UNESP - Universidade Estadual Paulista
“Júlio de Mesquita Filho”
Faculdade de Odontologia de Araraquara

KAMILA DE FIGUEIREDO PEREIRA

EFEITO DO RETRATAMENTO ENDODÔNTICO SOBRE A RESISTÊNCIA DE UNIÃO DE CIMENTOS RESINOSOS À DENTINA INTRARRADICULAR

Araraquara

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Dissertação apresentada ao programa de Pós-Graduação em Ciências Odontológicas, área de concentração Dentística Restauradora, da Faculdade de Odontologia de Araraquara, da Universidade Estadual Paulista como parte dos requisitos para título de Mestre em Ciências Odontológicas.

Orientador: Prof. Dr. Marcelo Ferrarezi de Andrade

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Comissão julgadora

Dissertação para obtenção do grau de mestre

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DADOS CURRICULARES

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Dedicatória

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“Life isn't about waiting for the storm to pass...
It's about learning to dance in the rain.”

Vivian Greene

Resumo

Pereira KF. Efeito do retratamento endodôntico sobre a resistência de união de cimentos resinosos à dentina intrarradicular [Dissertação de Mestrado]. Araraquara: Faculdade de Odontologia da UNESP; 2015.

RESUMO

O objetivo deste estudo foi verificar o efeito do retratamento endodôntico sobre a resistência de união e a penetrabilidade de diferentes sistemas de cimentação de pinos de fibra de vidro à dentina intrarradicular por meio de ensaio mecânico “push out”, microscopia confocal a laser e microscopia eletrônica de varredura. Foram utilizadas 60 raízes unirradiculares ovaladas de dentes humanos (n=15): ETA -Tratamento endodôntico e cimentação com RelyX ARC; ETU - Tratamento endodôntico e cimentação com U200; ERA - Retratamento endodôntico e cimentação com RelyX ARC; ERU - Retratamento endodôntico e cimentação com U200. Os grupos com tratamento endodôntico convencional foram obturados com AH plus (ETA e ETU) e os grupos que sofreram retratamento endodôntico foram obturados primeiramente com Endofill e após com AH Plus. Os pinos de fibra de vidro receberam como tratamento prévio à cimentação a limpeza com álcool 70%, aplicação de silano e para os grupos ETA e ERA aplicação de adesivo. Para análise em microscópio confocal a laser, foi adicionado ao primer do sistema adesivo e ao cimento autoadesivo o corante fluorescente rodamina B isotiocianato RITC 0,01%. Cada terço radicular foi submetido ao teste de “push-out” com velocidade de 0,5 mm/min e para verificar a área de adesão e para determinação da penetração e adaptação do cimento na dentina radicular foi feita analise sob microscopia confocal a laser. Na sequência cada um dos espécimes foi analisado em microscopia eletrônica de varredura, as falhas foram classificadas com (AD) adesiva; (MI) mista e (CO) coesiva. Para análise estatística dos resultados foram selecionados os testes ANOVA a dois critérios fixos e Tukey (α<0,05). Como resultado o grupo ETA apresentou maiores valores de resistência de união à dentina intrarradicular que os outros grupos ($p<0,05$), em todos os terços radiculares. O retratamento endodôntico interferiu negativamente na penetrabilidade e resistência de união dos cimentos RelyX ARC e U200, independentemente do terço radicular analisado.

Palavras-chave: Preparo de canal radicular; força compressiva; cimentos de resina; adesivos dentinários; pinos dentários.

Abstract

Pereira KF. Effect of endodontic retreatment on the bond strength of resin cements to intraradicular dentin [Dissertação de Mestrado]. Araraquara: Faculdade de Odontologia da UNESP; 2015.

ABSTRACT

The aim of this study was to evaluate the effect of endodontic retreatment on the bond strength and the penetrability of different cementing systems of fiberglass posts to root dentin through the push out bond strength, confocal laser microscopy and scanning electron microscopy. Sixty human teeth with single canals and oval-shaped were used (n=15): ETA - Endodontic treatment and cementation with RelyX ARC; ETU - Endodontic treatment and cementation U200; ERA - Endodontic retreatment and cementation RelyX ARC; ERU - Endodontic retreatment and cementation with U200. The groups with conventional endodontic treatment were filled with AH plus (ETA and ETU) and the groups that suffered endodontic retreatment were filled, primarily, with Endofill and, after, with AH Plus. The fiber glass posts received as a previous treatment, an alcohol 70% cleaning and application of silane. The groups ETA and ERA received adhesive application. For analysis in confocal laser microscope, were added to the primer adhesive system and the self-adhesive cement, the fluorescent dye rhodamine B isothiocyanate RITC 0.01%. Each root third passed for the "push-out" test, with a speed of 0.5 mm / min and to verify the penetration and adaptation of the cement in the root dentin analysis were made under confocal laser scanning microscopy. Subsequently each of the specimens were analyzed in scanning electron microscopy, the failures were classified (AD) adhesive; (MI) mixed and (CO) cohesive. For statistical analysis of the results, were selected two criteria: the tests two-way ANOVA and the Tukey test ($\alpha < 0.05$). As a result for push out bond strength ETA showed higher bond strength to radicular dentin than the other groups ($p < 0.05$) in all radicular thirds. Endodontic retreatment interfered negatively on the penetrability and on the push out bond strength of RelyX ARC and U200 cements to dentin, regardless of the analyzed radicular third.

Keywords: Root canal preparation; compressive strength; resin cement; dentin bonding; dental pins.

SUMÁRIO

Introdução

1 Introdução

Quando o elemento dental sofre grande perda estrutural e encontra-se enfraquecido nos deparamos com o desafio de como restaurá-lo adequadamente. Para aumentar a retenção do material restaurador ao remanescente dentário faz-se necessária a utilização de pinos intrarradiculares[19, 20, 29].

Por muito tempo utilizou-se o núcleo metálico fundido como opção, por possuir íntima adaptação às paredes do canal radicular alcançada pela moldagem do conduto e sua fiel reprodução, resultando em alta imbricação mecânica e considerável força adesiva por possuir fina espessura de cimentação[10, 13]. Porém características indesejáveis fizeram com que estes perdessem espaço dentre os clínicos, como o fato de não ser estético, sofrer corrosão, incluir uma etapa laboratorial, elevado custo e possuir alto módulo de elasticidade. Por possuir módulo de elasticidade superior à estrutura dental, os núcleos metálicos podem levar à transmissão de tensões gerando fraturas irreversíveis e desfavoráveis[11, 30, 45] .

Os pinos de fibra de vidro, devido ao módulo de elasticidade próximo ao dente e ao cimento resinoso tornaram-se muito populares na odontologia restauradora por ser uma opção mais biologicamente favorável[29, 35, 42]. Sendo a estética um fator muito procurado por profissionais e pacientes, os pinos que possuem cor próxima ao dente são opções buscadas quando comparados ao pino de fibra de carbono[9, 14].

Para realizar adequada cimentação ao longo de todo comprimento radicular é necessária utilização de agentes cimentantes duais, já que a luz não é capaz de chegar ao terço apical de forma apropriada, sendo então uma problemática descrita em técnicas de cimentação que necessitam de iniciação por luz[11, 13, 14]. Quando comparamos valores de resistência de união, o terço apical possui um baixo valor em relação aos terços médio ou cervical[9, 11, 13, 14]. Recentemente foram introduzidos no mercado cimentos resinosos autoadesivos duais que eliminam o pré-tratamento dentinário, evidenciados na literatura por possuírem um valor de resistência de união inferior aos cimentos convencionais para a região cervical, porém com valor mais homogêneo para todos os terços radiculares e com eficácia adesiva satisfatória[2, 8]. É conhecido que o mecanismo de adesão dos cimentos autoadesivos é por meio de retenção micromecânica e adesão química à hidroxiapatita[3, 14, 15, 21] que deve ser, provavelmente, o motivo pelo qual a adesão é homogênea ao longo do canal radicular, sendo necessárias maiores investigações e estudos futuros para que haja resposta para qual agente cimentante é mais indicado para a prática clínica diária[22].

A dentina intrarradicular sofre diversas agressões durante o tratamento restaurador, que inclui desde o tratamento endodôntico, preparo do conduto, procedimento adesivo ao restabelecimento protético com retentores radiculares[39, 44]. Danos estes, que se repetidos podem levar a trincas, fraturas e injúrias às paredes dentinárias.

O sucesso do tratamento endodôntico do canal radicular é parte essencial para dar continuidade ao tratamento restaurador. Sem que haja saúde do elemento dental prosseguir com a fase protética pode acarretar em sérios danos e prejuízos à estrutura dental remanescente e perda da restauração, porém mesmo com o avanço técnico em relação ao desenvolvimento de pesquisas, materiais e técnicas endodônticas, as taxas de sucesso que envolve esta terapêutica ainda apresentam-se inconclusivas[25, 28]. A necessidade de retratamento endodôntico é comumente diagnosticada ao realizar uma avaliação protética, o que implica que a maioria dos retratamentos endodônticos advem de tratamentos protéticos, sugerindo assim, um maior enfraquecimento radicular devido ao duplo tratamento intrarradicular e a utilização agentes agressores, como a utilização de solventes para remoção de guta-percha, acarretando em diminuição da microdureza dentinária[10, 39].

