UNIVERSIDADE FEDERAL DE GOIÁS
PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIAS DA SAÚDE

FERNANDA RIBEIRO SANTANA

Influência da terapia endodôntica e do envelhecimento artificial acelerado na resistência de união de pinos de fibra de vidro à dentina intrarradicular

Goiânia
2012

FERNANDA RIBEIRO SANTANA

Influência da terapia endodôntica e do envelhecimento artificial acelerado na resistência de união de pinos de fibra de vidro à dentina intrarradicular

Tese de Doutorado apresentada ao Programa de Pós-Graduação em Ciências da Saúde da Universidade Federal de Goiás para obtenção do Título de Doutora em Ciências da Saúde.

Orientador: Prof. Dr. Carlos Estrela

Coorientador: Prof. Dr. Carlos José Soares

Goiânia
2012

Programa de Pós-Graduação em Ciências da Saúde
da Universidade Federal de Goiás

BANCA EXAMINADORA DA TESE DE DOUTORADO

Aluna: Fernanda Ribeiro Santana

Orientador: Prof. Dr. Carlos Estrela

Coorientador: Prof. Dr. Carlos José Soares

Membros:

1. Prof. Dr. Carlos Estrela
2. Prof. Dr. Carlos José Soares
3. Prof. Dr. Alfredo Júlio Fernandes Neto
4. Prof. Dr. Lawrence Gonzaga Lopes
5. Prof. Dr. Gersinei Carlos de Freitas

Suplentes:

1. Prof.ª Dra. Ana Helena Gonçalves de Alencar
2. Prof. Dr. Daniel Almeida Decúrcio

Data: 28/05/2012

Dedicatória

Dedico este trabalho às pessoas mais importantes da minha vida: meus pais Eduardo e Margareth, meu esposo Elvis, e minhas irmãs Fabiana e Flávia. Agradeço eternamente a vocês pelo amor, incentivo, confiança, apoio e companheirismo para a realização deste trabalho. Amo vocês.

Agradecimentos

À Deus

"Você se fez presente em todos os momentos, firmes ou trêmulos. E passo a passo, pude sentir a Sua mão na minha, transmitindo-me segurança necessária para enfrentar o meu caminho e seguir..." (Vinícius de Moraes)

Aos meus amados pais, Eduardo e Margareth

Meus alicerces e exemplos de vida.

Não tenho palavras suficientes para expressar a imensa gratidão que sinto por vocês, que tantas vezes fizeram de meus sonhos os seus. A capacidade de dedicação e entrega total aos filhos que vocês possuem é admirável e inspiradora!!! Estejam certos de que nesta grande conquista vocês foram fundamentais, pois sempre me motivaram a lutar pelos meus sonhos e nunca mediram esforços para me apoiar nesta jornada. Agradeço a vocês pelo amor incondicional, pelo incentivo, pelas orações diárias, pela dedicação, pelo imensurável esforço em minha formação e por estarem sempre ao meu lado me encorajando nas horas difíceis e me aplaudindo nos momentos de vitória. Agradeço a Deus por ter me dado a graça de tê-los como pais, fonte de inspiração, apoio e ensino diário.

Amo vocês!!

"Se eu cheguei mais longe, é porque estava sobre os ombros de gigantes." (Albert Einstein)

Ao meu amado esposo, Elvis

Meu amor, meu amigo, meu parceiro, meu companheiro, meu cúmplice, meu conselheiro, minha vida… Se hoje estou concluindo mais esta etapa tão importante e sonhada, é porque sempre pude contar com seu apoio, dedicação, incentivo, confiança, paciência e amor incondicional. Agradeço imensamente a Deus pela graça em poder dividir minha vida com uma pessoa tão especial como você. Obrigada meu amor por ser exatamente como você é.
Amo-te profundamente!!!

"*Alma gêmea da minha Alma, Flor de luz da minha vida...*"(Emmanuel/Chico Xavier)

"*Só pelo amor o homem se realiza plenamente.*"(Platão)

Às minhas amadas irmãs, Fabiana e Flávia

Pelo simples fato de existirem dão mais brilho à minha vida. Obrigado pelo amor, carinho, respeito, conselhos, incentivos, admiração, maior do que realmente mereço, e por estarem dispostas a me ajudar em qualquer situação. Admiro muito vocês e tenho um imenso orgulho de tê-las como irmãs. Fabiana, sua competência e dedicação à docência é um exemplo para mim e motivo de grande orgulho para nossa família. Vocês também foram fundamentais nesta conquista.
Amo vocês!!

"Perto está quem mora dentro do coração." (Irmã Safira - Toca de Assis)

Aos meus familiares

Aos meus tios(as), primos(as), sogro(a), cunhados(as), concunhados(as), afilhados(as) que, apesar de minha ausência em muitos momentos, em função desta jornada dedicada à docência, sempre me apoiaram e torceram pelo meu sucesso. Obrigada pelas constantes orações, carinho, respeito e admiração.
É uma alegria imensa tê-los como família!!!

"A verdadeira felicidade está na própria casa, entre as alegrias da família."(Léon Tolstoi)

Ao meu orientador, Professor Carlos Estrela

Agradeço imensamente por ter me recebido com tanto carinho e dedicação. Trabalhar ao seu lado foi uma experiência maravilhosa e enriquecedora!!! Obrigada pela liberdade de trabalho e enorme confiança depositada, pela paciência nos momentos em que me ausentei em favor de minha vida pessoal, pelo incentivo, pelos inúmeros ensinamentos e, principalmente, pelo exemplo de sabedoria, simplicidade, humildade, caráter, fé e dedicação à profissão e à família. Agradeço a você e à sua esposa, Cyntia Estrela, por terem me recebido tão carinhosamente em sua casa durante a realização deste trabalho. Muito obrigado por ter me dado a honra e a oportunidade de aprender e crescer profissionalmente ao seu lado.

"*Grandes obras são feitas por pessoas que não têm medo de serem grandes.*" *(Fernando Flores)*

"*O professor se liga à eternidade. Ele nunca sabe quando cessa a sua influência.*"
(Henry Adams)

Ao meu coorientador, Professor Carlos José Soares

Meu pai da Odontologia, que me ensinou os primeiros passos nesta jornada rumo à docência e continua me guiando, mesmo à distância, com um amor, carinho, dedicação e respeito indescritíveis. Em minha trajetória profissional você fez parte de cada conquista e em mais esta vitória não seria diferente. Obrigado, meu querido, pela disposição constante em ajudar, pelo exemplo de dedicação e amor à docência, pela amizade, respeito e zelo ao longo de todos estes anos de convivência. Obrigado por me receber sempre tão bem e com tanto carinho na UFU. Serei eternamente grata por tudo que você fez por mim e espero tê-lo sempre ao meu lado, independente de onde eu estiver. A você, meu eterno orientador, meu amigo, minha fonte de inspiração, expresso minha imensa gratidão, admiração e respeito.

"Fale, e eu esquecerei, ensina-me, e eu poderei lembrar, envolva-me, e eu aprenderei."
(Benjamin Franklin)

Só os sonhadores podem nos ensinar a voar." *(Anne Marie Pierce)*

"*Só são verdadeiramente grandes aqueles que são verdadeiramente bons.*" *(George Chapman)*

Ao Magnífico Reitor da Universidade Federal de Uberlândia, Professor Alfredo Júlio Fernandes Neto

Tive a grande honra de ser sua aluna na Graduação e Mestrado e poder aprender, admirar e me espelhar na sua capacidade na arte de ensinar, no dom da convivência, nas verdadeiras lições de liderança, empreendedorismo, força, coragem, profissionalismo e competência. Obrigado pelo carinho, conselhos, incentivo, pelos inúmeros auxílios no desenvolvimento dos trabalhos de pesquisa, por sempre ter me apoiado desde a iniciação científica e estimulado meu crescimento profissional. A você que me ensinou muito mais que teorias, me preparando também para a vida, todo o meu carinho, gratidão e profundo respeito.

"*Os grandes líderes são como os melhores maestros, eles vão além das notas para alcançar a mágica dos músicos.*"*(Blaine Lee)*

"*Não basta ensinar ao homem uma especialidade, porque se tornará assim uma máquina utilizável e não uma personalidade. É necessário que adquira um sentimento, senso prático daquilo que vale a pena ser empreendido, daquilo que é belo, do que é moralmente correto.*"*(Albert Einstein)*

Aos Professores Aline, Ana Helena, Daniel, Gersinei, João Batista, Lawrence, Rodrigo

Agradeço pela oportunidade de compartilhar conhecimentos, pela convivência, prestatividade e pela disposição em contribuir com meu trabalho. Agradeço especialmente ao Lawrence e João Batista pela oportunidade de trabalhar com vocês, pelo carinho, confiança, disponibilidade, e, ao Rodrigo pela grande amizade desde a minha graduação, carinho e disposição em ajudar a qualquer momento. Tenho grande admiração por vocês!!!

