model DL 5000, to which axial traction loading was applied at a speed of 0.5 mm/min. Tensile strength values were obtained in Kgf.

STATISTICAL ANALYSIS: For the statistical analysis, the Analysis of Variance ANOVA double factor was used atthe level of 5%, making an average comparison between the different groups in which the endodontic treatments were performed and between the groups of the two types of adhesives employed.

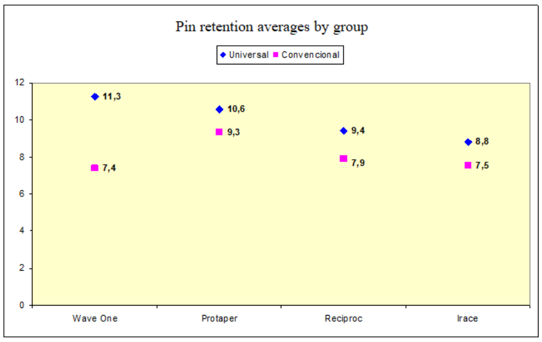
RESULTS

It can be observed that the self-conditioning adhesive was superior to the conventional adhesive in the adhesiveness of the fiberglass pins, with significant difference. Mo., with no significant difference between endodontic treatments in the interaction with the type of adhesive, it was observed that the Wave One system group presented a higher retention of the fiberglass pin. Graphs 1 and 2objectivelyshow the behavior of the glass fiber pin retention averages for the Ambar and Ambar Universal adhesives, as well as for the four endodontic treatments tested. Aiming to be sure about the behavior of treatments and adhesives,variance analysis was performed at the level of 5% to compare the factors (Table 1). It can be concluded that the Universal adhesive obtained a higher average of 10.01 in the retention of the fiberglass pin than the Conventional adhesive, withan average of 8.02.



Source: Search data

Graph 1. Average snare of the fiberglass pin for the four groups



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Graph 2. Averages of fiberglass pin retention per group

DISCUSSION

The loss of the dental structure and the attempt to reduce the level of fractures after endodontic treatment, with the use of intraradicular pins, is a common practice in dentistry. Adhesive procedures play an important role in the long-term success of a restoration and, consequently, in the success of endodontic treatment. Thus, satisfactory support becomes indispensable. In this research, glass fiber pins cemented with different types of adhesives were used. The fiber pins have provided a reduction in the incidence of fractures, making their occurrence less likely, when compared to the metallic pins (Foschi, 2005; Gondo, 2005).

Table 1. Variance Analysis

Universal	Reciproc	Wave One	PTN	iRace	Total
Count	6	6	6	6	24
Sum	56,47	67,66	63,4	52,77	240,3
Average	9,41	11,28	10,57	8,80	10,01
Variance	15,96	9,68	8,62	5,12	9,54
Conventional	**Reciproc**	**Wave One**	**PTN**	**iRace**	**Total**
Count	6	6	6	6	24
Sum	47,26	44,27	55,88	45,17	192,58
Average	7,88	7,38	9,31	7,53	8,02
Variance	11,60	14,25	14,19	11,45	11,81
Total	**Reciproc**	**Wave One**	**PTN**	**iRace**	
Count	12	12	12	12	
Sum	103,73	111,93	119,28	97,94	
Average	8,64	9,33	9,94	8,16	
Variance	13,17	15,02	10,80	7,97	

Source: Search data.

However, Silva (Goracci *et al*., 2007), observing the fracture resistance of teeth submitted to internal whitening and restored with different procedures, concluded that the teeth can be restored with only composite resin, since the use of pins in these teeth did not increase their fracture resistance. In this study, four groups were used – PROTAPER NEXT, iRACE, RECIPROC and WAVE ONE– divided into subgroups according to the adhesive used: Ambar and Ambar Universal. All groups were prepared, cemented and submitted to a universal test machine, and a load was applied at a speed of 0.5 mm / min until the pin was dislodged from the root canal (Goracci, 2006; Liu, 2014). Flattened singleroot teeth were selected, endodontically treated, in which fiberglass pin retention was required as part of the restorative treatment plan (Mallmann, 2005). All crowns were sectioned horizontally, leaving 2 mm of dental remnant. The influence of residual coronary dentin is of fundamental importance, because the risk of rupture is significantly higher in teeth where all coronal walls were lost (Marques, 2016). The preparation and irrigation of the root canal are considered more important than the cementation step of the fiber pin, to increase the union resistance to intraradicular dentin (Martins, 2007). In the present study, the channels were instrumented with the Nickel-Titanium Protaper Next and iRace rotational systems and reciprocating reciprocating systems Reciproc and Wave One, associated with manual files. The preparation of the root canal for pin cementation was performed after endodontic treatment (Foschi, 2005; Martins, 2007; Monticelli, 2008; Morgano, 1999). Muniz (Muniz, 2005), in his study, used a different methodology, in which the preparation for the pin was performed prior to endodontic treatment.

