PONTIFÍCIA UNIVERSIDADE CATÓLICA DE MINAS GERAIS
Programa de Pós-graduação em Odontologia

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AVALIAÇÃO DA RESISTÊNCIA ADESIVA ATRAVÉS DO TESTE DE *PUSH OUT* DE PINOS DE FIBRA DE VIDRO CONVENCIONAL E ANATÔMICO EM FUNÇÃO DO CIMENTO UTILIZADO

Belo Horizonte
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Dissertação apresentada ao Programa de Pós-graduação em Odontologia da Pontifícia Universidade Católica de Minas Gerais, como requisito parcial para a obtenção do título de Mestre em Odontologia, Área de Concentração: Clínicas Odontológicas – Área Temática: Prótese Dentária.
Linha de Pesquisa: Propriedades físicas, químicas e biológicas dos materiais Odontológicos.

Orientador: Prof. Dr. Frank Ferreira Silveira

Belo Horizonte
2018

FICHA CATALOGRÁFICA
Elaborada pela Biblioteca da Pontifícia Universidade Católica de Minas Gerais

S676a

Soares, Patrícia Maia Costa
Avaliação da resistência adesiva através do teste de *push out* de pinos de fibra de vidro convencional e anatômico em função do cimento utilizado / Patrícia Maia Costa Soares. Belo Horizonte, 2018.
54 f. : il.

Orientador: Frank Ferreira Silveira
Dissertação (Mestrado) – Pontifícia Universidade Católica de Minas Gerais. Programa de Pós-Graduação em Odontologia

1. Cimentos dentários. 2. Pinos dentários. 3. Cimentação. 4. Adesivos dentários. 5. Resistência de materiais. I. Silveira, Frank Ferreira. II. Pontifícia Universidade Católica de Minas Gerais. Programa de Pós-Graduação em Odontologia. III. Título.

CDU: 616.314:615.46

Ficha catalográfica elaborada por Rosane Alves Martins da Silva – CRB 6/2971

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DATA DA APRESENTAÇÃO E DEFESA: 15 de março de 2018

A dissertação, nesta identificada, foi aprovada pela Banca Examinadora

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AGRADECIMENTOS

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Agradeço a Deus por todas as bênçãos recebidas nesta caminhada. Agradeço a **Ivan, Natália e Felipe**, que não só me ajudaram como souberam me dar colo nos momentos de desespero, quando pensei várias vezes em desistir; que souberam compreender minhas ausências; que não mediram esforços para concretização deste sonho.

Agradeço aos meus pais, que sempre foram meus maiores incentivadores. A eles, devo a vida. Eles foram até aqui minha fortaleza, meu refúgio, meu abrigo. **Obrigada pai, obrigada, mãe.**

Agradeço a minhas irmãs, em especial, a Elisângela, que desde o começo me proporcionou condições para realizar o mestrado, além de sempre acompanhar com presteza cada detalhe. Obrigada, minhas companheiras, minhas irmãs. Amo vocês.

Agradeço a Tia Valmira, Marco e Mel, que me suportaram por longos dias, durante dois anos, de maneira carinhosa e acolhedora. Marco e tia, vocês foram verdadeiros pais. Muito obrigada.

Agradeço ao meu orientador, Frank, que, com muita paciência, soube me guiar na construção deste sonho.

Agradeço ao amigo que a pesquisa na UFMG me deu, Ivson, que não mediu esforços para esclarecer minhas dúvidas e me conduzir no caminho certo. Muitíssimo obrigada.

Agradeço aos meus colegas de mestrado, Alyssa, Bel, Bia, Mari, Ricardo, Daniel, que dividiram comigo muitas angústias, muita euforia e alegria. Obrigada amigos, vocês serão sempre lembrados.

Agradeço aos professores da PUC, que dividiram sua experiência profissional e acadêmica, com muita competência e profissionalismo.

Não poderia deixar de agradecer aos funcionários da instituição, em especial a Silvania e Angélica, que sempre ajudaram na concretização deste sonho.

“Gratidão é o segredo. Tanto pelas coisas boas que aconteceram, quanto pelas coisas que no final viraram lição.” (AUTOR DESCONHECIDO).

RESUMO

O objetivo deste trabalho foi avaliar a força de resistência adesiva dos pinos de fibra de vidro convencional e o pino de fibra de vidro individualizado com resina composta, também chamado de pino de fibra de vidro anatômico. Foram selecionados 72 dentes bovinos unirradiculares, que tiveram suas coroas seccionadas na junção amelocementária em máquina de cortes precisos. Em seguida, as raízes receberam tratamento endodôntico sendo os canais desobstruídos em comprimento de 12 mm para receber pino de fibra de vidro. Foi realizado o espaço para núcleo em formato irregular em 9 mm de comprimento simulando desgaste excessivo da dentina. Para cimentação, os espécimes foram distribuídos aleatoriamente em 6 grupos experimentais (N=12), conforme o tipo de pino usado, anatômico ou convencional e o cimento resinoso utilizado (Relyx U200, Allcem, Allcem Core). A comparação entre os dois tipos de pino em relação à resistência adesiva foi realizada utilizando-se o teste *Mann-Whitney*. O teste de *Friedman* mostrou que não houve diferença estatisticamente significativa ($p > 0,05$) nos valores de resistência de união em cada cimento resinoso entre os terços radiculares. Para o mesmo pino o teste de *Kruskal-Wallis* também mostrou que não houve diferença estatisticamente significativa ($p > 0,05$) nos valores de resistência de união entre os cimentos resinosos em cada terço radicular. Concluiu-se que o tipo de pino, convencional e anatômico, não influencia nos valores de resistência de união em cada cimento resinoso entre os terços radiculares.

Palavras-chave: Resistência adesiva. Pino de fibra de vidro. Pino de fibra de vidro anatômico. Cimento resinoso.

ABSTRACT

The objective of this work was to evaluate the strength of adhesive strength of the conventional fiberglass posts and the fiberglass posts individualized with composite resin, also called an anatomical fiberglass post. We selected 72 uniradicular bovine teeth, which had their crowns sectioned at the cemento enamel junction in a precision cut machine. Then, the roots received endodontic treatment, the canals were unobstructed in length of 12 mm to receive fiberglass post. The 9 mm long irregular core space was used to simulate excessive dentine wear. For cementation, the specimens were randomly distributed in 6 experimental groups (N = 12), according to the type of pin used, anatomical or conventional and the resin cement used (Relyx U200, Allcem, Allcem Core). The comparison between the two post types in relation to the adhesive strength was performed using the Mann-Whitney test. The Friedman test showed that there was no statistically significant difference ($p > 0.05$) in the bond strength values in each resin cement between the root thirds. For the same post, the Kruskal-Wallis test also showed that there was no statistically significant difference ($p > 0.05$) in the bond strength values between the resin cements in each root third. It was concluded that the conventional and anatomical post type does not influence the bond strength values.