"*A imortalidade de que se reveste a natureza humana faz o homem sempre presente. Presente pela amizade que conquistou; Presente pelo exemplo que legou; Sempre presente porque educou.*"*(Michel Wolle)*

À amiga, Paula Cicília

Obrigado por me receber tão carinhosamente na UFG, pela amizade, companheirismo, conselhos, apoio... enfim, por todos os momentos que passamos juntas. Torço muito por sua felicidade e sucesso. Obrigado por tudo querida amiga!!!

Aos amigos, Sara, Josemar, Raphaella e Renata

Coorientar vocês foi uma experiência engrandecedora e marcante. Obrigada por tudo que vivemos juntos, pela amizade, carinho, respeito, confiança e aprendizado mútuo.

Aos amigos da UFG, Germana, Orlando, Júlio, Daniel, Guilherme, Iury, Francine, pelo convívio, carinho, apoio, troca de conhecimentos e por fazerem parte desta importante etapa de minha vida! Desejo-lhes muita felicidade e sucesso!!!

Aos amigos da UFU, Andréa, Carol Guimarães, Carol Assaf, Priscilla, Rodrigo Jaiba, Fabiane, Aline, Euridsse, Marina, Marília, Ludmila, Luís Raposo, Bruno, Fabrícia, João Paulo, Lucas Dantas, Lucas Zago, por me fazerem sentir em casa em Uberlândia, pelos momentos que partilhamos e que me deixam tanta saudade, por estarem sempre dispostos a ajudar, pelo eterno carinho e amizade. Agradeço especialmente à Andréa e ao Rodrigo Jaiba pelas contribuições neste trabalho.

"Um amigo é fruto de uma escolha. É uma opção de amor. É a descoberta da alma irmã. É a consciência clara e permanente de algo sublime que não está na natureza das coisas perecíveis. É um tesouro sem preço, um gostar sem distância, de alguém presente em nosso caminho, nas horas de dúvida, de alegria. Demais para ser perdido, Importante para ser esquecido." (Antoine de Saint-Exupéry)

Aos Professores da Dentística da UFU, Gisele, Murilo, Paulo César, Paulo Quagliatto, Paulo Vinícius, Roberto Elias e Veridiana

Obrigada por sempre me receberem com tanto carinho, por deixarem as portas da Dentística sempre abertas, pela amizade e pela grande contribuição em minha formação profissional.

"O que as grandes e puras afeições têm de bom é que depois da felicidade de as ter sentido, resta ainda a felicidade de recordá-las." (Alexandre Dumas)

Ao Sr. Advaldo

Agradeço pela dedicação, carinho e paciência com que sempre me atendeu, sempre disposto a encontrar soluções para todos os problemas. Agradeço também pelas palavras de incentivo, apoio e pela torcida. Muito obrigada!

"A mais nobre missão do ser humano é prestar ajuda aos seus semelhantes por todos os meios ao seu alcance." (Sófocles)

Aos professores da Pós-graduação em Ciências da Saúde da Universidade Federal de Goiás

Muito obrigada a todos pelos ensinamentos e por dividirem suas experiências.

Aos colegas da pós-graduação e graduação da UFG

Agradeço pela convivência e conhecimentos compartilhados.

À Faculdade de Odontologia da Universidade Federal de Goiás,

que possibilitou a realização de parte deste estudo com a disponibilização de estrutura e equipamento.

À Faculdade de Odontologia da Universidade Federal de Uberlândia,

que possibilitou a realização de parte deste estudo com a disponibilização do Laboratório Integrado de Pesquisa Odontológica.

Ao Laboratório de Análise de Imagem, Técnicas Histológicas e Microscopia da Universidade Federal de Uberlândia,

em nome do Professor Marcelo Emilio Beletti e Mariani Borges Franco que possibilitaram a realização das microscopias confocais desta pesquisa.

À CAPES,

pelo apoio financeiro por meio de bolsa de doutorado.

Às empresas Angelus, 3M-ESPE e ao Jorge Lázaro (Optimum),

pelo apoio por meio da doação de material a esta pesquisa.

"A melhor forma de observarmos o tempo que passou é através daquilo que construimos, das lições que aprendemos e das amizades que fizemos."(Barbosa Filho)

Epígrafe

***"Só sabemos com exatidão quando
sabemos pouco; à medida que vamos
adquirindo conhecimentos, instala-se a dúvida."
(Johann Wolfgang von Göethe)***

Sumário

Tabelas, figuras e anexos	xiii
Símbolos, siglas e abreviaturas	xv
Resumo	xvii
Abstract	xix
1. Introdução	21
2. Objetivo	26
3. Material e métodos	27
4. Resultados	41
5. Discussão	53
6. Conclusões	63
7. Referências bibliográficas	64
8. Publicações	76
9. Anexos	123

Tabelas, figuras e anexos

Tabela 1. Médias de resistência de união em MPa (desvio padrão) dos grupos testados imediatamente (sem envelhecimento) e categorias estatísticas definidas pelo teste de Tukey (n = 10). 42

Tabela 2. Médias de resistência de união em MPa (desvio padrão) dos grupos mediatos, testados após envelhecimento artificial em água, e categorias estatísticas definidas pelo teste de Tukey (n = 10). 44

Tabela 3. Médias de resistência de união em MPa (desvio padrão), como resultado do envelhecimento artificial e terço radicular, e categorias estatísticas definidas pelo teste de Tukey para cada grupo (n = 10). 46

Tabela 4. Padrões de falha (%) para os grupos experimentais da parte 1. 47

Tabela 5. Médias de resistência de união em MPa (desvio padrão) das amostras testadas imediatamente (sem envelhecimento) e categorias estatísticas definidas pelo teste de Tukey e teste de Dunnet (n = 10). 49

Tabela 6. Médias de resistência de união em MPa (desvio padrão) das amostras mediatas, testadas após envelhecimento artificial em água, e categorias estatísticas definidas pelo teste de Tukey e teste de Dunnet (n = 10). 50

Tabela 7. Médias de resistência de união em MPa (desvio padrão), como resultado do envelhecimento artificial e terço radicular, e categorias estatísticas definidas pelo teste de Tukey para cada cimento endodôntico (n = 10). 50

Tabela 8. Padrões de falha (%) para os grupos experimentais da parte 2. 51

Figura 1. Seleção e preparo dos dentes: Critério da similaridade externa (A), Demarcação de 15 mm a partir da porção apical da raíz (B), Seccionamento do dente (C), Remanescente radicular de 15 mm e critério da similaridade interna (D). 27

Figura 2. Organograma dos grupos experimentais da parte 1. 28

Figura 3. Preparo do canal radicular para os grupos PAI (A) e PNiTi (B). 30

Figura 4. Pinos de fibra de vidro (Reforpost n. 3; Angelus) (A), Preparo para o pino intrarradicular (B), Recobrimento da raíz externamente com cera utilidade (C). 30

Figura 5. Tratamento de superfície do pino de fibra de vidro (A), Cimentação do pino com o cimento RelyX U100 (3M-ESPE) (B), Fotoativação do cimento (C). 31

Figura 6. Seccionamento da raíz com disco diamantado de dupla face montado em micrótomo de tecido duro. 32

Figura 7. Espécimes armazenados individualmente em *eppendorfs* com água destilada para envelhecimento em estufa a 37°C por dois meses. 32

Figura 8. Posicionamento do espécime no dispositivo para o ensaio de *micropush-out* (A), Aplicação de carregamento de compressão em ensaio de *micropush-out* e fórmula para cálculo da resistência de união (B). 33

Figura 9. Organograma dos grupos experimentais da parte 2. 35

Figura 10. Cimentos endodônticos empregados no presente estudo: SX- Sealapex (Kerr), S26- Sealer 26 (Dentsply), AH- AH Plus (Dentsply) (A), Obturação do canal radicular (B) e Selamento da abertura do canal radicular com ionômero de vidro (C). 37

Figura 11. *d – dentina; c – cimento resinoso; p – pino de fibra de vidro.* Parte 1. Microscopias dos padrões de falha após o teste de micropush-out (aumento 10X): (I) falha adesiva entre o pino e o cimento resinoso; (II) falha adesiva entre o cimento resinoso e a dentina; (III) falha coesiva no cimento; (IV) falha coesiva na dentina; (V) falha coesiva no pino; (VI) falha mista entre pino, cimento resinoso e dentina. 48

Figura 12. *d – dentina; c – cimento resinoso; p – pino de fibra de vidro.* Parte 2. Microscopias dos padrões de falha após o teste de micropush-out (aumento 10X): (I) falha adesiva entre o pino e o cimento resinoso; (II) falha adesiva entre o cimento resinoso e a dentina; (III) falha coesiva no cimento; (IV) falha coesiva na dentina; (V) falha coesiva no pino; (VI) falha mista entre pino, cimento resinoso e dentina. 52