Portanto, em função das variadas técnicas encontradas na literatura e dos diversos cimentos apresentados ao mercado torna-se evidente a necessidade de maiores investigações a respeito da melhor técnica adesiva e protocolo restaurador dos elementos dentais com ampla destruição coronária e enfraquecimento dentinário referente ao retratamento endodôntico, por haver dúvida quanto à falha e/ou interferência de uma dentina enfraquecida no procedimento adesivo. A metodologia utilizada neste trabalho está detalhada no apêndice 1 e o certificado do comitê de ética em pesquisa e seres humanos em anexo.

Proposição

2 Proposição

Proposição geral

O presente estudo tem por objetivo geral avaliar o efeito do retratamento endodôntico sobre a resistência de união e a interface adesiva de retentores intrarradiculares de fibra de vidro.

Proposição específica

Como objetivo específico o estudo pretende avaliar o efeito do tipo de cimentação resinosa, convencional ou autoadesiva, na resistência de união à dentina intrarradicular, assim como as diferenças encontradas em cada terço radicular, cervical, médio e apical.

Capítulos

3 Capítulos

3.1 Capítulo 1

“Effect of endodontic retreatment on the bond strength of resin cements to root dentin”

A ser submetido para publicação no periódico The Journal of Prosthetic Dentistry

3.2 Capítulo 2

“Evaluation with confocal laser microscopy of the effect of endodontic retreatment on the penetrability of resin cements to intraradicular dentin”

A ser submetido para publicação no periódico The Journal of Prosthetic Dentistry

Capítulo 1

3.1 Capítulo 1

Effect of endodontic retreatment on the bond strength of resin cements to root dentin

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ABSTRACT

Statement of the Problem

No studies have evaluated the effect of endodontic retreatment on the push-out bond strength of resin cements to the root dentin.

Objective

This study intends to verify the effect of endodontic retreatment on the bond strength of different cementations technique (self-adhesive and conventional resin cement) through the push out mechanical testing and scanning electron microscopy.

Materials and Methods

Sixty human tooth roots were used (n=15): G1- Endodontic treatment and cementation with RelyX ARC (ETA); G2- Endodontic treatment and cementation with U200 (ETU); G3- Endodontic retreatment and cementation with RelyX ARC (ERA); G4- Endodontic retreatment and cementation with U200 (ERU). The groups with conventional endodontic treatment were filled with AH plus (ETA and ETU) and the groups that were submitted to endodontic retreatment were filled, primarily, with Endofill and, after, with AH Plus. Each radicular third was submitted to push-out bond strength test, with a speed of 0.5 mm / min. Subsequently each specimen was analyzed in scanning electron microscopy to evaluate the failure mode. The data were evaluated by ANOVA and Tukey tests ($\alpha < 0{,}05$).

Results

ETA, in the cervical third, showed higher bond strength to radicular dentin than the other groups ($p < 0{,}05$). The other groups were similar to each other ($p > 0{,}05$); in the middle third,

ETA showed higher bond strength to radicular dentin than the other groups ($p < 0,05$). ETU showed higher bond strength than ERU ($p < 0,05$) and the other groups were similar to each other ($p > 0,05$); in the apical third, the groups showed decreasing values of bond strength (ETA > ETU > ERA > ERU), ERA and ERU were similar to each other ($p > 0,05$).

Conclusions

The endodontic retreatment was prejudicial on the push out bond strength of both cementations systems

CLINICAL IMPLICATIONS

The bond strength between fiber posts and root dentin can be affect by several factors, as technical failure, type of cementation, radicular dentin pretreatment, kind of post and adaptation. The endodontic retreatment might adversely affect the bond strength, due the over preparing and aggression to root canal.

INTRODUCTION

Intraradicular posts are usually indicated when non-vital tooth presents wide coronary destruction, to improve the retention of the tooth / restoration[1 and 2]. Glass fiber posts have been used as first choice when compared to cast posts for presenting elastic modulus similar to dentin, distribute occlusal forces homogeneously throughout the root, good aesthetic, and does not corrode[1 and 2].

The success of this type of dental rehabilitation is intimately related to the type of cementing agent[3]. The relationship between intraradicular post, cement and dentin transmits occlusal loads where the failure among one of them may generate undesirable forces leading to root fracture and / or restoration[3 and 4]. The adhesive cementation has been used in dentistry in order to adhere chemically and micromechanically the glass fiber post to root dentin through modification or incorporation of hybrid layer[3vand 5]. Self-etching resin cements has the advantage of eliminating some clinical steps, reducing the working time through simplified technique[3, 4 and 5]. The decrease of nanoleakage is one of the benefits generated by these cements, where the smear layer is demineralized according to the diffusion of monomer acid within dentin[3 and 6]. However after root preparation, dentin is impregnated with debris that may impair adhesion, being unfavorable to self-etching systems that do not require cleaning and etching[7].

The adhesion can be even more impaired after root canal preparation in cases of endodontic retreatment, where a thick smear layer sticks to the remaining tooth structure, besides of the use of solvents that can chemically modify the dentin surface, as well the permeability and solubility, providing a challenge for adhesion dental[8, 9 and 10]. In the literature there are several studies evaluating the bond strength of root canal sealers to intraradicular dentin as a result of the effect of endodontic procedures[8 and 11]. However, there are no studies on the effect of endodontic retreatment on the bond strength of resin cements to root dentin.

Therefore, the aim of this study was to test the hypothesis that the endodontic retreatment interfere with the bond strength of resin cements to intraradiclar dentin. Glass fiber posts were cemented in endodontically treated and retreated teeth with different resin cements, self-etching and conventional, where they were evaluated using the push-out mechanical tests and the fracture pattern analyzed in scanning electron microscopy (SEM). The null hypothesis tested in this study was: 1) endodontic retreatment does not affect the bond strength of resin cements to intraradicular dentin.

MATERIALS AND METHODS

The materials used in this study are listed in Table I. The study was approved by the research and ethics committee of the Araraquara Dental School, São Paulo, Brazil (Protocol nº 27664114.8.0000.5416). Sixty single-rooted human teeth (premolars and canines) were obtained from the teeth bank of this institution, without curvatures and cracks, stored in 0,1% thymol. With the assistance of a digital caliper Mitutoyo (DIN 862), roots were measured for a standardization of the study, the buccolingual and mesiodistal directions, beyond the three sectors, cervical, middle and apical.

The teeth were endodontically treated with rotary system at F5 instrument (Protaper; Dentsply Maillefer, Ballaigues, Switzerland) and the root canals were irrigated with 2.5% sodium hypochlorite. After biomechanical preparation, the root canals were filled with 5 ml EDTA (Biodynamics, Ibiporã, PR, Brazil) for 3 minutes with subsequent irrigation with 2.5% sodium hypochlorite. The root canal was dried with absorbent paper points and obturated by single cone technique, using gutta-percha point (F5). For teeth that were retreated endodontically, initially was used zinc oxide and eugenol-based sealer (Endofill; Dentsply Maillefer, Petrópolis, RJ, Brazil) and for teeth that were endodontically treated was used an epoxy-based sealer (AH Plus; Dentsply Maillefer, Ballaigues, Switzerland). The roots were stored in artificial saliva and kept in an incubator at 37 ° C for 7 days to occur the final set of sealer.

The endodontic retreatment was done with the removal of gutta-percha with organic solvent (Xylene, Synth, São Paulo, SP, Brazil) and mechanical preparation with Protaper Retreatment System (Dentsply Maillefer, Ballaigues, Switzerland). Subsequently, the root canal was retreated and obturated by single cone technique with F5 gutta-percha point and an epoxy-based sealer (AH Plus; Dentsply Maillefer, Ballaigues, Switzerland).

The coronal portion of all the teeth was removed by cutting the horizontally with a low speed diamond disk (Isomet 2000; Buehler Ltd., Lake Buff, IL, USA) for standardizing, length 16 mm. In sequence, the root canal obturation was partially removed with a #2 bur (White DC Post; FGM, Joinville, SC, Brazil). The roots were distributed randomly into 4 groups. The RelyX ARC cement (3M ESPE, St. Paul, USA) and U200 (3M ESPE, St. Paul, USA) were used, with distribution of the groups as shown in Table II.

The posts were cleaned with 70% alcohol superficially and received a silane layer (Prosil; FGM, Joinville, SC, Brazil), drying for 1 minute with light air jets. A layer of adhesive (Adper Scotchbond Multipurpose Plus, 3M ESPE) was applied to the groups with conventional cementation and was light cured for 20 seconds. To facilitate analysis in confocal laser microscopy was added to the primer and to the self-adhesive resin cement fluorescent dye rhodamine B isothiocyanate RITC (absorption maximum 540 nm and emission maximum 625 nm) to approximately a concentration of 0.01%.

Cementation with RelyX ARC (ETA and ERA)

The application of the adhesive system Adper Scotchbond Multipurpose Plus (3M ESPE) was made according to manufacturer's recommendations. Manipulation of the resin cement RelyX ARC (3M ESPE) for 10 seconds, insert inside the root canal with endodontic file. The cement was applied on the surface of the post and post/cement was placed inside the root canal. After stabilization of the post the excess were removed before curing. The resin cement was light cured for 40 seconds.

Cementation with U200 (ETU and ERU)

The RelyX U200 self-adhesive resin cement (3M ESPE) was mixed for 10 seconds and placed in the post space with an endodontic file. The resin cement was applied to the post surface and was placed inside the root canal. After stabilization of the post the excess were removed before curing. The resin cement was light cured for 40 seconds.