Keywords: Adhesive strength. Fiberglass post. Anatomical fiberglass pin. Resin cement.

LISTA DE ABREVIATURAS E SIGLAS

ACC	- Cimento Resinoso Allcem Core, FGM
ACD	- Cimento Resinoso Allcem Dual, FGM
U200	- Cimento Resinoso Relyx U200
TM	- terço médio
TA	- terço apical
TC	- terço cervical
CEUA	- Comitê de ética no uso de animais

SUMÁRIO

1 INTRODUÇÃO

Em dentes tratados endodonticamente com grande perda de estrutura dentinária, tem sido indicado o uso de pinos de fibra para retenção do material restaurador ou reabilitação protética (MORGANO, 1996). Um dos fatores importante, que pode influenciar a longevidade das restaurações em dentes com remanescente dentinário insuficiente, é a capacidade de retenção dos pinos de fibra de vidro (BATEMAN; RICKETTS; SAUNDERS, 2003). A resistência de fratura de um dente tratado endodonticamente depende da quantidade de estrutura dentária remanescente e da escolha do material restaurador ideal (BALKAYA; BIRDALB, 2013). A escolha do material para reconstruir dentes tratados endodonticamente, tem indicado material com características mecânicas mais próximas da dentina, como é o caso dos pinos de fibra de vidro, que são facilmente utilizados e diminuem o risco de fratura, uma vez que possuem módulo de elasticidade bem próximo da dentina (ASLANTAS et al., 2014).

Estudos têm demonstrado que a grande vantagem dos pinos de fibra de vidro em relação aos pinos metálicos está relacionada ao modo de fratura, sendo observado um número maior de fraturas catastróficas nos pinos metálicos (DURET; REYNARD; DURET, 1990). Desta forma, as fraturas que ocorrem com os pinos de fibra são mais frequentemente observadas no nível da coroa, podendo em muitas situações ser recuperáveis (SORRENTINO et al., 2007). Essa diferença se dá devido à necessidade de maior remoção de tecido para colocação do pino metálico, enquanto o preparo do espaço para pino de fibra de vidro deve conservar a estrutura coronária e radicular. A forma de retenção está associada à geometria do preparo, às características do pino, como conicidade, comprimento, diâmetro, textura e ao agente cimentante (FARIA et al., 2011). A resistência relaciona-se à estrutura dental remanescente que afeta a capacidade do pino e do dente de suportarem as forças laterais, rotacionais e a transmissão de forças oclusais (FARIA et al., 2011).

Existem situações em que os pinos de fibra pré-fabricados não têm indicação precisa por não conformarem a anatomia do preparo radicular, como acontece em canais ovoides ou em canais anteriormente preparados para receber pinos metálicos fundidos. Para a reconstrução de dentes tratados endodonticamente com amplas perdas coronárias, verifica-se uma tendência clínica atual pela confecção de pinos anatômicos (GRANDINI; SAPIO; SIMONETTI, 2005; CLAVIJO, 2009).

Os pinos anatômicos são indicados principalmente para canais excessivamente ampliados iatrogenicamente, cônicos ou elípticos. Esses pinos favorecem a justaposição do pino em relação às paredes do canal radicular, o que aumenta a retenção mecânica, podendo reduzir o volume de cimento resinoso e, consequentemente, o estresse na interface adesiva durante a contração de polimerização (TANOUE et al., 2007). Esses pinos anatômicos são confeccionados com resina composta incrementada em um pino de fibra de vidro convencional por técnica simples, segura e em sessão única.

A cimentação dos pinos de fibra de vidro no canal radicular depende sobremaneira da eficiência e da longevidade da cimentação adesiva do pino intrarradicular à dentina radicular (RADOVIC et al., 2008). Levando em consideração o cimento resinoso, o tipo de sistema adesivo empregado para fixação de pinos de fibra de vidro também pode influenciar o sucesso da restauração com pinos intrarradiculares. A técnica convencional utiliza o condicionamento ácido do substrato dental e aplicação do sistema adesivo. Nessa técnica, o controle da umidade é fundamental para a formação da camada híbrida (MAZZONI et al., 2009; VIOTTI et al., 2009).

Assim, várias técnicas de cimentação adesiva têm sido propostas e há uma grande variedade de sistemas adesivos e cimentos indicados para o procedimento de fixação de pinos (GORACCI et al., 2004; VAN MEERBEEK et al., 2011). Além da seleção do sistema de fixação, alguns fatores devem ser considerados na cimentação do pino de fibra de vidro, como qualidade do substrato; fator de configuração cavitária (Fator-C), contração de polimerização do cimento resinoso; técnica de tratamento do substrato dentinário e o cimento utilizado.

Assim, parece oportuno estudar e avaliar a resistência adesiva do pino de fibra de vidro convencional ou anatômico em função do cimento utilizado através do teste mecânico de cisalhamento por extrusão (*push out*).

2 OBJETIVOS

2.1Objetivo geral

Avaliar a força de resistência ao deslocamento através do teste de *push out* em dentes, com diferentes técnicas de reconstrução com pinos de fibra de vidro.

2.2 Objetivos específicos

a) avaliar a resistência cisalhamento do pino de fibra de vidro convencional ou anatômico;
b) avaliar a resistência de três diferentes cimentos resinosos na cimentação de pinos convencionais ou anatômicos.

3 ARTIGO

Evaluation of the adhesive resistance through the push-out test of post of conventional and anatomical fiberglass as a function of the cement used

Artigo será submetido à **Journal of Prosthetic Dentistry (Qualis A1)** cujas normas para submissão de artigos podem ser visualizadas no endereço eletrônico: https://www.elsevier.com/__data/promis_misc/jpd-author-guidelines-portuguese-2013.pdf

Evaluation of the adhesive resistance through the push-out test of post of conventional and anatomical fiberglass as a function of the cement used

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ABSTRACT

Problem statement: The fiberglass pin is used as an intraradicular retainer, and the resin cement is most commonly used as indirect retention of the retainer to the dentin. However, failures in adherence are common, and the reasons should be studied.