Anexo 1. Publicações no triênio 2010/2011/2012. 123

Anexo 2. Normas de publicação do periódico. 125

Anexo 3. Parecer do Comitê de Ética em Pesquisa – UFG 137

Símbolos, siglas e abreviaturas

n	Número
=	Igual
%	Porcentagem
EDTA	Ácido etilenodiamino tetra-acético
°C	grau Celsius
MPa	Megapascal
ANOVA	Análise de variância
α	Nível de confiabilidade
Mm	Milímetro
et al.	e outros
&	e (comercial)
RJ	Rio de Janeiro
SP	São Paulo
mL	Mililitro
GO	Goiás
Ltda.	Limitada
L	Litro
g/h	Grama por hora
min	Minuto
PR	Paraná
MN	Minnesota
EUA	Estados Unidos da América
mW/cm^2	Miliwatts por centímetro quadrado
s	Segundo
"	Polegada
CT	Connecticut
IL	Illinois
cm	Centímetro
kgf	Quilograma-força

mm/min	Milímetro por minuto
N	Newton
SAS	Statistical analysis system
NC	North Carolina
ANOVA Two-way	Análise de variância dois fatores
ANOVA One-way	Análise de variância um fator
P	Probabilidade
<	Menor
X	Magnitude de aumento de tomada de imagem
UFU	Universidade Federal de Uberlândia
CAPES	Coordenação de Aperfeiçoamento de Pessoal de Nível Superior
CNPq	Conselho Nacional de Desenvolvimento Científico e Tecnológico
#	Número

Resumo

Objetivo: Analisar *in vitro* a influência das técnicas de instrumentação do canal radicular, dos irrigantes e cimentos endodônticos e do envelhecimento artificial acelerado na resistência de união do pino de fibra de vidro à dentina intrarradicular em dentes bovinos. **Metodologia: Parte 1.** Cento e vinte incisivos bovinos foram divididos em doze grupos experimentais (n=10) resultantes da interação entre três fatores em estudo: técnica de instrumentação do canal radicular (PAI – preparo do canal radicular com instrumentos de aço inoxidável - K-File; PNiTi – preparo do canal radicular com instrumentos de Níquel-Titânio - K3); irrigante endodôntico (NaOCl- hipoclorito de sódio 1%; CHX- clorexidina 2%; O_3- água ozonificada 1,2%) (em todas as amostras o EDTA 17% foi utilizado para a remoção de smear layer) e envelhecimento artificial acelerado dos espécimes (Imediato, teste sem envelhecimento; Mediato, teste após 2 meses de envelhecimento em água a 37℃). Após o preparo dos canais radiculares não foi realizada a obturação endodôntica. Pinos de fibra de vidro foram cimentados com cimento resinoso auto-adesivo (RelyX U100, 3M-ESPE) e as raízes foram seccionadas para obtenção de duas fatias de cada terço. As amostras foram submetidas ao teste de *micropush-out* e os dados de resistência de união (MPa) foram analisados por ANOVA com parcela subdividida e teste de Tukey (α = 0,05). Os padrões de falha foram avaliados por meio de microscopia confocal. **Parte 2.** Sessenta incisivos bovinos foram divididos em seis grupos experimentais (n=10) resultantes da interação entre dois fatores em estudo: cimento endodôntico (SX- Sealapex; S26- Sealer 26; AH- AH Plus) e envelhecimento artificial acelerado dos espécimes (Imediato, teste sem envelhecimento; Mediato, teste após 2 meses de envelhecimento em água a 37℃). Foram empregados dois grupos controles (sem obturação do canal radicular) representados pelos grupos PNiTiNaOCl imediato e PNiTiNaOCl mediato da parte 1 do presente estudo. Nos seis grupos experimentais os canais radiculares foram preparados 1mm aquém do ápice com instrumentos de Níquel-Titânio - K3 associado a irrigação com NaOCl 1% e EDTA 17%. Em seguida, foram obturados com guta-percha e o cimento endodôntico específico de cada grupo, usando a técnica de condensação lateral. Pinos de fibra de vidro foram cimentados com cimento resinoso auto-adesivo (RelyX U100, 3M-ESPE) e as raízes foram seccionadas para obtenção de duas fatias de cada terço. As amostras foram submetidas ao teste de *micropush-out* e os dados de resistência de união (MPa) foram analisados por ANOVA com parcela subdividida e teste de Tukey (α = 0,05). Comparações com os grupos controles foram feitas pelo teste de Dunnet (α = 0,05). Os padrões de falha foram avaliados por meio de microscopia confocal. **Resultados: Parte 1.** Nos espécimes submetidos ao envelhecimento artificial em água, PNiTi apresentou maiores valores de resistência de união que PAI no terço apical irrigado com NaOCL ou CHX. A irrigação com NaOCL resultou em maior resistência de união comparada a O_3. O envelhecimento artificial resultou em aumento significante da resistência de união, exceto para os terços médio e apical de $PAIO_3$ e apical de $PNiTiO_3$. A resistência de união reduziu significativamente no terço apical. A prevalência de falha adesiva cimento-dentina foi verificada em todos os grupos. **Parte 2.** Os cimentos endodônticos não mostraram diferenças significantes entre si, entretanto apresentaram valores de resistência de união significativamente menores que os grupos controles (sem obturação), exceto no terço cervical dos grupos testados imediatamente. O envelhecimento artificial não interferiu na resistência de união à dentina intrarradicular. Houve uma diminuição significante na resistência de união do terço cervical para o apical. A prevalência de falha adesiva cimento-dentina foi verificada em todos os grupos. **Conclusões: Parte 1.** O preparo do canal radicular com instrumentos de NiTi associado a irrigação com NaOCl e uso do EDTA aumentou a resistência de união de pinos de fibra de vidro cimentados com cimento auto-adesivo à dentina intrarradicular. **Parte 2.** Os cimentos endodônticos interferiram negativamente na união de pinos de fibra de vidro cimentados com cimento auto-adesivo à dentina intrarradicular.

Abstract

Aim: To evaluate *in vitro* the influence of root canal instrumentation techniques, endodontic irrigants, endodontic sealers and artificial accelerated aging on fibreglass post bond strength to bovine intraradicular dentine. **Methodology: Part 1.** 120 bovine incisors were divided into 12 experimental groups (n=10) resulting from the interaction among 3 study factors: root canal instrumentation technique (RCPSS- root canal preparation with stainless steel instruments - K-File; RCPNiTi- root canal preparation with K3 Nickel-Titanium instruments), endodontic irrigant (NaOCl- 1% sodium hypochlorite; CHX- 2% chlorhexidine; O_3- 1.2% ozonated water) (in all samples 17% EDTA was used to remove the smear layer) and specimens artificial accelerated aging (Immediate, test with no aging; Mediate, test performed after 2 months of water storage at 37℃). After root canal preparation, endodontic filling was not performed. Fibreglass posts were cemented with self-adhesive resin cement (RelyX U100, 3M-ESPE) and roots were cross-sectioned to obtain two slices of each third. Samples were submitted to micropush-out test and bond strength values (MPa) were analyzed by ANOVA in a split-plot arrangement and Tukey's test (α = 0.05). Failure modes were evaluated under a confocal microscope. **Part 2.** 60 bovine incisors were divided into 6 experimental groups (n=10) resulting from the interaction between 2 study factors: endodontic sealer (Sx- Sealapex; S26- Sealer 26; AH- AH Plus) and specimens artificial accelerated aging (Immediate, test with no aging; Mediate, test performed after 2 months of water storage at 37℃). Two control groups were employed (without root canal filling), represented by groups RCPNiTiNaOCl immediate and RCPNiTiNaOCl mediate of part 1 of the present study. In the six experimental groups, root canals were prepared 1mm from the apex with K3 Nickel-Titanium instruments associated with 1% sodium hypochlorite irrigation and 17% EDTA. They were then filled with gutta-percha and the specific sealer of each group, using the lateral compaction technique. Fibreglass posts were cemented with self-adhesive resin cement (RelyX U100, 3M-ESPE) and roots were cross-sectioned to obtain two slices of each third.

Samples were submitted to micropush-out test and bond strength values (MPa) were submitted to ANOVA in a split-plot arrangement and Tukey's test (α = 0,05). Comparisons with control groups were made using Dunnet test (α = 0.05). Failure modes were evaluated under a confocal microscope. **Results: Part 1.** In specimens submitted to water artificial aging, RCPNiTi presented higher bond strength values than RCPSS in apical third irrigated with NaOCl or CHX. Irrigation with NaOCl resulted in higher bond strength than O_3. Artificial aging resulted in significant bond strength increase, except for middle and apical thirds of $RCPSSO_3$ and apical of $RCPNiTiO_3$. Bond strength significantly reduced in apical third. The prevalence of adhesive cement-dentine failure was verified in all groups. **Part 2.** Endodontic sealers showed no significant differences among them, however they presented significantly lower bond strength values than control groups (without filling), except in cervical third of groups tested immediately. Artificial aging did not interfere on bond strength to intraradicular dentine. There was a significant decrease on bond strength from cervical to apical third. The prevalence of adhesive cement-dentine failure was verified in all groups. **Conclusions: Part 1.** Root canal preparation with NiTi instruments associated with NaOCl irrigation and EDTA increased the bond strength of fiberglass posts cemented with self-adhesive resin cement to intraradicular dentine. **Part 2.** Endodontic sealers interfered negatively on bonding of fibreglass posts cemented with self-adhesive resin cement to intraradicular dentine.