The teeth were embedded in plastic matrix filled with polyester resin (Maxi Rubber, SP, Brazil) to facilitate cutting and adaptation in mechanical testing machine. The roots were cut starting from the cervical portion where three slices were obtained with a distance between them of 3.0 mm and thickness of 2.0mm using a cutting machine (Isomet 2000; Buehler Ltd.) under intense cooling.

The cervical and apical diameter of the root canals was obtained individually through measurement using a stereomicroscope with magnification of 20x (Leica Microsystems, Germany). The value of g was obtained from the equation: $g^2 = (R - r)^2 + (2.0)^2$. Each root third was subjected to the test "*push-out*" in a mechanical test machine (DL 2000, EMIC, PR, Brazil), calibrated to a speed of 0.5 mm / min until occur displacement of fiber post cemented to the walls of the root canal. The bonding area was calculated using the formula: AD = π · (R

+ r) · g, where R = radius cervical root canal, in mm; r = radius of the apical root canal, in mm; g = relative height of the inverted cone in millimeters.

Each section was subjected to plating processes with three cycles of 60 seconds at 20 mA. Then, each specimen was analyzed in scanning electron microscopy (Aspex Express, FEI, Netherlands). Images were obtained at 100x, 10 mA and the fracture pattern was classified according to Skidmore et al. in 2006[12], as described:

(AD) adhesive failure, between the dentin and resin cement;

(CO) cohesive failure, within resin cement or dentin;

(MI) mixed failure, failure in both resin cement and dentin.

RESULTS

The mean values of bond strength (MPa) and standard deviations (± SD) are listed in Table III. Through the Shapiro-Wilk test was found normal distribution of samples. Therefore, the two way ANOVA was selected for statistical analysis, showing significant differences exist between the experimental groups ($p < 0.05$) in all root thirds.

The reduction in bond strength values is noticed when the self-etching resin cement was used, regardless of dentin treatment (treatment or endodontic retreatment) except at the root cervical third.

In cervical third, group ETA (endodontic treatment and RelyX ARC) showed the highest bond strength to root dentin than the other groups ($p < 0.05$). The other groups were similar ($p > 0.05$).

In the middle third, ETA showed higher bond strength to root dentin than the other groups ($p < 0.05$) and ETU (endodontic treatment and U200) showed higher resistance than ERU (endodontic retreatment and U200) ($p <0.05$). The groups ERA (endodontic retreatment and RelyX ARC) and ERU were similar ($p > 0.05$).

The root apical third, the groups presented decreasing order of bond strength to root dentin (ETA> ETU> ERA> ERU), with significant differences between all groups ($p < 0.05$), except between ERA and ERU that were similar each other ($p > 0.05$).

Endodontic retreatment showed worse bond strength to root dentin, on both cementing systems.

The frequency of the fracture pattern of the specimens in accordance with the experimental group and analyzed thirds, was listed in graphic I and illustrated by figures 1, 2 and 3.

DISCUSSION

Based on the results obtained, it was possible to reject the first null hypothesis (endodontic retreatment does not affect the bond strength of resin cements to intraradicular dentin), where all root thirds, in cementation with RelyX ARC, had negative interference with statistical significance. As well with respect to cementation with U200, all root thirds also had negative interference endodontic retreatment, except in the cervical third.

The adhesion to the root dentin should follow an ideal behavior, where the restorative interface should be strong, which depends on micromechanics stability and chemical union[13]. Favorable results for the use of glass fiber posts have been described in the literature[14], however, problems of dentin bonding, cementation and longevity of the procedure were still unresolved[6 and 8].

The behavior of cementation techniques showed variation from the bond strength due to local dentin morphology. The apical portion normally presents problems with integrity failure in the bonding interface and ideally considerably less than the recommended strength[13, 15, 16 and 17].

A dental element has density and unequal distribution of dentinal tubules along its length so that the apical region has lower density than the cervical region, which may correlate to the difficulty of getting higher bond strength values. The data found in this study are equivalent to those found in the literature[9 and 18-23].

The apical third has a higher amount of smear layer compacted, its difficult to remove even by etching. When adhesive resin cements are used, this step is not performed, as well washing with water, because it was used a partial modification of the smear layer by acidic groups responsible for the conditioning of the substrate, via chelation of calcium ions, resulting in chemical bond with hydroxyapatite[13 and 24]. The self-adhesive resin cement so can not form hybrid layer with root dentin as a conventional system for not being able to remove the thickest smear layer [25-27].

The endodontic retreatment was prejudicial on the bond strength of both cementation systems used in this study, due to the penetration of root canal sealer within the dentinal tubules, obliterating and interfering with the adhesion of resin cements[7 and 28]. Some studies in the literature have shown, by scanning electron microscopy (SEM) which is difficult to obtain a dentin surface free of debris to receive an adhesive cementation protocol[7, 29 and 30]. A study by Dimitrouli et al[31] showed that the bond strength of cementation methods of fiber posts to intraradicular dentin was higher in the group that there was no endodontic treatment, when compared to groups where it was performed endodontic treatment with different sealers and gutta-percha (AH plus/gutta-percha, Guttaflow/gutta-percha and pre-existing endodontic treatment). In another study, conducted by Demiryürek et al[29] it was shown that sealers such as Endofill, AH plus and Sealapex, negatively interfere on the bond strength of fiber posts.

The irrigation protocols and removal of filling material used in endodontic treatment can interfere with the adhesion performance of the techniques of cementation the fiber posts to root dentin.[7, 28 and 32]. Therefore, the root canal preparation produces a smear layer, rich in endodontic materials (root canal sealer and gutta-percha plasticized), which acts as a physical and chemical barrier against of the adhesion to dentin[7, 8, 30, 31 and 33].

With the limitations of this study, the aim was to perform more information on intraradicular adhesion, which still needs research to clarify the mechanism and to establish adhesion protocols to dentin that suffer endodontic retreatment. The use of resin cements for cementation of intraradicular posts is still questionable, because it is a more expensive method and don’t have so many advantages to root adhesion, especially when it dentin has undergone endodontic retreatment.

CONCLUSION

With the limitations of this study, it can be concluded that:

1. The endodontic retreatment was prejudicial on the bond strength of both cementation systems, regardless resin cement used.
2. The cementation system using cement RelyX ARC was better on the push out bond strength than RelyX U200, in cases of endodontic retreatment.
3. Both cementing systems, ARC and U200, are statistically similar after endodontic retreatment in all root thirds.

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TABLES

Table I. Materials used in this study.

Material	Type	Composition	Manufacturer
AH plus	epoxy resin-based sealer	Paste A: Bisphenol-A epoxy resin, Bisphenol-F epoxy resin, Calcium tungstate, zirconium oxide, silica, iron oxide pigments; Paste B: Dibenzyldiamine, Aminoadamantane, Tricyclodecane-diamine, Calcium tungstate, zirconium oxide, silica, silicone oil	Dentsply Maillefer
Endofill	eugenol-based sealer	Powder: zinc oxide, hydrogenated resin, bismuth subcarbonate, barium sulfate and sodium borate; Liquid: Eugenol, Sweet Almond Oil and BHT	Dentsply Maillefer
White Post DC	Translucent glass fiber post	Fiberglass, epoxy resin, inorganic filler and polymerization promoters	FGM
Silane Prosil	Bonding agent	3-methacryloxypropyltrimethoxysilane, ethanol and water	FGM
Adper Scotchbond Multipurpose Primer	Dental adhesive system	Aqueous solution of HEMA and a polyalkenoic acid	3M ESPE
Adper Scotchbond Multipurpose	Dental adhesive system	Bismethacrylate (1-methylethylidene) bis (4,1-phenylenoxy [2-hydroxy-3,1-propanediyl]) and HEMA	3M ESPE
RelyX ARC	Dual-polymerized resin luting agent	Paste A: BisGMA, TEGDMA, zirconia silica, pigments, amines and photoinitiator system; Paste B: BisGMA, TEGDMA, zirconia silica, benzoyl peroxide	3M ESPE
RelyX U200	Self-adhesive resin luting agent	Base paste: methacrylate monomers containing phosphoric acid groups, methacrylate monomers, silanated fillers, initiator components, stabilizers, rheological additives; Catalyst paste: methacrylate monomers, alkaline (basic) fillers, silanated fillers, initiator components, stabilizers, pigments, rheological additives.	3M ESPE

TEGDMA, triethylene glycol dimethacrylate; Bis-GMA, bisphenol-glycidyl methacrylate; HEMA, 2-hydroxyethyl methacrylate.

Table II. Division of experimental groups.