Objective: The objective of this research was to evaluate the strength of adhesive strength of the fiberglass pin, through the push out test, in bovine teeth.

Material and Methods: 72 uniradicular bovine teeth were selected. Its crowns were sectioned at the cemented junction with precision cut machine. Then, these roots received endodontic treatment using the ProTaper rotary technique. The teeth were unobstructed in length of 12 mm to receive fiberglass pin. The 9 mm long irregular core space was used to simulate excessive dentine wear. For cementation, the specimens were randomly distributed in 6 experimental groups (N = 12), according to the type of pin used, anatomical and conventional and the resin cement used, Relyx U200, Allcem, Allcem Core. The comparison between the two pin types in relation to the adhesive strength was performed using the Mann-Whitney test.

Results: The Friedman test showed that there was no statistically significant difference ($p > 0.05$) in the bond strength values in each resin cement between the root thirds. For the same pin the Kruskal-Wallis test also showed that there was no statistically significant difference ($p > 0.05$) in the bond strength values between the resin cements in each root third.

Conclusions: The pin type, conventional and anatomical, does not influence the bond strength values in each resin cement between the root thirds.

INTRODUCTION

In endodontically treated teeth with great loss of dentin structure, the use of fiber pins for restorative material retention or prosthetic rehabilitation is common.[1] One of the important factors that may influence the longevity of restorations on teeth with insufficient dentin remnant is the strength of fracture of an endodontically treated tooth depends on the amount of dental structure remaining and the choice of the ideal restorative material.[2,3] The choice of material to restore endodontically treated teeth has indicated material with mechanical characteristics closer to the dentin, such as fiberglass pins, which are easily used and reduce the risk of fracture, since they have a modulus of elasticity very close to the dentin.[4]

Studies have shown that the great advantage of fiberglass pins in relation to metallic pins is related to the mode of fracture, and a larger number of irreversible fractures are observed in the metal pins.[5] On the other hand, fractures occurring with the pins of fibers are more frequently observed at the level of the crown and may in many situations be recoverable.[6] This difference is due to the need for greater tissue removal for placement of the metal pin, while preparation of the fiberglass pin space must preserve the coronary and root structure. The retention shape is associated with the preparation geometry, pin characteristics such as conicity, length, diameter, texture and cementitious agent.[7] Resistance relates to the remaining dental structure that affects the ability of the pin and tooth to support the lateral, rotational forces and the transmission of occlusal forces.[7]

There are situations in which prefabricated fiber pins have no precise indication for not conforming the anatomy of the root preparation, as in channels ovoid’s, or in channels previously prepared to receive molten metal pins. For the reconstruction of endodontically treated teeth with extensive coronary losses, there is a current clinical tendency for the creation of anatomical pins.[8,9]

Anatomic pins are indicated primarily for excessively iatrogenic, conical, or elliptical canals. These pins favor the juxtaposition of the pin in relation to the walls of the root canal, which increases the mechanical retention and can reduce the volume of resin cement and consequently the stress at the adhesive interface during the polymerization contraction.[10] These anatomical pins are made with composite resin incremented in a conventional fiberglass pin by single technique, safe and in single session.

The cementation of the fiberglass pins in the root canal depends greatly on the efficiency and longevity of the adhesive cementation of the intraradicular pin to the root dentin.[11] Taking into account the resin cement, the type of adhesive system used to fix glass fiber pins may also influence the success of the restoration with intraradicular pins. The conventional technique uses the acid conditioning of the dental substrate and application of the adhesive system. In this technique, the control of the humidity is fundamental for the formation of the hybrid layer.[12,13]

Thus, several adhesive cementation techniques have been proposed and a wide variety of adhesive and cement systems are indicated for the pin-fastening procedure.[14,15] In addition to the selection of the fastening system, some factors must be considered in the cement of the fiberglass pin, as quality of the substrate; cavity configuration factor (Factor-C), polymerization contraction of the resin cement; treatment technique of the dentin substrate and the cement used. Thus, it seems opportune to study and evaluate the adhesive strength of the conventional or anatomical fiberglass pin as a function of the cement used through the mechanical push-out test.

MATERIAL AND METHODS

For the present study, 72 inferior uniradicular bovine teeth, called lateral tweezers, with apices formed, without excessive root curvature and similar diameters were selected.

After consultation, it was not necessary to submit the study to CEUA. After the radiographic examination, a new selection was made, excluding teeth with internal resorption, calcifications and pathologies. The sample was placed in pots containing physiological saline and stored in an oven at 37°C at 100% relative humidity until the beginning of the endodontic treatment. All teeth were standardized in length, exactly 17 mm, which were sectioned the crowns, close to the cementitious junction with Isomet 1000 precise cut machine (Buehler, Lake Forest, Illinois, USA) under abundant cooling. Then, these roots received endodontic treatment using the ProTaper rotary technique (Dentsply, Ballaigues, Swiss). After the canal exploration, the working length (TC) was determined, the preparation and the final modeling being carried out up to file # F5, always accompanied by constant irrigation with 2.5% sodium hypochlorite. The final irrigation was performed with 5 ml of saline solution, followed by drying the canal by suctioning with metal cannulas and absorbent paper cones (Dentisply-Herpo, Petropolis, Brazil).

After mechanical preparation, root canal filling was performed using R50 gutta cones (VDW GmbH, Munich, Germany), using the classical lateral condensation technique, using resin-based resin-based endodontic cement, AH PLUS, (Dentsply De Trey, Konstanz, Germany). The obturation was complemented with accessory FM cones (Odous De-Deus, Minas Gerais, Brazil). The excess of the cones was cut with a heated Paiva compactor, after which the vertical condensation was carried out. The specimens were kept in the oven at a constant temperature of 37º.

Seven days after obturation, the obturator material was removed from the root canal to the depth of 12 mm to receive fiberglass pin. For this procedure, first using the # 2 wide drill followed by the wide # 3 drill bit (Maillefer, Ballaigues, Switzerland), and finally the drill bit for the whitepost pin number 2 (FGM, Joinvile, Santa Catarina, Brazil) , which allowed the remaining 4 mm of the obturator material in the apical third.

Later, with a 720F handpiece drill (KG Sorensen, São Paulo, SP, Brazil), a 9 mm long irregular core space was used simulating excessive dentine wear, similarly in all cases the specimens, this preparation being further refined with the 720G drill (KG Sorensen, São Paulo, SP, Brazil). During these procedures the root was constantly irrigated with water, avoiding the burning of the dentine and root fracture.