1. Introdução

A restauração de dentes tratados endodonticamente representa um desafio, uma vez que geralmente apresentam estrutura coronária insuficiente para reter o material restaurador (Menezes *et al*., 2008; Santana *et al*., 2011). Assim, tem sido sugerido o uso de pino intrarradicular para melhorar a retenção do núcleo de preenchimento (Morgano *et al*., 2004; Cheung, 2005; Tang *et al*., 2010; Santana *et al*., 2011).

Pinos de fibra de vidro em associação ao núcleo de preenchimento em compósito são amplamente aceitos como alternativa a núcleos metálicos moldados e fundidos na restauração de dentes tratados endodonticamente (Schwartz & Robbins, 2004; Bitter & Kielbassa, 2007; Naves *et al*., 2011). Os pinos de fibra de vidro apresentam elevada resistência flexural e módulo de elasticidade similar ao da dentina, o que minimiza a transmissão de tensões para as paredes do canal radicular e reduz a possibilidade de fratura (Lassila *et al*., 2004; Schwartz & Robbins, 2004; Cecchin *et al*., 2011). Estes pinos têm sido cimentados com materiais adesivos (Kececi *et al*., 2008; Bitter *et al*., 2009; Cecchin *et al*., 2011).

A união entre pino-cimento e cimento-dentina é necessária para o sucesso do procedimento restaurador em dentes tratados endodonticamente (Soares *et al*., 2008a). A falta de união é o modo de falha mais comum em restaurações com pino de fibra e compósito (Ferrari *et al.,* 2007; Cagidiaco *et al.,* 2008; Albashaireh *et al.,* 2010; Jongsma *et al.,* 2010). Este fato provavelmente ocorre devido a ausência de visibilidade, características anatômicas (Mjör *et al.,* 2001; Bitter *et al.,* 2008; Pelegrine *et al.,* 2010) e limitada capacidade de dissipar as tensões geradas pela contração de polimerização em um espaço estreito e longo preparado para o pino, exibindo um fator de configuração cavitária altamente desfavorável (Tay *et al*., 2005; Pelegrine *et al*., 2010).

Procedimentos endodônticos realizados antes da cimentação dos pinos podem interferir na união à dentina intrarradicular (Ari *et al*., 2003; Erdemir *et al*., 2004; Hayashi *et al*., 2005; Muniz & Mathias, 2005; Bitter *et al*., 2008; Pelegrine *et al*., 2010). Na terapia endodôntica, o processo de sanificação de canais radiculares infectados tem início com a ação mecânica dos instrumentos e ação química dos irrigantes endodônticos (Estrela *et al*., 2003, 2004). Estes fatores podem induzir alterações químicas e estruturais na superfície dentinária e comprometer a interação com os materiais restauradores (Cecchin *et al*., 2010; Shokouhinejad *et al*., 2010).

No preparo do canal radicular, uma efetiva solução irrigante é essencial para o processo de sanificação porque ela favorece a limpeza, modelagem e neutraliza o conteúdo necrótico, o que favorece o alargamento do canal radicular para subsequente obturação. Diferentes agentes químicos auxiliares ao preparo do canal radicular têm sido propostos e a seleção de um irrigante ideal depende de sua ação nos micro-organismos e tecidos periapicais. O hipoclorito de sódio e a clorexidina são agentes antimicrobianos frequentemente usados no tratamento de infecções endodônticas (Zehnder, 2006; Estrela *et al.,* 2003, 2004, 2007).

O hipoclorito de sódio (NaOCl) é a solução irrigante mais utilizada na endodontia, porque seu mecanismo de ação causa alterações biossintéticas no metabolismo celular e destruição de fosfolipídios, formação de cloraminas que interferem no metabolismo celular, ação oxidativa com inativação enzimática irreversível na bactéria e degradação de lipídeos e ácidos graxos (Estrela *et al.,* 2002). A clorexidina (CHX) é um potente antisséptico com uma ação antimicrobiana de amplo espectro, substantividade (Okino *et al.,* 2004; Pelegrine *et al.,* 2010) e habilidade de decomposição (Barbin *et al.,* 2008), entretanto, é incapaz de dissolver tecidos pulpares (Okino *et al.,* 2004; Pelegrine *et al.,* 2010). A água ozonificada (O_3) no tratamento de infecções endodônticas tem sido estudada (Nagayoshi *et al.,* 2004; Hems *et al.,* 2005; Estrela *et al.,* 2007; Bitter *et al.,* 2008). O ozônio (O_3) é um agente oxidante poderoso cujo efeito antimicrobiano resulta da oxidação de componentes celulares microbianos (Estrela *et al.,* 2007).

Todavia, verifica-se ausência de consenso sobre os possíveis efeitos dos agentes químicos utilizados durante o preparo de canais radiculares em relação à união do pino de fibra à dentina intrarradicular (Morris *et al.,* 2001; Ari *et al.,* 2003; Varela *et al.,* 2003; Erdemir *et al.,* 2004; Muniz & Mathias, 2005; Hayashi *et al.,* 2005; Bitter *et al.,* 2008; Demiryürek *et al.,* 2009; Pelegrine *et al.,* 2010), uma vez que estes efeitos dependem do sistema adesivo empregado (Hayashi *et al.,* 2005; Bitter *et al.,* 2008).

A obturação do canal radicular, importante fase do tratamento endodôntico, apresenta como objetivo o selamento biológico endodôntico (Estrela *et al.,* 2007). Para tanto, utiliza-se a associação de materiais sólidos de preenchimento (como cones de guta-percha) e cimento endodôntico. Este material deveria aderir às paredes do canal radicular e fornecer uma configuração em bloco único permitindo o selamento do espaço do canal (Schwartz, 2006; Teixeira *et al.,* 2009). Este processo de adesão envolve forças mecânicas que permitem o entrelaçamento do material com a estrutura dentinária e pode resultar em uma capacidade maior de selamento, reduzindo assim o risco de microinfiltração no canal radicular e manutenção de uma massa de preenchimento coesiva (Saleh *et al.,* 2002; Teixeira *et al.,* 2009).

Houve uma busca permanente ao longo dos últimos anos de um cimento endodôntico que atendesse as propriedades físico-químicas ideais de selamento, radiopacidade, tempo de endurecimento e escoamento, bem como a tolerância tecidual (Duarte *et al.,* 2010; Holland & Souza, 1985). O Sealapex constitui um cimento endodôntico contendo óxido de cálcio, que apresenta capacidade de estimular a formação de tecido mineralizado (Holland & Souza, 1985). O Sealer 26 representa outro cimento endodôntico que incorpora hidróxido de cálcio, porém associado à resina epóxica (Gomes *et al.,* 2004; Nunes *et al.,* 2008; Demiryürek *et al.,* 2010). O AH Plus é um cimento à base de resina epóxica com boas caracteristicas físico-químicas (Kopper *et al.,* 2003; Solano *et al.,* 2005; Grecca *et al.,* 2009; Demiryürek *et al.,* 2010) e uma adequada adesão (Sousa-Neto *et al.,* 2005; Nunes *et al.,* 2008). A composição dos cimentos endodônticos pode interferir na adesão do pino à dentina intrarradicular (Hagge *et al.,* 2002; Muniz & Mathias, 2005; Baldissara *et al.,* 2006; Menezes *et al.,* 2008; Teixeira *et al.,* 2008; Demiryürek *et al.,* 2010; Cecchin *et al.,* 2011; Dimitrouli *et al.,* 2011).

Diante do exposto, verifica-se que a compatibilidade entre os diferentes materiais empregados na terapia endodôntica e na cimentação de pinos de fibra constitui aspecto importante a ser considerado para uma restauração satisfatória. Além disso, a qualidade de união à dentina radicular pode ser afetada pela densidade e orientação dos túbulos dentinários nos diferentes níveis das paredes do canal radicular (Ferrari *et al.,* 2000; Goracci *et al.,* 2004) e pela facilidade de acesso aos terços do canal radicular (Ferrari *et al.,* 2000; Ferrari *et al.,* 2001; Goracci *et al.,* 2004; Wang *et al.,* 2008; da Cunha *et al.,* 2010).

Vários métodos mecânicos têm sido empregados para mensurar *in vitro* a resistência de união do pino de fibra de vidro à dentina intrarradicular, como os testes de microtração e *micropush-out* (Soares *et al.,* 2008b). O método de *micropush-out* resulta em menor índice de falhas prematuras dos espécimes, menor variabilidade na distribuição dos dados (Goracci *et al.,* 2004; Soares *et al.,* 2008b) e distribuição de tensões mais homogênea (Soares *et al.,* 2008b) comparado ao método de microtração, constituindo assim uma metodologia mais segura (Goracci *et al*., 2004) e apropriada para a avaliação de pinos de fibra de vidro unidos à dentina intrarradicular (Soares *et al.,* 2008b).