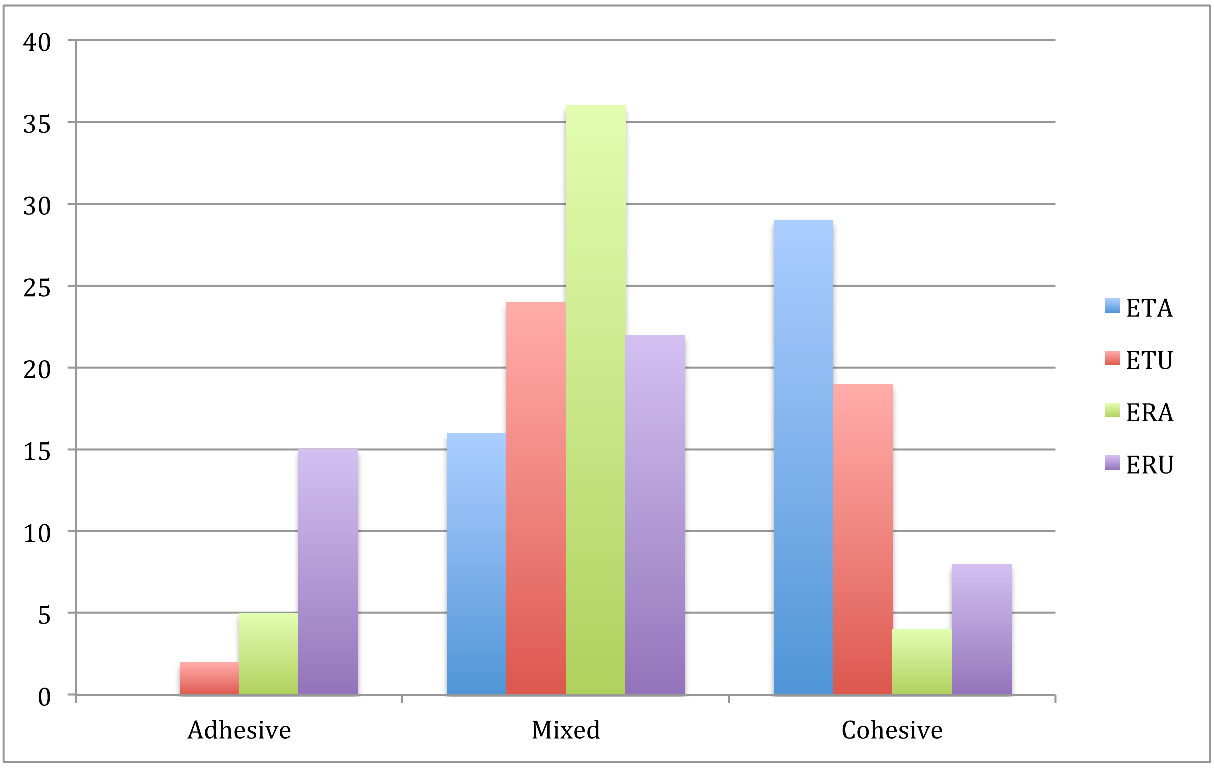
	Treatment	
Cement	Conventional	Retreatment
RelyX ARC	G1(ETA)	G3(ERA)
U200	G2(ETU)	G4(ERU)

Table III. Mean of the push-out bond strength (MPa) and standard deviations (±SD), depending on the condition of endodontic treatment and cementation system.

Group	Cervical third	Middle third	Apical third
ETA	7.51 ± 0.98^{a}	6.89 ± 1.41^{a}	6.95 ± 1.91^{a}
ETU	4.87 ± 0.87^{b}	5.56 ± 1.14^{b}	6.60 ± 2.18^{b}
ERA	4.99 ± 1.13^{b}	4.48 ± 0.87^{bc}	4.39 ± 1.44^{c}
ERU	4.06 ± 1.13^{b}	3.92 ± 1.79^{c}	3.74 ± 1.13^{c}

[a,b]Different letters (columns) show statistically significant difference ($p < 0.05$).

Graphic I: Frequency of pattern fracture according to experimental groups and thirds analyzed.



LEGENDS FOR ILLUSTRATIONS

Fig 1. Representative image of the pattern of adhesive fracture;

Fig2. Representative image of the pattern of mixed fracture;

Fig 3. Representative image of the pattern of cohesive failure.

ILLUSTRATIONS

Figure 1

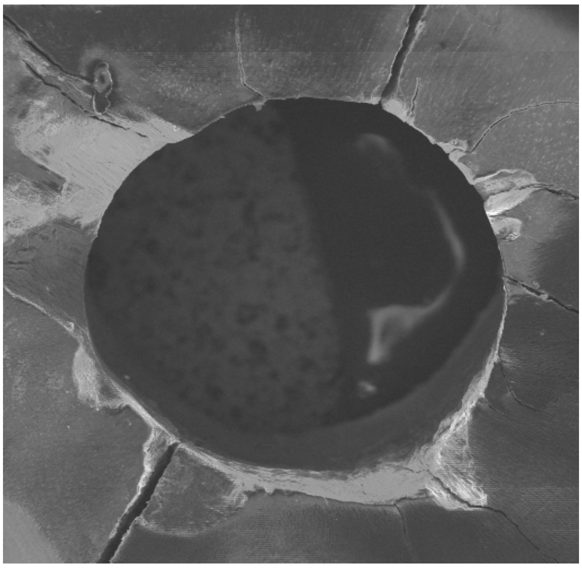


Figure 2

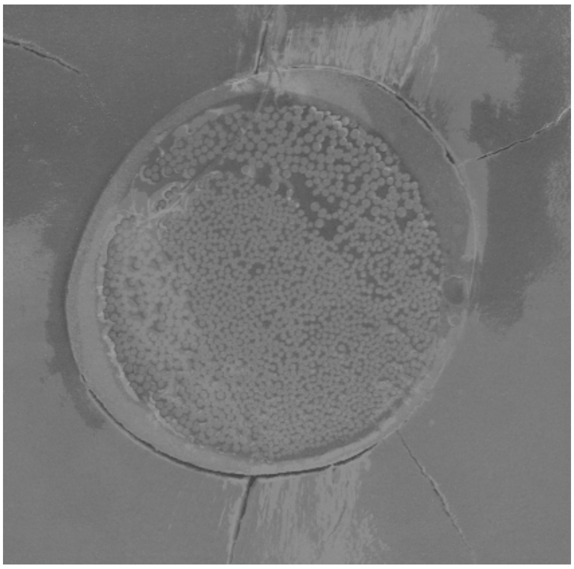
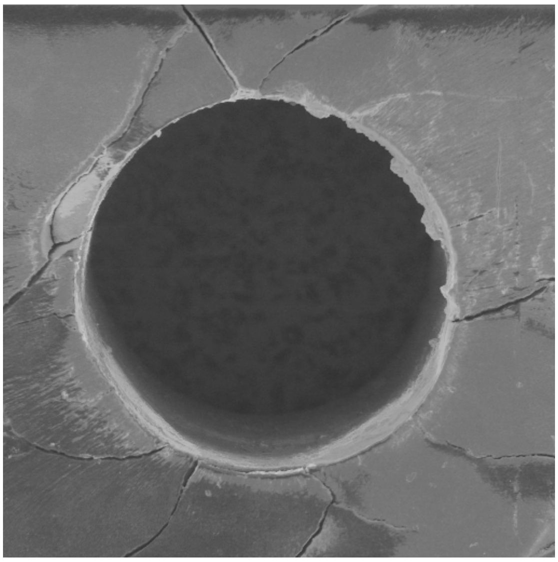


Figure 3



Capítulo 2

3.2 Capítulo 2

Evaluation with confocal laser microscopy of the effect of endodontic retreatment on the penetrability of resin cements to intraradicular dentin

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ABSTRACT

Statement of the Problem

The use of fiber post has increased in dentistry, but the adhesion to de root dentin still is a problem. However, there are no studies in the literature evaluating the effect of endodontic retreatment on the penetrability of resin cements.

Objective

The purpose of this study was evaluating the penetrability of resin cements to root dentin and verify if the endodontic retreatment interfere on the cementation techniques, through the confocal laser microscopy.

Materials and Methods

Sixty human teeth with similar lengths were randomly divided into (n=15): G1- Endodontic treatment and cementation with RelyX ARC (ETA); G2- Endodontic treatment and cementation with U200 (ETU); G3- Endodontic retreatment and cementation with RelyX ARC (ERA); G4- Endodontic retreatment and cementation with U200 (ERU). The groups with conventional endodontic treatment were filled with AH plus (ETA and ETU) and the groups that suffered endodontic retreatment were filled with Endofill and, after, with AH Plus. The teeth were sectioned perpendicular to their long axis into 2-mm-thick sections. Each root third was evaluated with confocal laser microscopy. For statistical analysis of the data, were selected: the tests Kruskal Wallis e Dunn ($\alpha < 0{,}05$).

Results

ETA and ERU, in the cervical and middle thirds, respectively had the highest and the lowest penetrability on root dentin than the other groups ($p < 0.05$). ETU and ERA showed no significant difference ($p > 0.05$). ETA showed the penetrability to root dentin than the other groups to the apical third ($p <0.05$). ERU had the lowest penetrability than the other groups but was similar to ERA ($p > 0,05$) and ETU and ERA remained similar to each other ($p > 0,05$).

Conclusions

Endodontic retreatment interferes negatively on the penetrability of RelyX ARC and U200 cements to dentin, regardless of the analyzed radicular third.

CLINICAL IMPLICATIONS

The most common clinical failure of restoration of endodontically teeth with fiber posts are loss of retention and fracture. The endodontic retreatment may affect the adhesion of resin cements to the root dentin. However, there are no studies in the literature evaluating penetrability in this cases.

INTRODUCTION

Endodontically treated teeth with extensive coronal destruction often exhibit indication of restoration with intraradicular posts, with the function of increasing the retention of future crown restoration[1, 2, 3 and 4]. Nowadays, fiberglass posts have been used because of their characteristics approximate to the dental element, such as modulus of elasticity compatible with the dentin, does not corrode and provide adequate aesthetic and lower work time for its preparation[3, 5 and 6]. Studies have been developed to improve the cementing protocol of these post-retained foundations, using bond strength tests to dentin[7, 8-12] and to the post[13], as well, fracture resistance tests[14]. However there is no consensus in the literature about the different cementation systems available on the market.