The teeth were divided into two groups, depending on the type of glass fiber received, anatomical or conventional. The following procedures were used to make anatomical fiberglass pins using Whitepost fiberglass pins (FGM, Joinvile, Santa Catarina, Brazil) with the following characteristics: conical, cervical diameter of 1.8 mm, apical diameter of 1.05 mm, total length of 20 mm, translucent and radiopaque. Firstly, the fiber pin was cleaned with gauze smears, soaked in 70% alcohol, according to the manufacturer's instructions. Then, Condac 37% phosphoric acid (FGM, Joinville, Santa Catarina, Brazil) was applied for 1 minute, washed for an equal period of time. After applying and cleaning the acid, a silane layer, PROSIL, (FGM, Joinvile, Santa Catarina, Brazil) was applied by means of microbrush (3M ESPE, St. Paul, MN, USA) over the entire surface of the pin , for a period of 1 minute. Subsequently, the pin was subjected to hot air jets for 1 minute. Then, the amber APS adhesive (FGM, Joinvile, Santa Catarina, Brazil) was applied with a microbrush, rubbing a drop of the liquid on the pin for 10 seconds, and again applying APS Amber adhesive for 10 seconds, followed (for evaporation of the solvent and consequently increased adhesion) and finally photoactivation with the use of the PolyWireless wireless photopolymerizer, Kavo (Kavo Dental GmbH, Biberach an der RiB, Germany) for 10 seconds. After the fiberglass pin was prepared, the root canal was lubricated with water-soluble agent KY (Johnson & Johnson Ind. And Com., São Paulo, SP, Brazil) with the aid of an extra-fine microbrush brush to make the anatomical fiber pin. Thus, a portion of composite resin VITTRA APS, in EA1 color (FGM, Joinvile, Santa Catarina, Brazil) was applied on the surface of the fiberglass pin in a single increment. A small layer of VITTRA APS composite resin was also placed at the conduit entrance, the pin / resin assembly being taken to the conduit and photoactivated for 5 seconds prior to polymerization. Then, the anatomical pin / resin was removed from the conduit to receive new photoactivation for 20 seconds on each of its surfaces, buccal, lingual, mesial and distal, thus making the anatomical pin. For removal of the water-soluble gel, irrigation with saline solution and aspiration with a metal cannula followed by the use of absorbent paper cones (Dentsply-Herpo, Petrópolis, Brazil) were used.

For cementation, the anatomical or conventional pins were divided into 6 groups according to the resinous material used in the cementation: Relyx U200 (3M ESPE, St. Paul, MN, USA), Allcem (FGM, Joinville, Santa Catarina, Brazil), Allcem Core (FGM, Joinvile, Santa Catarina, Brazil), as described in table 1.

Cementation of conventional pins with Relyx U200 self-etching cement

The first procedure was the cleaning of the fiber pin with 70% alcohol gauze smears. Thereafter, the 37% Condac phosphoric acid, FGM, was applied for 1 minute, followed by washing for an equal period of time. After application and cleaning of the acid for an equal period of time with abundant jets of water, a layer of silane, PROSIL, FGM was applied for one minute over the entire surface of the pin, followed by drying with hot air for 1 minute. Then, Relyx U200 3M cement was handled and applied to the fiberglass pin and also inserted into the conduit using long, thin metallic centrix tips (DFL, Taquara, Rio de Janeiro, Brazil). The pin was then placed inside the conduit and excess cement was removed with hollenback for further photoactivation for a period of 40 seconds, as per the manufacturer's guidelines.

Cementation of conventional pins with Allcem Cement and Allcem Core

The first procedure to be performed was cleaning of the fiber pin with 70% alcohol gauze smears and drying with air. Thereafter, the 37% Condac phosphoric acid, FGM, was applied for 1 minute and washed for an equal period of time with large jets of water. After application and cleaning of the acid, pplied for 1 minute a layer of silane, PROSIL, FGM over the entire surface of the pin and dry with hot air jets, for 1 minute. After these procedures, the Ambar APS adhesive was applied with microbrush aid, rubbing a drop of the liquid in the pine for 10 seconds. Next, a new application of the APS Amber adhesive is performed for 10 seconds as well as the application of air jet for 10 seconds, for solvent evaporation and consequently increase adhesion. Finally, photoactivation was carried out using the PolyWireless wireless photopolymerizer, Kavo (Kavo Dental GmbH, Biberach an der RiB, Germany) for 10 seconds. After the chemical preparation of the fiberglass pin, the acid conditioning of the root canal is started. The 37% Condac phosphoric acid, FGM, was applied for 15 seconds, followed by washing with copious water for 1 minute and drying with absorbent paper tips. Then, the AMBAR APS adhesive was applied with microbrush aid, and again a new application of the APS Amber adhesive for 10 seconds, air jet for 10 seconds and finally photoactivation with the use of Poly-Wireless wireless photopolymerizer Kavo (Kavo Dental GmbH, Biberach an der RiB, Germany) for 20 seconds.

In order to complete the cementing procedures, the Allcem or Allcem Core cement was taken into the conduit through self-aligning tips, which accompany the cement, in order to reduce the presence of air bubbles. Then the pin was taken to the root canal, removing all excess material with hollenback. Then, the photoactivation was performed for 60 seconds.

After the procedures described above, each specimen of its respective group was fixed in sheets of acrylic resin with the aid of sticky wax (Asfer Indústria Química, São Caetano do Sul, São Paulo, Brazil). The specimens were sectioned transversely in an Isomet 1000 cutting machine, buehler, equipped with diamond disc (South Bay Technology, CA, USA) at a speed of 325 rpm and weight of 75 g under constant cooling.