Entretanto, estes métodos mecânicos fornecem uma avaliação estática da resistência de união interfacial (Goracci *et al.,* 2004). Alguns estudos têm incluído procedimentos de envelhecimento artificiais, tais como a ciclagem térmica, simulação mastigatória e/ou armazenamento em água para avaliar a durabilidade da união (Balbosh *et al.,* 2005; De Munck *et al.,* 2005; Radovic *et al.,* 2007; Albashaireh *et al.,* 2010). O armazenamento em água é considerado como um teste *in vitro* de envelhecimento acelerado para as interfaces de união (Radovic *et al.,* 2007).

Portanto, torna-se oportuno avaliar a influência das técnicas de instrumentação do canal radicular, da composição química dos irrigantes e cimentos endodônticos e do envelhecimento artificial acelerado dos espécimes na resistência de união do pino de fibra de vidro à dentina intrarradicular, em função da profundidade do canal radicular.

2. Objetivo

O objetivo deste estudo foi avaliar os efeitos da terapia endodôntica (técnica de instrumentação, irrigantes e cimentos endodônticos) e do envelhecimento artificial acelerado dos espécimes na resistência de união de pinos de fibra de vidro cimentados adesivamente (RelyX U100, 3M-ESPE) ao canal radicular em incisivos bovinos, em função da profundidade do canal radicular.

O estudo foi desenvolvido em duas partes. Na parte 1, as hipóteses testadas foram que (1) as técnicas de instrumentação do canal radicular, (2) a composição química dos irrigantes endodônticos e (3) o envelhecimento artificial acelerado dos espécimes influenciam na resistência de união do pino de fibra de vidro à dentina intrarradicular, dependendo da profundidade do canal radicular.

Na parte 2, as hipóteses testadas foram que (4) os cimentos endodônticos e (5) o envelhecimento artificial acelerado dos espécimes influenciam na resistência de união do pino de fibra de vidro à dentina intrarradicular, dependendo da profundidade do canal radicular.

3. Material e métodos

Seleção e preparo dos dentes

A partir de 1000 incisivos inferiores bovinos recém-extraídos, limpos com curetas periodontais (SS White Duflex, Rio de Janeiro, RJ, Brasil) e submetidos a profilaxia com pedra pomes (Vigodent, Rio de Janeiro, RJ, Brasil) e água, foram selecionados 180 dentes (aprovação pelo Comitê de Ética da Universidade Federal de Goiás, n. 256/10), sendo 120 dentes para a parte 1 e 60 para a parte 2 do presente estudo. O critério de seleção usado foi a similaridade na morfologia anatômica externa e interna de dentes de animais adultos, no qual o diâmetro do canal radicular deveria ser menor que 1mm. Os dentes foram seccionados perpendicularmente ao longo eixo com disco diamantado de dupla face (KG Sorensen, São Paulo, SP, Brasil), sob refrigeração em água, permanecendo remanescente radicular de 15 mm a partir da porção apical da raíz (Figura 1).

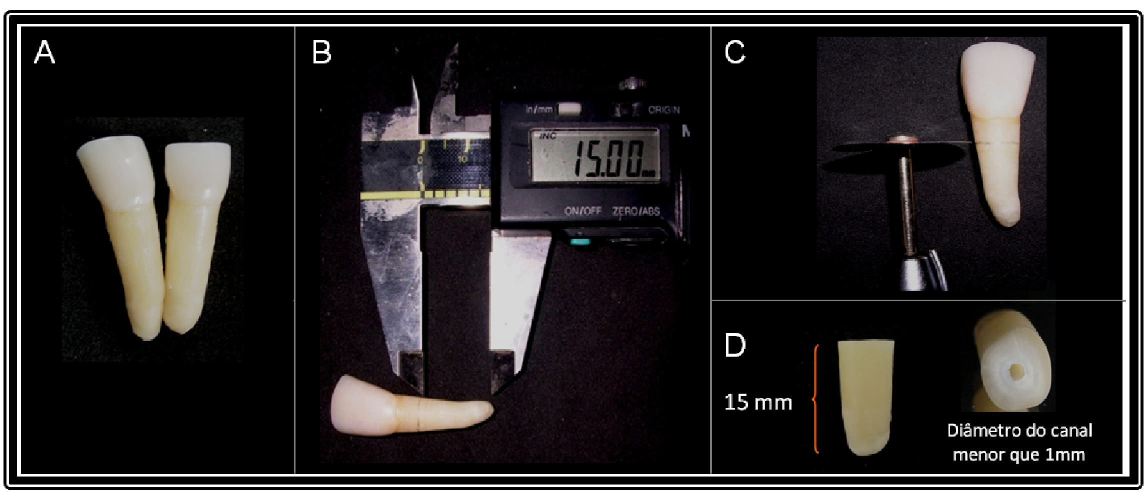

Figura 1. Seleção e preparo dos dentes: Critério da similaridade externa (A), Demarcação de 15 mm a partir da porção apical da raíz (B), Seccionamento do dente (C), Remanescente radicular de 15 mm e critério da similaridade interna (D).

Parte 1

Grupos experimentais

Cento e vinte raízes foram divididas aleatoriamente em 12 grupos experimentais (n=10) resultantes da interação entre três fatores em estudo: técnica de instrumentação do canal radicular (**PAI-** preparo do canal radicular com instrumentos de aço inoxidável - K-File; **PNiTi-** preparo do canal radicular com instrumentos rotatórios de Níquel-Titânio - sistema K3), irrigante endodôntico (**NaOCl-** hipoclorito de sódio 1%; **CHX-** clorexidina 2%; **O_3-** água ozonificada 1,2%) e envelhecimento artificial acelerado dos espécimes (**Imediato**, teste sem envelhecimento; **Mediato**, teste após 2 meses de envelhecimento em água a 37℃) (Figura 2).

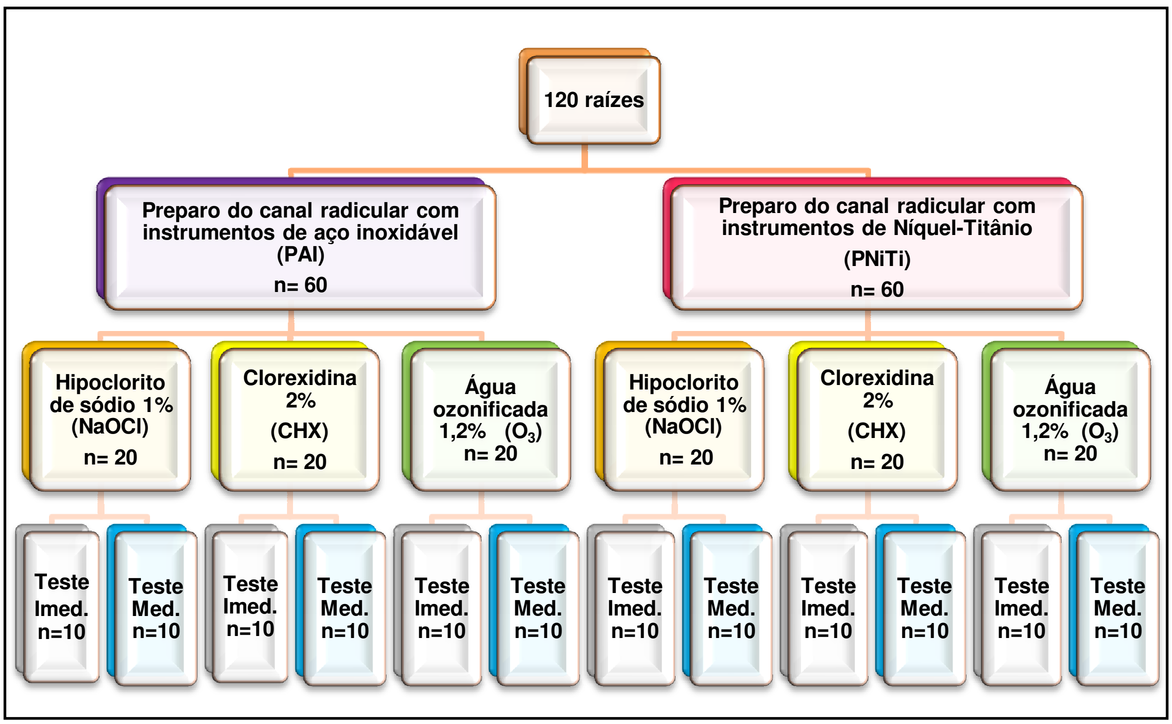

Figura 2. Organograma dos grupos experimentais da parte 1.