Several factors can interfere with clinical failure of fiberglass posts, varying from the type of post used, adhesive system and cementation until methodology used for dental preparation, dentin pretreatment and adaptation to the root canal[15-21]. The loss of retention and post fractures are the most common failures[22] and clinical studies have shown that there is a 90% survival rate among the first 3 years to 7 years following of endodontically treated teeth which were restored with glass fiber posts[23-26]. However, there is an annual rate of 4.6% failure after 10 years in observational studies[27]. This high failure rate is due to the challenge of adhesion to the root dentin, corresponding to hampered access to the preparation of the root canal visibility, as well, the reduced number of dentinal tubules from cervical to apical[28].

The use of confocal laser microscopy to analyze the hybrid layer exhibits morphological characteristics of the adhesive interface, distribution of the adhesive system in the dentinal tubules, as the resin cement and can also detect failures[29-30]. A comparison was made between scanning electron microscopy and confocal laser microscopy to analyze the thickness of the hybrid layer and laser confocal microscopy presented more details about the penetration and distribution of the adhesive system and resin cement inside the dentinal tubules[31].

The purpose of this study was to investigate the penetration of the resin cement and adhesive system, into the dentin that suffered endodontic retreatment. The null hypothesis was that there is no interference of endodontic retreatment in the penetration of resin cements to root dentin.

MATERIALS AND METHODS

The materials used in this study are listed in Table I. The study was approved by the research and ethics committee of the Araraquara Dental School, São Paulo, Brazil (Protocol nº 27664114.8.0000.5416). Sixty single-rooted human teeth (premolars and canines) were obtained from the teeth bank of this institution, without curvatures and cracks, stored in 0,1% thymol. With the assistance of a digital caliper Mitutoyo (DIN 862), roots were measured for a standardization of the study, the buccolingual and mesiodistal directions, beyond the three sectors, cervical, middle and apical. The teeth were endodontically treated with Protaper rotary (Dentsply Maillefer, Ballaigues, Switzerland) and the root canals were irrigated with 2.5% sodium hypochlorite during the preparation. After biomechanical preparation, the root canals were placed with 5 ml EDTA (Biodynamics, Ibiporã, PR, Brazil) for 3 minutes and neutralization with 2.5% sodium hypochlorite. The root canal was dried with absorbent paper and obdurated through the single cone technique with gutta percha cone (F5). For teeth that were retreated endodontically was used Endofill cement (Dentsply Maillefer, Petrópolis, RJ, Brazil) and for teeth that were endodontically treated was used cement AH plus (Dentsply Maillefer, Ballaigues, Switzerland). The roots were stored in artificial saliva and kept in an incubator at 37 ° C for 7 days to occur the final set of sealer.

The endodontic retreatment was done with the removal of gutta-percha through mechanical preparation with Protaper Retreatment (Dentsply Maillefer, Ballaigues, Switzerland). Subsequently, the root canal was retreated and obdurated by single cone technique with gutta percha cone F5 and endodontic sealer AH Plus.

The coronal portion of all the teeth was removed by cutting the horizontally with a steel diamond disk (Isomet 2000; Buehler Ltd., Lake Buff, IL, USA) for standardizing, length 16 mm.

The gutta percha cones were removed with a no. 2 drill from White DC Post (FGM, SC - Brazil). The roots were distributed randomly into 4 groups. The RelyX ARC cement (3M ESPE, St. Paul, USA) and U200 (3M ESPE, St. Paul, USA) were used, with distribution of the groups as shown in Table II.

The posts were cleaned with 70% alcohol superficially and received a silane layer, Prosil (FGM, SC, Brazil), drying for 1 minute with light air jets. A layer of adhesive (Adper Scotchbond Multipurpose Plus, 3M ESPE), was applied to the groups with conventional cementation and was light cured for 20 seconds. To facilitate analysis in confocal laser microscopy was added to the primer and to the self-adhesive resin cement fluorescent dye rhodamine B isothiocyanate RITC (absorption maximum 540 nm and emission maximum 625 nm) to approximately a concentration of 0.01%.

Cementation with RelyX ARC (ETA and ERA)

The application of the adhesive system Adper Scotchbond Multipurpose Plus (3M ESPE) was made according to manufacturer's recommendations. Manipulation of the resin cement RelyX ARC (3M ESPE) for 10 seconds, insert inside the root canal with a endodontic file. The cement was applied on the surface of the post and post/cement was placed inside the root canal. After stabilization of the post the excess were removed before curing. The resin cement was light cured for 40 seconds.

Cementation with U200 (ETU and ERU)

The RelyX U200 self-adhesive resin cement (3M ESPE) was mixed for 10 seconds and placed in the post space with an endodontic file. The resin cement was applied to the post surface and was placed inside the root canal. After stabilization of the post the excess were removed before curing. The resin cement was light cured for 40 seconds.

The teeth were embedded in plastic matrix filled with polyester resin (Maxi Rubber, SP, Brazil) to facilitate cutting and adaptation in mechanical testing machine. The roots were cut starting from the cervical portion where three slices were obtained with a distance between them of 3.0 mm and thickness of 2.0mm using a cutting machine (Isomet 2000; Buehler Ltd.) under continuous water cooling (5°C) to prevent frictional heat.

The measure of intradentinal penetrability was performed with Image J software. Initially of root canal perimeter was obtained. In sequence, the intradentinal penetration of cementation system of the fiber post was measure and the difference between measures was calculated and transformed in percentage. The dentinal tubules were evaluated with the orthogonal section tool (Z optical section) of the LAS software (Leica) using the 63 oil lens with additional Zoom 3. The data were evaluated by Kruskal Wallis e Dunn tests; the level of significance was set at $p < 0.05$.

RESULTS

Through the Shapiro-Wilk test was found not normal distribution of samples, so the non-parametric Kruskal Wallis and Dunn tests was selected for statistical analysis, showing significant differences between the experimental groups ($p < 0.05$) in all root thirds.
The cervical and middle thirds root, ETA and ERU respectively had the highest and the lowest penetrability on root dentin (Figs. 1, 3), compared to other groups ($p < 0.05$). There was no significant difference between ETU and ERA ($p > 0.05$) (Fig. 2). The root apical third, ETA, had the highest penetrability to root dentin compared to other groups ($p < 0.05$) (Fig. 4). However, ERU had the lowest penetrability to dentin than the other groups ($p < 0.05$) (Fig. 6), except for the ERA that were similar ($p > 0.05$). The penetrability demonstrated by ETU and ERA remained similar ($p > 0.05$) (Fig. 5).

DISCUSSION

The null hypothesis of this study was rejected because there is difference in penetration between teeth that were endodontically treated and those that were retreated.

During endodontic treatment, the root canal sealer is pressed to establish a close union to the root canal walls at the time of condensation, forcing its penetration within the dentinal tubules[12 and 32]. EDTA is usually employed to increase the penetration of root canal sealer / gutta-percha, which makes it difficult to remove them in cases of posts cementation and for cases of endodontic retreatment[32 and 33]. Just as the sealer is pressed to penetrate inside the dentinal tubules the resin cement suffers external mechanical factor. A difference of fluidity between the resin cements used in this study may have generated changes in penetration of values, where the self-adhesive resin cement U200 had lower values in percent.

A smear layer is produced during the confection of the canal restoration, rich in endodontic content (root canal sealer and gutta-percha plasticized), beyond residual dentin, oil and saliva. This smear layer becomes a physical and chemical barrier that acts interfering the bond strength to the root dentin[32 and 34-36].

In a study conducted by Santana[32] et al. 2014, it was verified that all root canal sealers worse effect on the bond strength of fiber posts to the root dentin when compared with the control group, which was not used root sealer. It can be concluded that the post preparation for is not able to properly clean the dentin for bonding procedures[32 and 37]. Rached-Junior[38] et al conducted a study evaluating the bond strength of sealers resin based (AH plus) to root dentin after removing the root sealer based on eugenol (Endofill) using various forms of endodontic retreatment. It was noted that the samples that were retreated with AH plus reduced their bond strength, which did not occur with the samples that were not retreated. The author concluded that eugenol negatively affects resin-based root canal sealers. Eugenol prejudice the quality of the adhesion of resin-based materials because it has a phenolic compound that prevent their adequate polymerisation, and there are free radicals that modify the surface of the cured resin, reducing the effectiveness of adhesion[38-41]. The methodology employed by Santana[32] and by Rached-Junior[38] was different, but the results found by both coincide with those found in this study. The groups that suffered endodontic retreatment had lower penetrability values, statistically significant when compared to the groups that were underwent conventional endodontic treatment. Leading to believe that the residual eugenol has hindered the polymerization of resin cements, both conventional (RelyX ARC) and the self-adhesive (U200), but also interacting with the smear layer, hindering the penetration.

Several studies in the literature confront these data, because the adhesion in the apical region is difficult and unfavorable[6, 7, 9, 10, 11, 12, 32, 38, 39, 42 and 43]. As stated previously a denser hybrid layer may be formed after preparation of the root canal, particularly in the apical region, where cleansing is often not efficient, due to difficult access, as well the quantity and diameter of dentinal tubules, which decreased, the cervical to apical direction[43 and 44]. The unfavorable cavity configuration and the high C-factor is another important aspect in the quality of the adhesion, can generate a polymerization shrinkage around 1.5-5%[46 and 47]. In a study by Bitter et al., in 2009[24], which evaluated the adhesive interface of different resin cements, there was no difference between the root thirds. Despite not using similar methodology, it can be concluded that the adhesion in the apical region is unfavorable and difficult to control[7, 9 and 48-49].