Six slices were obtained from each specimen, two slices from each third, apical, medium and cervical, approximately 1.5 mm thick. Both slices from each third were destined to the push out test. Each slice of the specimen was attached to a stainless steel metal base, to which it was attached to the lower portion of the universal machine Instron 2519-106 (Instron Corporation, Norwood, MA, USA). This base contained a 2.5 mm diameter hole in the central region under which the portion of the slice was positioned relative to the pin, with its apical face facing upwards. Then a metal rod attached to the upper portion of the universal machine was positioned under the radicular reinforcement area. The metal rod was selected according to the diameter of the root canal filled with the reinforcement (2.5 mm, 2.0 mm, 1.5 mm and 0.5 mm). The metal rod should only be positioned under the pin area. Then, the load cell (2000N) was activated and the compressive load was equilibrated. The metal rod was driven with a crosshead speed of 0.5 mm / min, exerting compressive force in the apex-cervical direction until the restorative material was displaced. The force required for the displacement of the pin was measured in Newtons (N) and converted, by means of a table, into Mpa. After carrying out the push out test, the values were annotated and filed in database. To determine the bond strength (RU), the lateral area of the pin (AL) was initially calculated by the following formula:

$$AL = \pi (R + r) \sqrt{h^2 + (R + r)}$$

In which "R" is the largest radius of the pin, in its coronary portion, "r" is the smallest radius of the pin, in its apical portion, and "h" is the thickness of the pin / height of the slice. The measures of "R", "r", "h" were obtained through visual examination with the digital caliper of each slice. Thereafter, the force required for the displacement of the restorative material (F) was divided by its lateral area, thus determining the bond strength, in Mpa.

RESULTS

Table 2 shows the behavior of the teeth in relation to the evaluation of the adhesive strength considering the third, cement type and pin type.

As can be seen in Table 3 and Graphs 1 and 2, there was a significant difference between the types of cements only when considering the conventional pin in the evaluation in the middle third. There were significant differences between the three types of cement, and a higher adhesive strength was identified when ACC cement was used and a lower resistance when U200 cement was used.

In the comparison between pin types, a significant difference was observed only when the U200 cement was used in the middle third, and the adhesive strength was higher when the anatomical pin was used. Table 4 and Figures 3 to 5 show these results.

Significant differences were observed between the slices only when the U200 cement combined with the conventional pine was used. In this case, a higher resistance was observed in the evaluations of the cervical and apical thirds and lower values in the middle third evaluations. These results can be evaluated in Table 5 and Graphs 6 and 7.

DISCUSSION

In the present study, the effectiveness of the union of two conventional cements (etch-and-rinse) to root dentin, Allcem Dual and Allcem Core, was evaluated and compared with a self-adhesive resin cement, Relyx U200, in relation to the use of conventional and anatomical fiberglass. In the interior of the root canal, where the configuration factor C is very high, resin cements with different polymerization methods could present different values of tension in the union interface Thus, the three cements evaluated presented the same mechanism of dual polymerization.

From the results obtained in the push out test, the null hypothesis that there would be no difference in the bond strength between the resin cements, in relation to the regional variations, cervical, middle and apical thirds, and the anatomical and conventional pin type, was rejected. Thus, a higher adhesive strength was identified when ACC cement was used and lower resistance when U200 cement was used, when the conventional pin was evaluated in the evaluation of the middle third. According to the manufacturer, Allcem Core cement has high bending and compressive strength for maximum stability of the prosthetic restoration as it has 62% load by weight. Another great advantage of this cement is to have self-aligning tips, which exclude the insertion by propellants, as a bond, providing a more uniform and bubble-free cement distribution. The flowability of this cement provides good viscosity and satisfactory cement film, reflecting the excellent flowability of Allcem Core cement. In contrast, the major disadvantage of Relyx U200 cement is the high viscosity, making it difficult to flow cement to the middle and apical thirds.

In the present study, a significant difference was observed in the comparison between pin types only when the U200 cement was used in the middle third, and the adhesive strength was higher when the anatomical pin was used. In agreement with the results of our study, Caiado et al.[16] and Kahnamouei et al.[17] verified that self-adhesive resin cements were significantly higher in bond strength than conventional resin cements, which require total acid conditioning. Self-adhesive strategies do not demineralize / completely dissolve the smear layer. However, although there is no formation of the hybrid layer and resinous tags, studies have reported good adaptation and continuity of resin cement in root dentin.[18-20] In addition, confirming the results of our research, anatomical pins are indicated mainly for iatrogenically enlarged, conical or elliptical channels.[10] These anatomical pins favor the juxtaposition of pin with respect to the root canal walls, which may increase mechanical retention, reducing the volume of resin cement and consequently the stress at the adhesive interface during the polymerization contraction. According to Carvalho et al.[21], Perdigão et al.[22], Sadek et al.[23], Moosavi et al.[24], Faria-e-Silva et al.[25] and Balkaya & Birdal[26] the advantages presented by this type of pin are the adhesiveness of the material elastic modulus near the dentin, ease and speed of the technique, good stress distribution and resistance to corrosion.

Also in this study, significant differences were observed between the thirds only when the U200 cement combined with the conventional pine was used. In this case, a higher resistance was observed in the evaluations of the cervical and apical thirds and inferior values in the evaluations of the middle third. According to Onay et al.[20] the highest values of union strength were recorded in the cervical third of the root canal. The explanation for this result can be attributed to several factors, such as the less dense configuration of the dentinal tubules in the apical portion of the root canal system,[27,28] the difficulty of visualization and access to the apical portion of the root canal system and the restrictions of the cement flow to this part of the root canal.[29] The reduced tubular density in the apical third of the root implies in a smaller number of dentinal tubules available for the penetration of the adhesive systems, however a greater amount of intertubular dentine is available for chemical interaction with the cements The results of the present study are in agreement with the results of Kahnamouei et al.[17], who presented values of high union strength in the third of the root canal. Thus, in self-adhesive strategies, dentin bond strength seems to be more related to intertubular dentin than to dentinal tubule density.

However, further studies should be carried out constantly to evaluate the best clinical procedures as well as to monitor and monitor the evolution of materials.

CONCLUSION

From the results obtained in this study, we conclude that:

1. The highest adhesive strength was identified when conventional resin cement Allcem Core was used and the lowest resistance was when using the Relyx U200 self-adhesive cement with the conventional pin in the middle third;
2. Relyx U200 resin cement presented higher bond strength than conventional resin cements, Allcem Core and Allcem Dual, for both conventional and anatomical pin types;
3. The bond strength of self-adhesive resin cements, Relyx U200, was less influenced by root dentin depth.