For endodontic filling, endodontic cement AH Plus based on resin and gutta-percha cones was used. The preparation for the fiberglass pins was performed with the drills recommended by the manufacturer, leaving the retentive preparation for the pin in order to provide a smaller cement line, minimizing the effects of Factor-C (Consani, 2007). Faults can also occur at the interface between composite and pin. In order to avoid such failures, various modifications to the surface of the pins are proposed, including chemical and mechanical treatments such as application of silane, hydrofluoric acid, phosphoric acid, hydrogen peroxide and blasting with aluminum oxide particles (Naumann, 2008; Pashley, 2005). In the present study, two treatments were chosen: phosphoric acid for cleaning the fiberglass pin and the application of silane. Errors in the adhesive process can compromise the success of restorative and endodontic treatment. It is known that the main failure in the union of fiberglass pins occurs at the interface between cement and dentin, due to the complexity and sensitivity of the adhesive and cementation technique (Pashley, 1995). In the present study, we used the conventional cement AllCem Core, associated with amber adhesive, which contains MDP in its composition. Functional monomers, such as MDP (meta-criloiloxidecil dihydro-genophosphate), are incorporated into the adhesive in order to improve the ad take, favoring surface wettability and demineralization, and allowing chemical binding to calcium (Quagliatto, 2001; Santos, 2010).

The MDP molecule has a hydrophobic grouping and a hydrophilic grouping, which allows the adhering with the hydrophilic dentin surface and the hydrophobic surface of resinous monomers. Additionally, in the present work, a self-adhesive system, The Universal Ambar, was used, with a view to simplifying the protocol for cementing the pins, eliminating steps considered critical in the suit. A study by Susin (Schneider, 2006) compared the dentin union resistance of three adhesive systems, two self-conditioning systems and one of total conditioning, under three different dentin substrate conditions: moist, dry and rehydrated. The result indicated that wet dentin showed the highest values of union resistance when compared to dry dentin and rehydrated dentin. Thus, it was taken care that the samples were stored in a humidifier, in relative humidity, for a period of 45 days, hoping to have the best result.

The results found in this study did not present statistical differences between the means in the groups of endodontic treatment systems. However, the reciprocating Wave One system proved superior to the iRace rotational system, which is shown in Graph 1. The depth of dentin in the root canal can be considered a possible failure in intraradicular pin retention. According to Mallmann (Schwartz, 2004), there is a significant difference in the regions of the root dentin, since lower values of adhesive resistance were found in the middle and apical thirds. Yoldas and Alaçam (Silva, 2011), testing the microhardness of a resin cement at different depths of root dentin, reported that microhardness could not be evaluated in the apical region due to insufficient polymerization. Casselli (Soares, 2008), evaluating the effect of the mode of application of the adhesive and the strength of the dentin strength of the fiber pin, concluded that, regarding the effects of depth on the union resistance, in the apical third, this resistance was significantly lower than in the other two thirds. Martins (Susin, 2007) andConsani (Turp, 2013), evaluating, in one study, the degree of conversion of a dual cure resin cement, when used in fiber pins with different translucency, demonstrated that the cure of dual resin cement in the apical third was compromised. On the other hand, Gondo (Van Landuyt, 2008) reported that there was no statistical difference between the cervical, middle and apical thirds in the resistance of resin cements and adhesive systems in the cementation of the fiberglass pin. The influence of the type of bonding agent and root dentin on adhesive cementation with conventional and self-adhesive resin cement of glass fiber aesthetic pins is essential, because self-conditioning cement has higher values of adhesive resistance (Liu, 2014). A movement of dentin fluids occurs through adhesives when they are applied to root canals. On the surfaces of all full conditioning and *self-etch* adhesives, fluid transudation was observed. On the other hand, the total conditioning adhesive is devoid of fluid droplets (Mallmann, 2005). Based on the result of this work, the use of self-conditioning adhesives seems to be an excellent alternative. The important thing of the proposed technique, using the specific drill of the fiberglass pin itself, indicated by the manufacturer, is that there was a perfect adjustment between the pin and the channel walls, considerably reducing the resin cement film (Muniz, 2005).

Different stages of endodontic treatment can influence the structure of the teeth and a significant destabilization occurs after access and preparation for pin. Therefore, both the loss of substances and the modifications of the natural geometry within the root canal play an important role (Yoldas, 2005). In this sense, it is fundamental to know the endodontic instruments used during the biomechanical preparation of root canals, since the diameter of the file should be as close as possible to that of the pin indicated for the root canal, in order to avoid a stress and a deformation of the root, thus promoting the improvement of the adhesivity between the dentin and the intraradicular pin.

CONCLUSION

Based on the data obtained during the tensile strength tests and the results of the statistical analysis, it is concluded:

- The adhesive agents tested showed significant differences: the Ambar Universal self-conditioning adhesive was superior to the Ambar adhesive.
- There was no difference between the automated systems tested, although the Wave One reciprocating group demonstrated higher degree of adhesivity when compared to the iRace rotational group, even statistically insignificant.

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