The self-adhesive resin cement U200 had a worse performance than the conventional cement RelyX ARC, except for the apical region of the ERU group. Can be explained by the fact that the self-adhesive resin cement chemically interact with hydroxyapatite and form a more stable union[7, 32 and 50]. What is opposed to the other groups, where the U200 had a lower penetration. Several authors in the literature agree with worse performance of self-adhesive cements[7, 8, 9 and 48], where the interaction of this cement with the hybrid layer does not show up as effective, as for systems that use acid etching and adhesive. The acidic monomers responsible for penetrating the smear layer retained in the dentinal walls and change it, not produce a visible hybrid layer and resin tags[9]. However, the chemical interaction with the dentin can be more effective when there is an adequate smear layer removal and cleaning of the root canal, being more efficient[7].

The results in this study lead to discouraging the use of self-adhesive systems for cementation fiber posts on teeth that have undergone endodontic retreatment, because the penetrability is affect, with no formation of visible hybrid layer.

CONCLUSION

Front of the methodology used in this study and its limitations, can be concluded that:

1. Endodontic retreatment interferes negatively on the penetration of RelyX ARC and U200 to dentin, regardless of the analyzed radicular third.

2. The RelyX ARC penetration to the root dentin was always higher than the U200, except in cases where we performed the endodontic retreatment.

3. When it was analyzed the situation of endodontic retreatment, RelyX ARC remained superior to cement U200, except the root apical third.

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TABLES

Table I. Materials used in this study.

Material	Type	Composition	Manufacturer
AH plus	epoxy resin-based sealer	Paste A: Bisphenol-A epoxy resin, Bisphenol-F epoxy resin, Calcium tungstate, zirconium oxide, silica, iron oxide pigments; Paste B: Dibenzyldiamine, Aminoadamantane, Tricyclodecane-diamine, Calcium tungstate, zirconium oxide, silica, silicone oil	Dentsply Maillefer
Endofill	eugenol-based sealer	Powder: zinc oxide, hydrogenated resin, bismuth subcarbonate, barium sulfate and sodium borate; Liquid: Eugenol, Sweet Almond Oil and BHT	Dentsply Maillefer
White Post DC	Translucent glass fiber post	Fiberglass, epoxy resin, inorganic filler and polymerization promoters	FGM
Silane Prosil	Bonding agent	3-methacryloxypropyltrimethoxysilane, ethanol and water	FGM
Adper Scotchbond Multipurpose Primer	Dental adhesive system	Aqueous solution of HEMA and a polyalkenoic acid	3M ESPE
Adper Scotchbond Multipurpose Adhesive	Dental adhesive system	Bismethacrylate (1-methylethylidene) bis (4,1-phenylenoxy [2-hydroxy-3,1-propanediyl]) and HEMA	3M ESPE
RelyX ARC	Dual-polymerized resin luting agent	Paste A: BisGMA, TEGDMA, zirconia silica, pigments, amines and photoinitiator system; Paste B: BisGMA, TEGDMA, zirconia silica, benzoyl peroxide	3M ESPE
RelyX U200	Self-adhesive resin luting agent	Base paste: methacrylate monomers containing phosphoric acid groups, methacrylate monomers, silanated fillers, initiator components, stabilizers, rheological additives; Catalyst paste: methacrylate monomers, alkaline (basic) fillers, silanated fillers, initiator components, stabilizers, pigments, rheological additives.	3M ESPE

TEGDMA, triethylene glycol dimethacrylate; Bis-GMA, bisphenol-glycidyl methacrylate; HEMA, 2-hydroxyethyl methacrylate.

Table II. Division of experimental groups.

	Treatment	
Cement	Conventional	Retreatment
RelyX ARC	G1(ETA)	G3(ERA)
U200	G2(ETU)	G4(ERU)

Table III. Median of dentin penetration (%) and first and third quartile, depending on the condition of endodontic treatment and cementation system.

Group	Cervical third	1Q - 3Q	Middle third	1Q - 3Q	Apical third	1Q - 3Q
ETA	44,11[a]	32,15-49,27	51,53[a]	38,83-80,71	60,70[a]	57,70-69,55
ETU	17,32[b]	13,41-25,49	10,55[b]	9,38-28,66	22,54[b]	20,63-29,05
ERA	15,67[bc]	8,39-19,84	11,04[bc]	9,13-16,75	9,94[bc]	8,41-13,95
ERU	3,89[d]	2,70-4,82	3,87[d]	2,94-5,45	4,96[c]	3,64-5,59

[a,b]Different letters (columns) show statistically significant difference ($p < 0.05$).

LEGENDS FOR ILLUSTRATIONS

Fig 1. Representative image of the group ETA, on the cervical and middle third;

Fig 2. Representative image of the group ETU and ERA, on the cervical and middle third;

Fig 3. Representative image of the group ERU, on the cervical and middle third;

Fig 4. Representative image of the group ETA, on the apical third;

Fig 5. Representative image of the group ETU and ERA, on the apical third;

Fig 6. Representative image of the group ERU, on the apical third.