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LIST OF TABLES

Table 1. Cements used in the study on anatomical or conventional posts

	Relyx U200	Allcem	Allcem Core
Anatomical Post			
Conventional Post			

Table 2. Resistance evaluation considering the type of cement, post type and slice evaluated

Cement	Post	Slice		
		Cervical	**Middle**	**Apical**
Allcem Core	Anatomical	77.5 ± 50.6 Md = 64.5	68.6 ± 25.1 Md = 65.6	106.1 ± 41.7 Md = 100.3
Allcem Core	Conventional	84.9 ± 43.9 Md = 95.2	76.9 ± 24.2 Md = 75.3	95.6 ± 43.1 Md = 94.9
Allcem Dual	Anatomical	70.7 ± 25.8 Md = 64.8	63.6 ± 30.3 Md = 59.8	78.2 ± 29.8 Md = 64.7
Allcem Dual	Conventional	66.5 ± 33.8 Md = 59.8	55.0 ± 24.6 Md = 50.2	74.8 ± 30.8 Md = 74.8
U200	Anatomical	72.3 ± 41.9 Md = 59.8	73.3 ± 30.8 Md = 70.3	75.8 ± 35.3 Md = 85.4
U200	Conventional	67.5 ± 35.5 Md = 50.6	34.8 ± 22.8 Md = 39.8	59.7 ± 28.6 Md = 65.0

Table 3. Evaluation of the influence of the type of cement in the resistance considering the type of post and slice evaluated

Kind of post	Kind of cement	Slices		
		TC	TM	TA
Anatomical	ACC	64.5[A]	65.6[A]	100.3[A]
	ACD	64.8[A]	59.8[A]	64.7[A]
	U200	59.8[A]	70.3[A]	85.4[A]
p		0.953	0.756	0.140
Conventional	ACC	95.2[A]	75.3[A]	94.9[A]
	ACD	59.8[A]	50.2[B]	74.8[A]
	U200	50.6[A]	39.8[C]	65.0[A]
p		0.508	0.001	0.073

Note: The value shown in the table refers to the median of the adhesive strength.
The probability of significance (p) refers to the Kruskal-Wallis test

Table 4. Evaluation of the influence of the post type on the resistance considering the type of cement and slice evaluated

Kind of post	Kind of cement	Slices		
		TC	TM	TA
ACC	Anatomical	64.5^{A}	65.6^{A}	100.3^{A}
	Conventional	95.2^{A}	75.3^{A}	94.9^{A}
p		0.514	0.291	0.713
ACD	Anatomical	64.8^{A}	59.8^{A}	64.7^{A}
	Conventional	59.8^{A}	50.2^{A}	74.8^{A}
p		0.671	0.443	1.000
U200	Anatomical	59.8^{A}	70.3^{A}	85.4^{A}
	Conventional	50.6^{A}	39.8^{B}	65.0^{A}
p		0.887	0.002	0.143

Note: The value shown in the table refers to the median of the adhesive strength.
The probability of significance (p) refers to the Mann-Whitney test

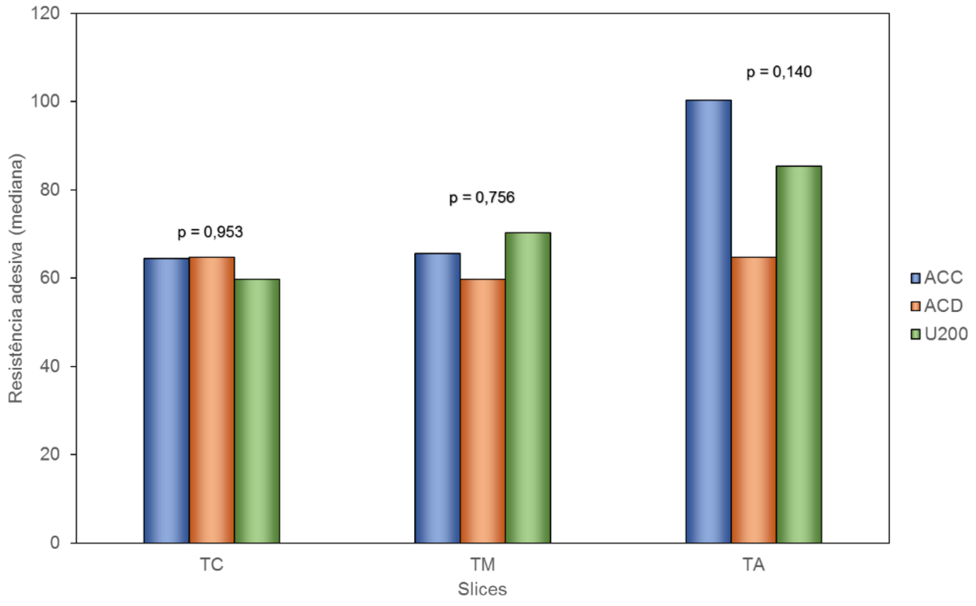
Table 5 Evaluation of the influence of the slice on the resistance considering the type of cement and type of post

Kind of post	Slice	Kind of cement		
		ACC	ACD	U200
Anatomical	TC	64.5[A]	64.8[A]	59.8[A]
	TM	65.6[A]	59.8[A]	70.3[A]
	TA	100.3[A]	64.7[A]	85.4[A]
p		0.174	0.076	0.717
Conventional	TC	95.2[A]	59.8[A]	50.6[A]
	TM	75.3[A]	50.2[A]	39.8[B]
	TA	94.9[A]	74.8[A]	65.0[A]
p		0.472	0.174	0.018

Note: The value shown in the table refers to the median of the adhesive strength.
The probability of significance (p) refers to the Friedman test

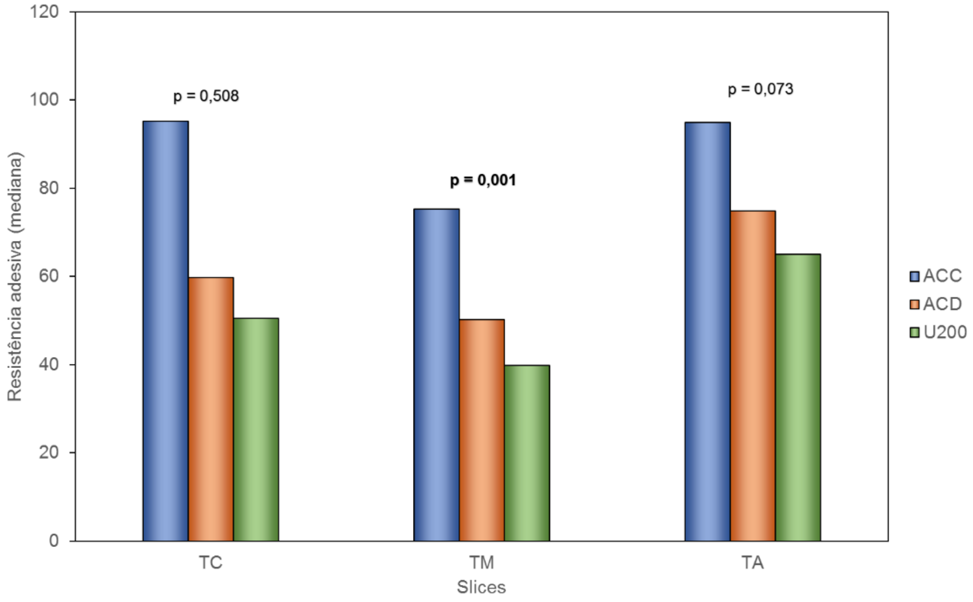
LIST OF GRAPHICS

Graph 1. Evaluation of the influence of the type of cement in the resistance considering the evaluated slice and the anatomical post