Preparo do canal radicular

Os canais radiculares foram preparados 1 mm aquém do ápice por meio da técnica coroa-ápice. Nos grupos PAI, o preparo do canal radicular foi realizado utilizando-se brocas Gates Glidden n. 1,2 (Dentsply Maillefer, Ballaigues, Suíça) (Comprimento de Trabalho - CT 10 mm), brocas Largo n. 2 (Dentsply Maillefer) (CT 10 mm) e instrumentos de aço inoxidável (K-File; Dentsply Maillefer) até a lima n. 45 K-File (CT 14 mm). Nos grupos PNiTi, os canais radiculares foram preparados com brocas Gates Glidden n. 1,2 (Dentsply Maillefer) (CT 10 mm) e instrumentos rotatórios de Níquel-Titânio do sistema K3 (SybronEndo, Optimum, São Paulo, SP, Brasil) na seguinte sequência: lima 25 taper 10 (CT 10 mm); limas 15-25 taper 2 (CT 14 mm); lima 25 taper 4 (CT 14mm); lima 25 taper 6 (CT 14 mm); limas 30-45 taper 2 (CT 14 mm).

Durante a instrumentação, a cada troca de lima, os canais foram irrigados com 2 mL de uma das soluções irrigantes testadas no presente estudo: NaOCl- hipoclorito de sódio 1% (Fitofarma, Goiânia, GO, Brasil); CHX- clorexidina 2% (Fitofarma); O_3- água ozonificada 1,2%. O ozônio foi produzido por uma descarga elétrica através de uma corrente de oxigênio (PXZ3507, Eaglesat Tecnologia em Sistemas Ltda., São José dos Campos, SP, Brasil) e inserido em 1L de água destilada estéril com uma vazão de ozônio de 7 g/h (1,2%) (Estrela *et al.,* 2007). Em todos os grupos, 3 mL de EDTA 17% (Biodinâmica Química e Farmacêutica Ltda., Ibiporã, PR, Brasil) foram utilizados por 5 min para a remoção de smear layer. A irrigação final foi realizada com 5 mL da mesma solução irrigante empregada no preparo do canal radicular. Após o preparo dos canais radiculares não foi realizada a obturação endodôntica (Figura 3).

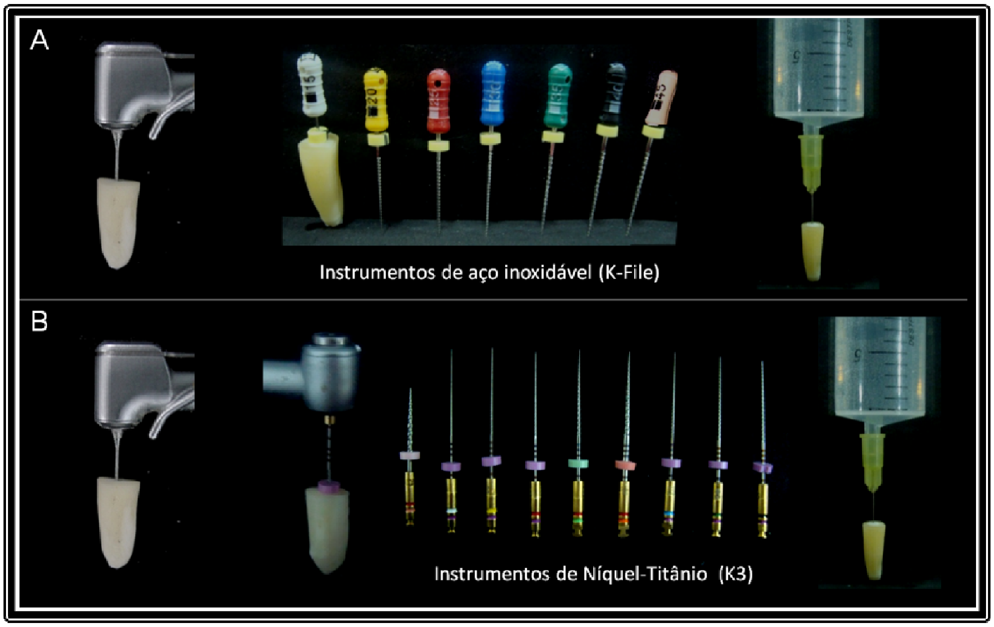

Figura 3. Preparo do canal radicular para os grupos PAI (A) e PNiTi (B).

Preparo para o pino intrarradicular

O preparo para o pino foi realizado usando brocas Largo n. 3-5 (Dentsply Maillefer) (CT 10 mm) correspondente ao pino de fibra de vidro paralelo e serrilhado de 1,5 mm de diâmetro (Reforpost n. 3; Angelus, Londrina, PR, Brasil). Os canais radiculares foram irrigados, a cada troca de brocas e após o preparo, com 2 mL da mesma solução irrigante usada previamente, e foram secos com cones de papel absorventes. Todas as raízes foram cobertas externamente com cera utilidade para evitar polimerização lateral pelo fotoativador (Soares *et al.,* 2012) (Figura 4).

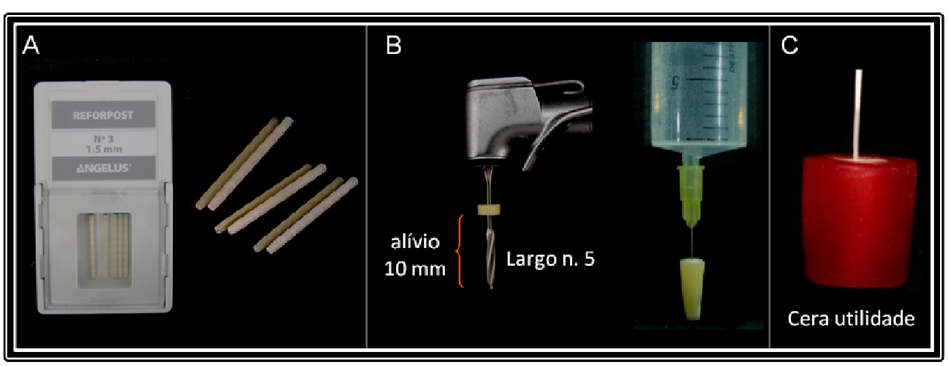

Figura 4. Pinos de fibra de vidro (Reforpost n. 3; Angelus) (A), Preparo para o pino intrarradicular (B), Recobrimento da raíz externamente com cera utilidade (C).

Cimentação do pino intrarradicular

Os pinos de fibra foram limpos com álcool 70% e, em seguida, em uma única aplicação usando um microbrush, e após a secagem, o agente silano foi aplicado por um minuto (Silano; Angelus). O cimento resinoso auto-adesivo (RelyX U100; 3M-ESPE, St. Paul, MN, EUA) foi manipulado de acordo com as instruções do fabricante, introduzido no canal radicular com limas K-File e aplicado na superfície do pino. O pino foi inserido no canal com pressão digital. O excesso de cimento foi removido após 1 min. Após 5 min, o cimento resinoso foi fotopolimerizado com 1200 mW cm^{-2} (Radii-Cal; SDI, Bayswater, Austrália) por 40 s na face cervical da raíz, em direção ao longo eixo da raíz, e obliquamente nas superfícies vestibular e lingual, totalizando 120 s. A interface pino-cimento-dentina na face cervical foi selada com resina composta e as raízes foram armazenadas em água destilada a 37ºC por 24 horas (Figura 5).

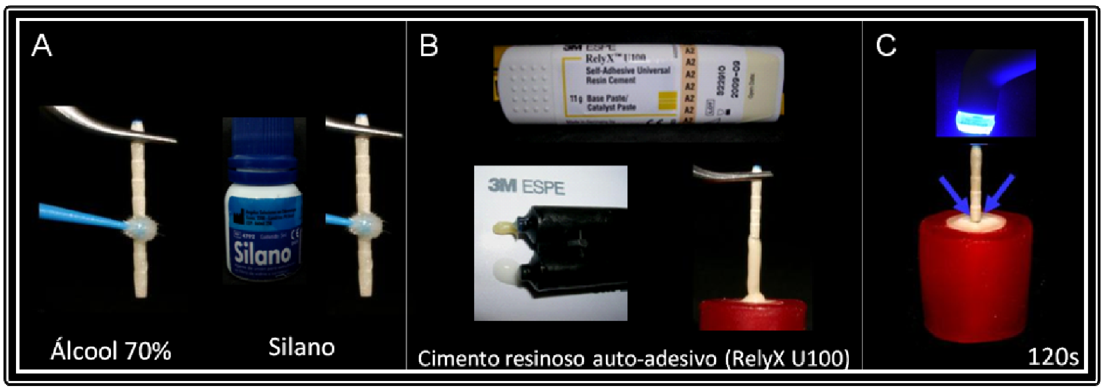

Figura 5. Tratamento de superfície do pino de fibra de vidro (A), Cimentação do pino com o cimento RelyX U100 (3M-ESPE) (B), Fotoativação do cimento (C).