ILLUSTRATIONS

Figure 1

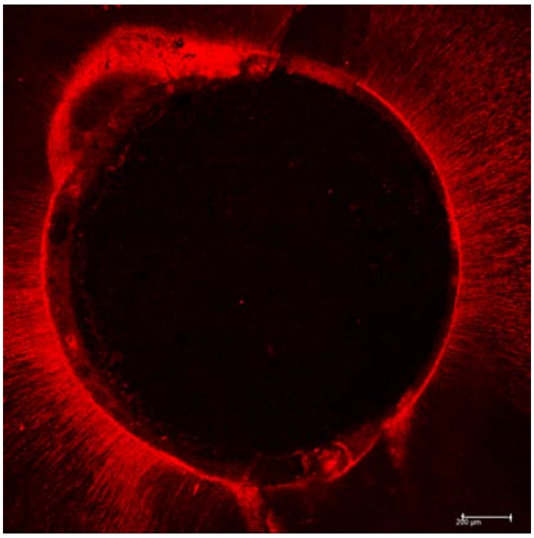


Figure 2

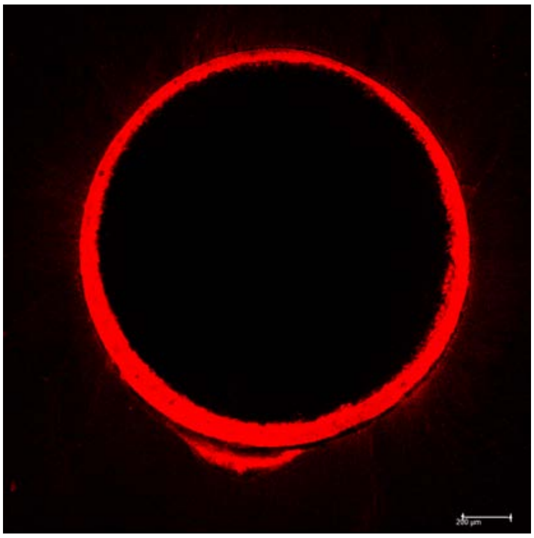


Figure 3

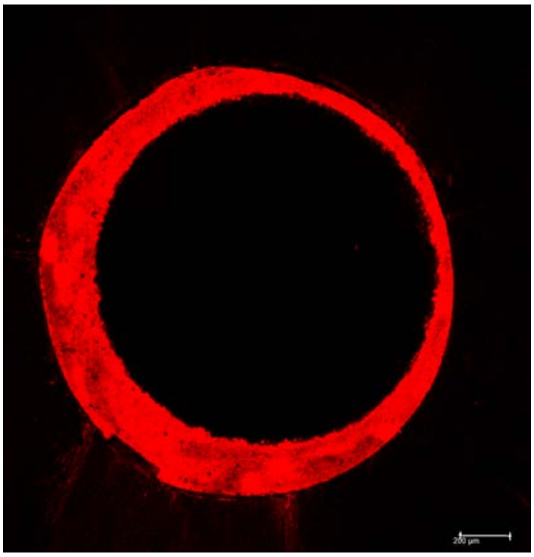


Figure 4

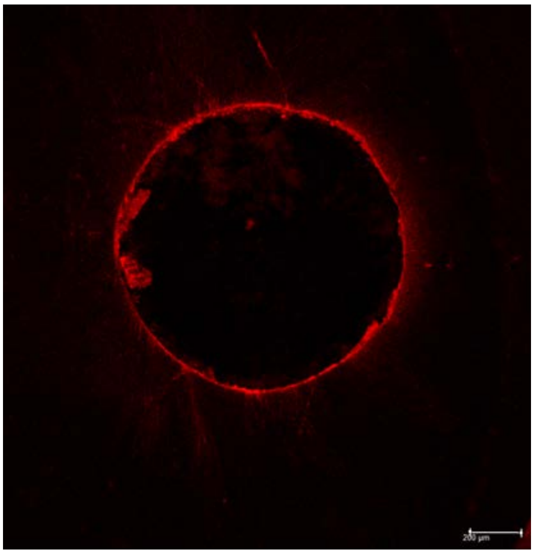


Figure 5

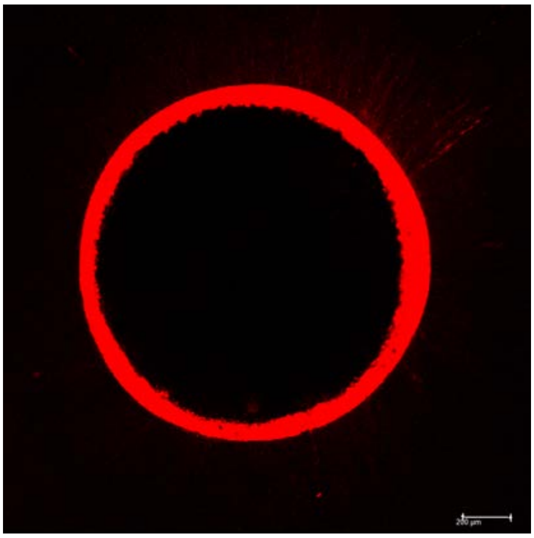
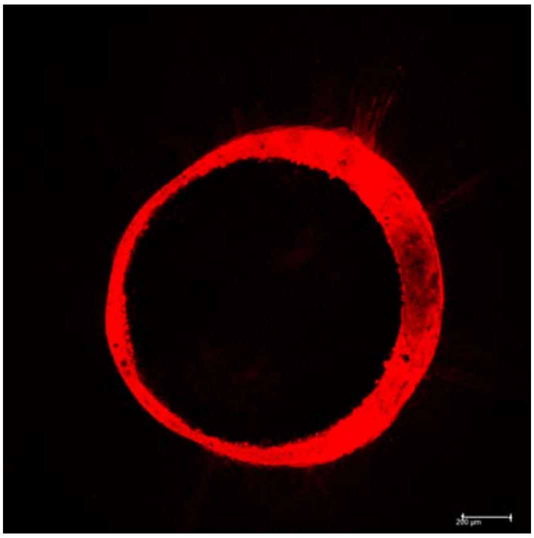


Figure 6



Considerações finais

4 Considerações finais

O retratamento endodôntico é uma necessidade constante na odontologia e a sua existência implica na qualidade da interface adesiva, quando existe a necessidade de restaurar o remanescente dental com um retentor intrarradicular[18, 34]. Muitos estudos na literatura mostram interferência na resistência adesiva de cimentos resinosos quando cimentos obturadores à base de eugenol são utilizados, porém ainda não há trabalhos elucidando se o retratamento endodôntico, independentemente do cimento obturador utilizado, intervém na adesão e como interfere[34, 27, 12, 16]. O primeiro estudo deste trabalho teve como objetivo analisar a resistência de união, através de ensaio mecânico "push out" e microscopia eletrônica de varredura, de dentes tratados e retratados endodonticamente, cimentados com pinos de fibra de vidro e dois diferentes cimentos resinosos, convencional e autocondicionante. Observou-se que o sistema de cimentação convencional obteve maiores valores de resistência adesiva, entretanto ambos sistemas sofreram interferências negativas após o retratamento endodôntico.

Os resultados apresentados no primeiro trabalho corroboram com estudos da literatura, onde os cimentos autoadesivos apresentam um desempenho inferior aos cimentos convencionais[4, 23, 1, 15]. Pode-se explicar este comportamento pelo fato da hibridização dentinária neste tipo de cimentação ser realizada por monômeros acídicos que modificam a smear layer e interagem com a hidroxiapatita realizando uma união micromecânica e química à dentina intrarradicular, contudo esta camada de lama dentinária não consegue ser inteiramente dissolvida impedindo a penetração do cimento no interior dos túbulos dentinários, gerando gaps na interface adesiva[37, 21]. A smear layer torna-se mais densa e compactada na regiões mais profundas e de difícil acesso, como a região apical, desfavorecendo a adesão até mesmo de sistemas que utilizam o condicionamento ácido, logo, o uso dos sistemas autocondicionantes para cimentação resinosa é desmotivado em dentes retratados endodonticamente[36, 41, 38, 17, 7].

Além do fato do terço apical ser desfavorecido na adesão pela quantidade de smear layer, existe o fato de que existe uma distribuição não homogênea da quantidade de túbulos dentinários, que diminui de cervical para apical, assim como dentina secundária irregular e presença de canais acessórios, tornando este terço radicular menos propenso à adesão[19, 31]. A diferença encontrada neste estudo com relação aos terços radiculares para um mesmo sistema de cimentação é suportada pela literatura[26, 32, 33, 5, 6, 24].

A penetrabilidade do cimento resinoso no interior dos túbulos dentinários é o que confere a formação de uma camada híbrida uniforme e resistente[44]. No segundo trabalho deste estudo foi verificado a porcentagem de penetrabilidade dentinária do sistema de cimentação de pino de fibra de vidro, em relação ao diâmetro do canal radicular. Pode-se concluir que o retratamento endodôntico interfere negativamente sobre a resistência de união e penetrabilidade dos cimentos RelyX ARC e U200 à dentina, independentemente do terço radicular analisado. Assim como, a resistência de união do cimento RelyX ARC à dentina radicular foi superior ao do U200. Contribuindo assim com os resultados do primeiro estudo, onde pode-se constatar que o retratamento endodôntico interferiu negativamente em ambos sistemas e que, comparativamente, o sistema RelyX ARC obteve melhores resultados adesivos, analisados através de ensaio mecânico push out e microscopia eletrônica de varredura.

Com as limitações deste trabalho, podemos concluir que a cimentação adesiva do canal radicular com cimentos resinosos, convencional e autoadesivo, sofrem interferência negativa na resistência de união de pinos de fibra de vidro à dentina intrarradicular. Porém, a cimentação convencional, ou seja, que utiliza o condicionamento com ácido fosfórico e sistema adesivo, obteve valores de resistência de união maiores que o sistema de cimentação autocondicionante. Os resultados deste estudo nos levam a indicar a cimentação convencional em casos de dentes que sofreram retratamento endodôntico, além de sugerir que a adequada limpeza do conduto deve ser realizada para qualquer tipo de cimentação.

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*De acordo com o manual da FOAr/UNESP, adaptadas das normas Vancouver. Disponível no site: http://www.foar.unesp.br/#!/biblioteca/manual

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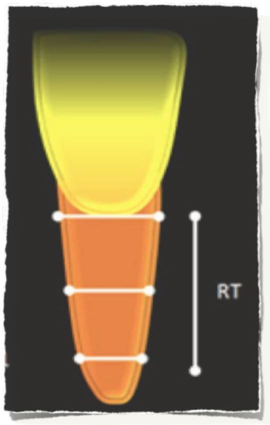
Apêndice

Apêndice A - Material e método

Seleção e preparo dos dentes

Inicialmente o projeto de pesquisa foi submetido e aprovado no Comitê de Ética em Pesquisa da Faculdade de Odontologia de Araraquara, da Universidade Estadual Paulista, CAAE nº 27664114.8.0000.5416. Os dentes humanos extraídos foram obtidos do banco de dentes da mesma instituição.

Figura 1: Mensuração do elemento dental



Foram obtidos para este projeto dentes humanos, que não possuíam curvaturas ou trincas, armazenados em timol a 0,1%. Com o auxílio de um paquímetro digital Mitutoyo (DIN 862) as raízes foram mensuradas para obter uma padronização do estudo, nos sentidos vestíbulo-lingual e mésio-distal, além dos três setores ao longo do comprimento, cervical, médio e apical (figura 1).

A porção coronária de todos os dentes foi removida cortando-se horizontalmente no seu eixo longitudinal com disco diamantado em baixa velocidade (Isomet 2000; Buehler Ltd., Lake Buff, IL, USA) para uniformização, no comprimento de 16 mm e instrumentados usando o sistema Protaper rotário (Dentsply Maillefer, Ballaigues, Switzerland), sob constante irrigação, aspiração e inundação do conduto radicular com 5 mL de hipoclorito de sódio a 2,5% (Asfer, São Caetano do Sul, SP, Brasil) a cada troca de instrumento, preservando 1mm apical para evitar extravasamento de material. Após preparo biomecânico dos canais radiculares foi colocado 5 mL de EDTA (Biodinâmica, Ibiporã, PR, Brasil) no interior do canal radicular por 3 minutos e neutralização com hipoclorito de sódio a 2,5% (Asfer, São Caetano do Sul, SP, Brasil). Em seguida o conduto radicular foi secado com papel absorvente e obturado através da técnica do cone único com cone de guta percha referente ao último instrumento utilizado (F5). Para o grupo que sofreu retratamento endodôntico foi utilizado o cimento endodôntico Endofill (Dentsply Maillefer, Petrópolis, RJ, Brasil) e para o grupo que sofreu somente tratamento endodôntico foi utilizado o cimento AH plus (Dentsply Maillefer, Ballaigues, Switzerland). As raízes foram acondicionadas em saliva artificial (Quadro 1) e mantidas em estufa a 37ºC por 7 dias para que ocorresse a presa final do cimento obturador.

Quadro 1. Composição da saliva artificial.

Cloreto de Potássio	0,96 g
Cloreto de Sódio	0,67 g
Cloreto de Magnésio	0,04 g
Fosfato de Potássio	0,27 g
Cloreto de Cálcio	0,12 g
Nipagin	0,01 g
Nipasol	0,10 g
Carboxil Metil Celulose	8,00 g
Sorbitol	24, 00 g
Água purificada q.s.p.	1000 mL

O retratamento endodôntico foi feito com a remoção de guta-percha através de preparo mecânico com instrumentos rotatórios Protaper Retratamento (Dentsply Maillefer, Ballaigues, Switzerland). Posteriormente à remoção total do material obturador, o canal radicular foi retratado como descrito acima e obturado através da técnica do cone único com cone de guta percha F5 e cimento endodôntico AH Plus (Dentsply Maillefer, Ballaigues, Switzerland), à base de resina epóxica.