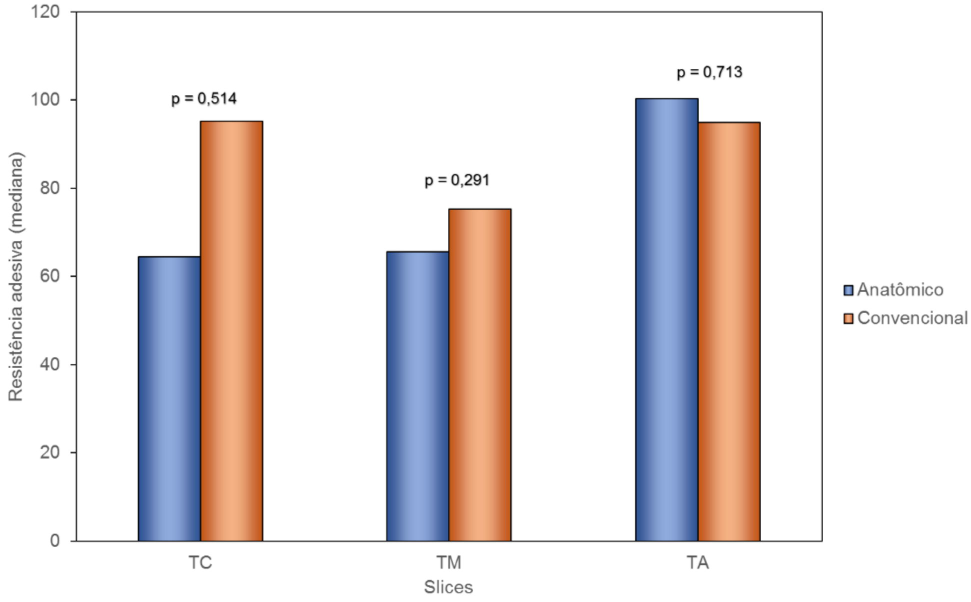
Note: the probability of significance (p) refers to the Kruskal-Wallis test

Graph 2. Evaluation of the influence of the type of cement in the resistance considering the evaluated slice and the conventional post



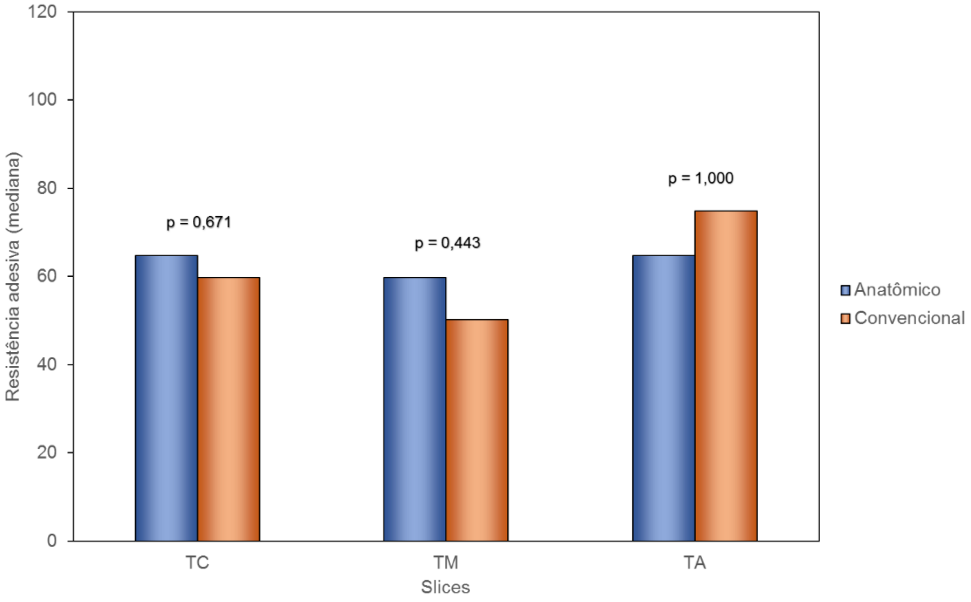
Note: the probability of significance (p) refers to the Kruskal-wallis test.

Graph 3. Evaluation of the influence of the post type on the resistance considering the slice evaluated and the cement ACC



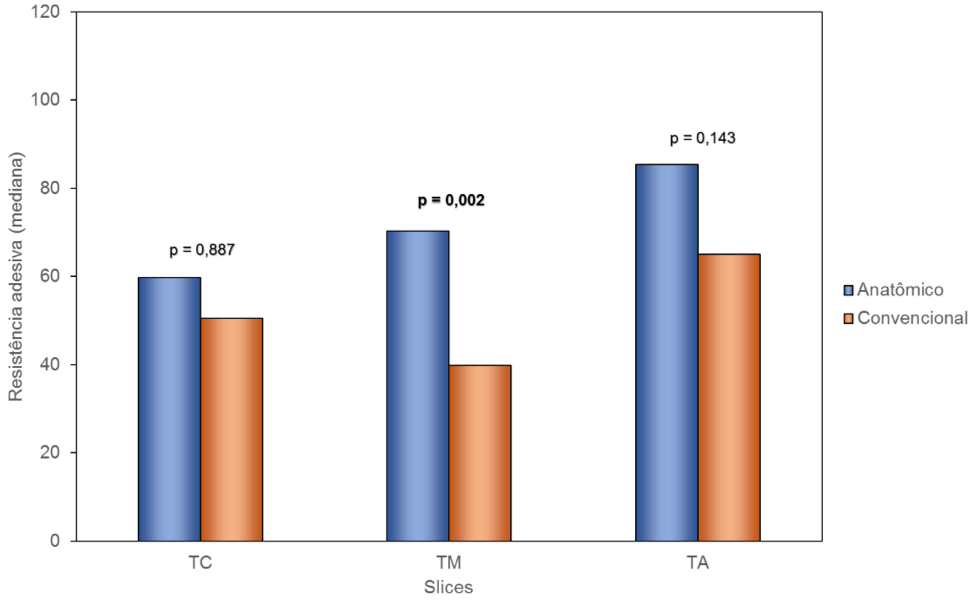
Note: the probability of significance (p) refers to the Mann-Whitney test