Preparo dos espécimes para o ensaio de *micropush-out*

As raízes foram coladas em placa acrílica com auxílio de adesivo a base de cianoacrilato (Loctite Super Bonder, Henkel Loctite Corporation, EUA) e godiva, e então seccionadas perpendicularmente ao seu longo eixo com disco diamantado dupla face (4" Diameter x 0,012" Thickness x 1/2" Arbor, Extec, Enfield, CT, EUA) em baixa velocidade e sobre refrigeração com água (Isomet 1000, Buehler, Lake Bluff, IL, EUA) para obtenção de duas fatias, com aproximadamente 1mm de espessura, de cada terço radicular (cervical, médio e apical), totalizando seis fatias por raíz (Figura 6).

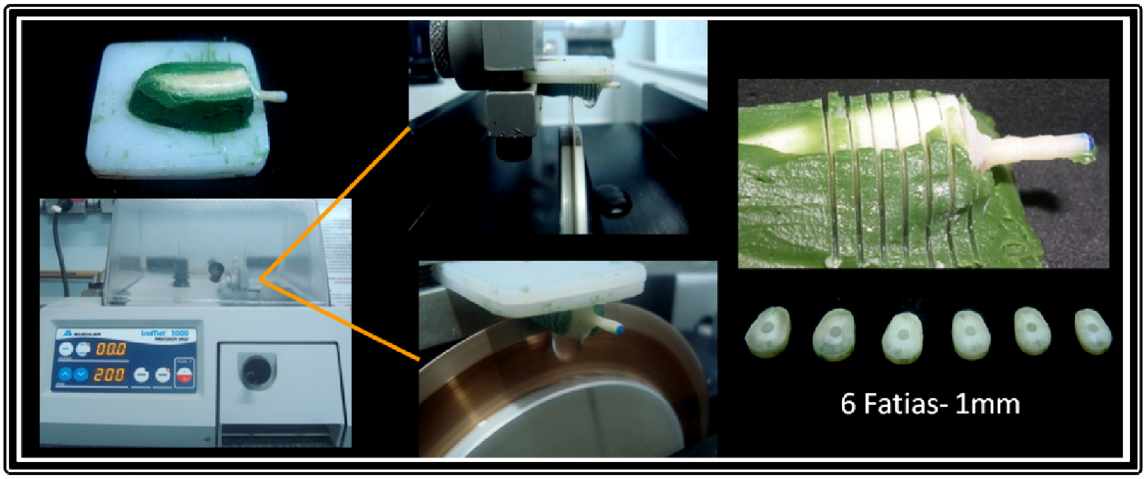

Figura 6. Seccionamento da raíz com disco diamantado de dupla face montado em micrótomo de tecido duro.

Envelhecimento artificial acelerado dos espécimes

Nos grupos mediatos, as fatias foram individualmente armazenadas em *eppendorfs* com água destilada e mantidas em estufa a 37℃ por dois meses antes do teste de *micropush-out (Figura 7)*.

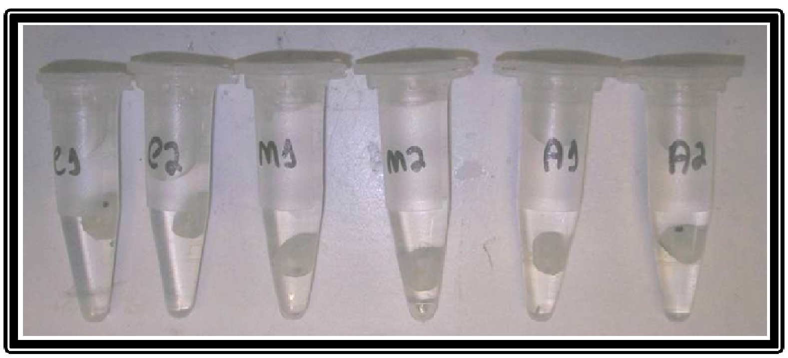

Figura 7. Espécimes armazenados individualmente em *eppendorfs* com água destilada para envelhecimento em estufa a 37℃ por dois meses.

Ensaio de *micropush-out*

Para a realização do ensaio de *micropush-out* foi utilizado dispositivo desenvolvido especificamente para este teste (Menezes *et al*., 2008), constituído por base metálica em aço inoxidável com 3 cm de diâmetro, contendo orifício de 2 mm na região central e ponta aplicadora de carga com 1 mm de diâmetro e 3 mm de comprimento. Após o posicionamento do conjunto na base da máquina de ensaio mecânico (EMIC DL 2000, São José dos Pinhais, PR, Brasil) contendo célula de carga de 20 Kgf, as fatias foram posicionadas de forma que a ponta aplicadora de carga coincidisse com o orifício da base metálica. Em seguida, foi aplicado carregamento de compressão no sentido ápice/coroa sob velocidade de 0,5 mm/min, até ocorrer a extrusão do pino. A resistência de união foi calculada em MPa dividindo-se a carga que levou a falha do sistema (N) pela área da interface de união. A área da interface de união foi calculada pela fórmula: **A = 2πrh**, sendo **A** a área da interface de união; **π** a constante 3,14; **r** o raio do segmento do pino (mm) e **h** a espessura do segmento do pino (mm) (Goracci *et al.,* 2004; Soares *et al.,* 2008b; Soares *et al.,* 2012) (Figura 8).

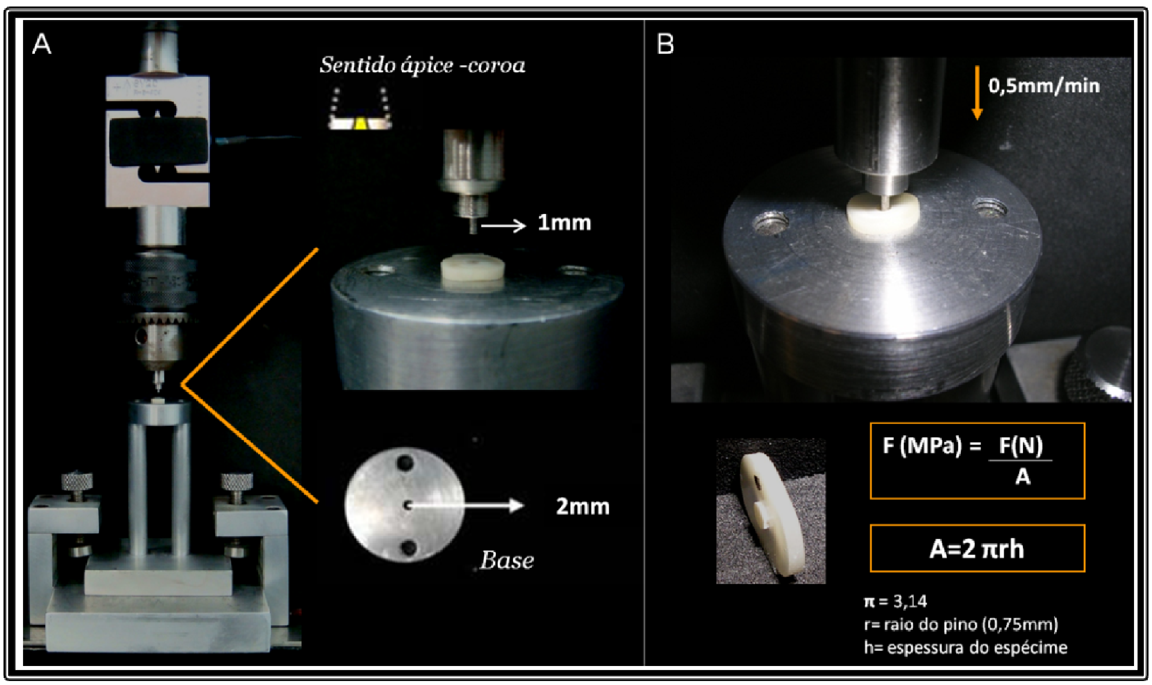

Figura 8. Posicionamento do espécime no dispositivo para o ensaio de *micropush-out* (A), Aplicação de carregamento de compressão em ensaio de *micropush-out* e fórmula para cálculo da resistência de união (B).

Análise estatística

A análise estatística foi realizada utilizando o programa estatístico SAS (Institute Inc., Cary, NC, EUA, Release 9,2). Os dados foram submetidos ao teste de normalidade Shapiro-Wilk. Os efeitos, na resistência de união, da técnica de instrumentação, do irrigante endodôntico e da profundidade do canal radicular foram analisados usando ANOVA Two-way em esquema de parcela subdividida, com as parcelas representadas pelos fatores técnica de instrumentação, irrigante endodôntico e suas interações, e a sub-parcela representada pelos terços do canal radicular (cervical, médio e apical). Comparações relacionadas ao envelhecimento artificial foram realizadas por ANOVA One-way com a parcela representada por este fator e a sub-parcela representada pelo terços do canal radicular. Comparações múltiplas foram feitas pelo teste de Tukey (α=0,05).