Inclusão dos dentes

Subsequente à obtenção de matrizes plásticas de PVC com 20 mm de diâmetro por 20 mm de altura, as raízes foram posicionadas de forma vertical com a ajuda de paralelômetro (BioArt B2, São Carlos, SP, Brasil) sobre uma lâmina de cera e estas matrizes foram preenchidas com resina poliéster (Maxi Rubber, Diadema, SP, Brasil), mantendo 1,0 mm do segmento cervical da raiz fora da inclusão (figura 2 e 3). Todo o conjunto permaneceu intacto por 24 horas, para que ocorresse a completa polimerização da resina. Posteriormente foi desincluído o conjunto resina/raiz.

Figura 2 e 3: Inclusão dos dentes

Desobturação dos dentes

A desobturação foi realizada com fresa do próprio kit de pinos White Post DC (FGM, Joinville SC – Brasil) ampliando os condutos e padronizando-os, com posterior avaliação com paquímetro digital para uniformização.

Grupos experimentais

As raízes foram distribuídas de forma randomizada em 4 grupos. Foram utilizados os cimentos RelyX ARC (3M ESPE, St. Paul, USA) e U200 (3M ESPE, St. Paul, USA), com distribuição dos grupos conforme a tabela 1.

Tabela 1: Divisão dos grupos experimentais

	Tratamento	
Cimento	Convencional	Retratamento
RelyX ARC	G1 (ETA)	G3 (ERA)
U200	G2 (ETU)	G4 (ERU)

Tratamento dos pinos

Todos os pinos receberam o mesmo tratamento prévio à cimentação, sendo a limpeza superficial com álcool 70%. Aplicação com microbrush (KG Sorensen, SP, Brasil) de silano Prosil (FGM, Joinville, SC, Brasil), secagem por 1 minuto com leves jatos de ar e uma camada de adesivo (Adper Scotchbond Multiuso Plus, 3M ESPE, St. Paul, USA), nos grupos que sofreram cimentação convencional, com fotoativação por 20 segundos. Para facilitar a análise sob microscopia confocal laser, foi adicionado ao primer do sistema adesivo e ao cimento resinoso autoadesivo o corante fluorescente rodamina B isotiocianato RITC (máxima absorção 540 nm e máxima emissão de 625 nm) até aproximadamente a concentração de 0,01%.

Cimentação

Grupo 1: Cimentação com RelyX ARC

Foi feita aplicação do sistema adesivo Adper Scotchbond Multiuso Plus (3M ESPE, St. Paul, USA) com microbrush (KG Sorensen, SP, Brasil) conforme recomendações do fabricante. Manipulação do cimento resinoso RelyX ARC (3M

ESPE, St. Paul, USA) feita por 10 segundos, seguida de inserção dentro do conduto com uma sonda milimetrada (Duflex SS White, RJ, Brasil). Aplicação de uma camada sobre a superfície do pino intrarradicular. Posicionamento do pino no interior do conduto e estabilização do mesmo, remoção dos excessos antes da fotoativação, que foi feita por 40 segundos no sentido ocluso-apical.

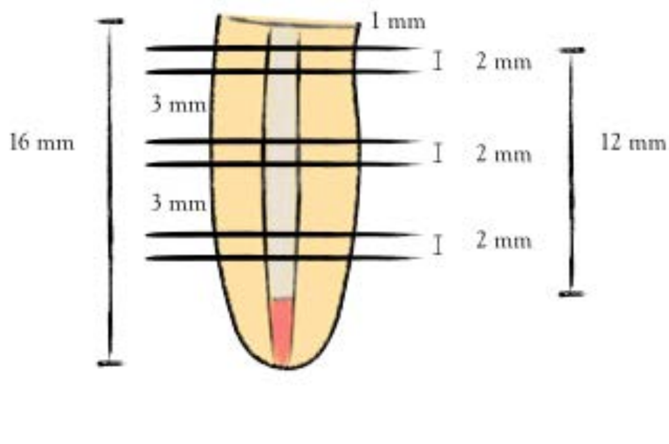
Grupo 2: Cimentação com U200

Manipulação do cimento resinoso autoadesivo U200 (3M ESPE, St. Paul, USA) por 10 segundos e inserção dentro do conduto com uma sonda milimetrada (Duflex SS White, RJ, Brasil). Aplicação de uma camada sobre a superfície do pino intrarradicular. Posicionamento do pino no interior do conduto e estabilização do mesmo, remoção dos excessos antes da fotoativação, que foi feita por 40 segundos no sentido ocluso-apical.

Secção das raízes

Após cimentação dos retentores intrarradiculares, as raízes foram acondicionadas em estufa a 37o C por 48 horas. As raízes foram seccionadas iniciando da porção cervical, onde foram obtidas três fatias com distância de 3,0 mm entre si utilizando-se uma máquina de corte (Isomet 2000; Buehler Ltd., Lake Buff, IL, USA), sob intensa refrigeração (figura 4).

Figura 3: Localização e obtenção das fatias



Três secções foram obtidas, com espessura de 2,0 mm dos terços apical, médio e cervical de cada raiz. As irregularidades das secções foram removidas com lixa d'água de granulação 1200 (Norton, São Paulo, SP, Brasil), limpas com pincel e jatos de ar.

Ensaio mecânico

Cada terço radicular foi submetido ao teste de *“push-out”* em máquina de ensaios mecânicos (DL 2000, EMIC, São José dos Pinhais, PR, Brasil) (figura 5), calibrada para uma velocidade de 0,5 mm/min, até que ocorresse deslocamento do pino de fibra de vidro cimentado das paredes do canal radicular. Um cilindro para deslocamento foi utilizado com os diâmetros de 1,3 mm, 0,9 mm e 0,5 mm, nos terços cervical, médio e apical, respectivamente. Os valores da força necessária para que ocorresse o deslocamento do pino foram obtidos em N (Newton) e, posteriormente transformados em força de adesão (MPa) através da fórmula: MPa = F/AD. A área de adesão foi calculada utilizando a seguinte fórmula: $AD = \pi \cdot (R + r) \cdot g$, onde R = raio cervical do canal radicular, em mm; r = raio apical do canal radicular, em mm; *g* = altura relativa do cone invertido, em milímetros.

Figura 4: EMIC DL 2000, máquina de ensaios mecânicos.

O diâmetro cervical e apical dos canais radiculares foi obtido individualmente através de mensuração com auxílio de estereomicroscópio, com magnificação de 50x (Leica Microsystems, Wetzlar,Germany). O valor de *g* foi obtido a partir da equação: $g^2 = (R - r)^2 + (2.0)^2$.

Análise na microscopia confocal a laser

As secções foram analisadas sob microscópico confocal a laser (Leica TCS NT, Leica Microsystems, Wetzlar,Germany) para determinação da adaptação e penetração dos cimentos na interface entre cimento resinoso/dentina, onde o perímetro do canal com penetração do cimento nos túbulos dentinários foi analisado. As imagens foram avaliadas pelo software Image J, com calibração executada por meio de régua adaptada sob as amostras. O perímetro total do canal e o perímetro de dentina com penetração de cimento nos túbulos dentinários foram mensurados, sendo calculada a porcentagem do perímetro do canal com penetração do cimento nos túbulos dentinários.

Os resultados apontados foram compilados em uma planilha e analisados pelos testes estatísticos para determinação da segurança científica dos resultados alcançados e para determinação de possíveis diferenças entre os grupos e/ou terços analisados.

Análise em microscopia eletrônica de varredura

Após a conclusão da análise pelo microscópio confocal a laser, cada secção foi submetida à metalização com três ciclos de 60 segundos a 20 mA. Na sequência cada um dos espécimes foi analisado em microscopia eletrônica de varredura (JEOL, Tokyo, Japan), obtendo-se imagem em 100x, em 10 mA e o padrão de fratura classificado de acordo com Skidmore et al.[40] (2006), conforme descrito:

(AD) falha adesiva, entre a dentina e o cimento resinoso;

(CO) falha coesiva, no cimento resinoso ou na dentina;

(MI) falha mista, em ambos, cimento resinoso e dentina.

Anexo A - Certificado comitê de ética

Anexo A

unesp UNIVERSIDADE ESTADUAL PAULISTA
"JÚLIO DE MESQUITA FILHO"
CAMPUS DE ARARAQUARA

COMITÊ DE ÉTICA EM PESQUISA E SERES HUMANOS

Rua Humaitá, 1680 - 14801-903 Araraquara - SP - FONE: 0xx16 3301-6432 - FAX: 0xx16 33016433

D E C L A R A Ç Ã O

Declaro para os devidos fins, que o projeto de pesquisa CAAE nº **27664114.8.0000.5416**, intitulado ***"EFEITO DO RETRATAMENTO ENDODÔNTICO SOBRE A RESISTÊNCIA DE UNIÃO DE CIMENTOS RESINOSOS À DENTINA INTRARRADICULAR"***, de responsabilidade do Prof. Dr. MILTON CARLOS KUGA, foi aprovado por este CEP em 28/04/2014, não apresenta pendências até o momento e seu relatório final está em fase de tramitação para análise.

Araraquara, 5 de fevereiro de 2015.

Profa. Dra. Lígia Antunes Pereira Pinelli
Vice-coordenadora do Comitê de Ética em Pesquisa
da Faculdade de Odontologia

Araraquara, 10 de março de 2015.

KAMILA DE FIGUEIREDO PEREIRA