Graph 4. Evaluation of the influence of the post type on the resistance considering the evaluated slice and the cement ACD



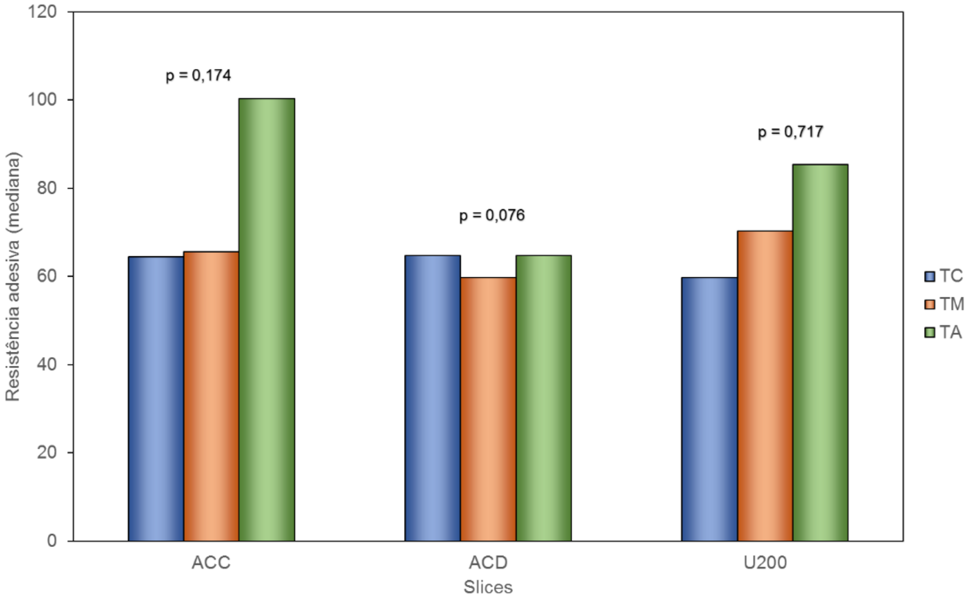
Note: the probability of significance (p) refers to the Mann-Whitney test

Graph 5. Evaluation of the influence of the post type on the resistance considering the evaluated slice and cement U200



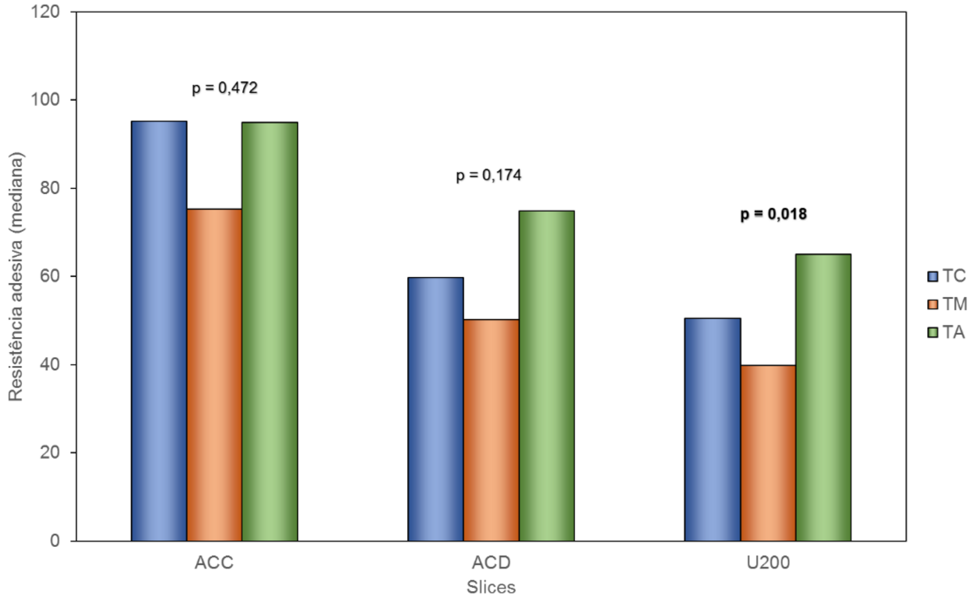
Note: the probability of significance (p) refers to the Mann-Whitney test

Graph 6. Evaluation of the influence of the slice on resistance considering the cement type and the post anatomy of significance (p) refers to the Mann-Whitney test



Note: the probability of significance (p) refers to the Friedman test

Graph 7. Evaluation of the influence of the slice on the resistance considering the type of cement and the conventional post



Note: the probability of significance (p) refers to the Friedman test.

4 CONSIDERAÇÕES FINAIS

O presente estudo buscou evidenciar a importância do conhecimento sobre os agentes cimentantes empregados em reconstruções de dentes tratados endodonticamente com pinos de fibra de vidro. Atualmente, é grande o número de cimentos resinosos empregados com este objetivo, podendo ter cada material suas indicações ou limitações. Cabe ressaltar, que a grande falha em reabilitações protéticas com uso de pino de fibra de vidro ocorre com a ruptura da união adesiva com consequente deslocamento do pino do canal radicular, principalmente na etapa de remoção de restaurações provisória.

Assim, pareceu oportuno verificar sobre a utilização de pinos de fibra de vidro convencional e anatômico, pois o último tem indicação em dentes com grande perda de estrutura dentinária ou canais amplos ou ovoides, condição muito comum em dentes tratados endodonticamente, que apresentam grande destruição da dentina, principalmente da porção cervical radicular, resultando em paredes bastante delgadas, podendo aumentar o maior índice de fratura quando submetidas as forças de mastigação convencionais.

Finalizando, foram apresentados os resultados da resistência adesiva do pino de fibra de vidro convencional ou anatômico em função do cimento utilizado através do teste mecânico de cisalhamento por extrusão. Entretanto, mais estudos devem ser constantemente realizados a fim de avaliar os melhores procedimentos clínicos bem como monitorar e acompanhar a evolução dos materiais odontológicos.

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