Definição dos padrões de falha por Microscopia Confocal a laser de varredura

Para determinar os padrões de falha, todos os espécimes fraturados (n=720) foram secos com jato de ar e analisados em microscópio de varredura confocal a laser (Carl Zeiss Laser Scanning Systems, LSM510, META, Oberkochen, Alemanha). As imagens foram analisadas usando o Zeiss LSM Image Browser (META, Alemanha). Os padrões de falha foram classificados em seis tipos: (I) falha adesiva entre o pino e o cimento resinoso; (II) falha adesiva entre o cimento resinoso e a dentina intrarradicular; (III) falha coesiva no cimento; (IV) falha coesiva na dentina; (V) falha coesiva no pino (Castellan *et al.,* 2010) e (VI) falha mista entre pino, cimento resinoso e dentina intrarradicular (Bitter *et al.,* 2009).

Parte 2

Grupos experimentais

Sessenta raízes foram divididas aleatoriamente em seis grupos experimentais (n=10) resultantes da interação entre dois fatores em estudo: cimento endodôntico (**SX**- Sealapex, cimento à base de óxido de cálcio; Kerr Corporation, Orange, EUA; **S26**- Sealer 26; cimento à base de hidróxido de cálcio; Dentsply Maillefer, Petrópolis, RJ, Brasil; **AH**- AH Plus; cimento à base de resina epóxica; Dentsply DeTrey GmbH, Konstanz, Alemanha) e envelhecimento artificial acelerado dos espécimes (**Imediato**, teste sem envelhecimento; **Mediato**, teste após 2 meses de envelhecimento em água a 37℃) (Figura 9).

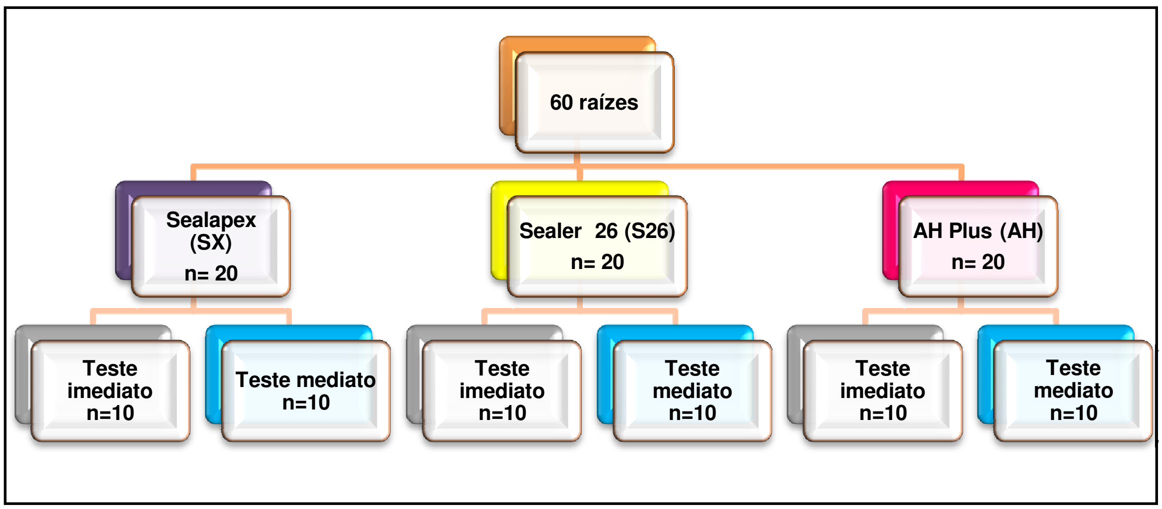

Figura 9. Organograma dos grupos experimentais da parte 2.

Nesta parte do presente estudo, foram empregados dois grupos controles (sem obturação do canal radicular), sendo um controle imediato e um controle mediato. Os valores de resistência de união e padrões de falha dos grupos controle imediato e mediato foram obtidos dos grupos PNiTiNaOCl imediato e PNiTiNaOCl mediato da parte 1, respectivamente.

Preparo do canal radicular

Nos grupos experimentais, os canais radiculares foram preparados 1 mm aquém do ápice por meio da técnica coroa-ápice com instrumentos rotatórios de Níquel-Titânio do sistema K3 (SybronEndo, Optimum, São Paulo, SP, Brasil) associados aos agentes químicos NaOCl 1% e EDTA 17%. Assim, os canais radiculares foram preparados com brocas Gates Glidden n. 1,2 (Dentsply Maillefer, Ballaigues, Suíça) (CT 10 mm) e instrumentos rotatórios NiTi na seguinte sequência: lima 25 taper 10 (CT 10 mm); limas 15-25 taper 2 (CT 14 mm); lima 25 taper 4 (CT 14mm); lima 25 taper 6 (CT 14 mm); limas 30-45 taper 2 (CT 14 mm).

Durante a instrumentação, a cada troca de lima, os canais foram irrigados com 2 mL de NaOCl 1% (Fitofarma, Goiânia, GO, Brasil). Em todos os grupos, 3 mL de EDTA 17% (Biodinâmica Química e Farmacêutica Ltda., Ibiporã, PR, Brasil) foram utilizados por 5 min para a remoção de smear layer. A irrigação final foi realizada com 5 mL de NaOCl 1% (Fitofarma).

Os canais radiculares foram secos com cones de papel absorventes e obturados com cones de guta-percha (Dentsply Maillefer) e o cimento endodôntico específico de cada grupo, utilizando a técnica de condensação lateral. Os cimentos endodônticos foram preparados e utilizados de acordo com as instruções dos fabricantes. Após a obturação, as aberturas dos canais radiculares foram seladas com cimento de ionômero de vidro (Vidrion R; SSWhite, Rio de Janeiro, RJ, Brasil) e as amostras foram armazenadas em água destilada a 37℃ por 24 horas (Figura 10).

Figura 10. Cimentos endodônticos empregados no presente estudo: SX-Sealapex (Kerr), S26-Sealer 26 (Dentsply), AH- AH Plus (Dentsply) (A), Obturação do canal radicular (B) e Selamento da abertura do canal radicular com ionômero de vidro (C).

Preparo para o pino intrarradicular

Após 24 horas, o material obturador foi removido com brocas Gates Glidden na profundidade de 10 mm mantendo-se 5 mm de selamento apical.

O preparo para o pino foi realizado usando brocas Largo n. 3-5 (Dentsply Maillefer) (CT 10 mm) correspondente ao pino de fibra de vidro paralelo e serrilhado de 1,5 mm de diâmetro (Reforpost n. 3; Angelus, Londrina, PR, Brasil). Os canais radiculares foram irrigados, a cada troca de brocas e após o preparo, com 2 mL de NaOCl 1% e foram secos com cones de papel absorventes. Todas as raízes foram cobertas externamente com cera utilidade para evitar polimerização lateral pelo fotoativador (Soares *et al.,* 2012).

Cimentação do pino intrarradicular

Os pinos de fibra foram limpos com álcool 70% e, em seguida, em uma única aplicação usando um microbrush, e após a secagem, o agente silano foi aplicado por um minuto (Silano; Angelus). O cimento resinoso auto-adesivo (RelyX U100; 3M-ESPE, St. Paul, MN, EUA) foi manipulado de acordo com as instruções do fabricante, introduzido no canal radicular com limas K-File e aplicado na superfície do pino. O pino foi inserido no canal com pressão digital.

O excesso de cimento foi removido após 1 min. Após 5 min, o cimento resinoso foi fotopolimerizado com 1200 mW cm^{-2} (Radii-Cal; SDI, Bayswater, Austrália) por 40 s na face cervical da raíz, em direção ao longo eixo da raíz, e obliquamente nas superfícies vestibular e lingual, totalizando 120 s. A interface pino-cimento-dentina na face cervical foi selada com resina composta e as raízes foram armazenadas em água destilada a 37ºC por 24 horas.

Preparo dos espécimes para o ensaio de *micropush-out*

As raízes foram coladas em placa acrílica com auxílio de adesivo a base de cianoacrilato (Loctite Super Bonder, Henkel Loctite Corporation, EUA) e godiva, e então seccionadas perpendicularmente ao seu longo eixo com disco diamantado dupla face (4" Diameter x 0,012" Thickness x 1/2" Arbor, Extec, Enfield, CT, EUA) em baixa velocidade e sobre refrigeração com água (Isomet 1000, Buehler, Lake Bluff, IL, EUA) para obtenção de duas fatias, com aproximadamente 1mm de espessura, de cada terço radicular (cervical, médio e apical), totalizando seis fatias por raíz.

Envelhecimento artificial acelerado dos espécimes

Nos grupos mediatos, as fatias foram individualmente armazenadas em *eppendorfs* com água destilada e mantidas em estufa a 37°C por dois meses antes do teste de *micropush-out*.

Ensaio de *micropush-out*

Para a realização do ensaio de *micropush-out* foi utilizado dispositivo desenvolvido especificamente para este teste (Menezes *et al.*, 2008), constituído por base metálica em aço inoxidável com 3 cm de diâmetro, contendo orifício de 2 mm na região central e ponta aplicadora de carga com 1 mm de diâmetro e 3 mm de comprimento. Após o posicionamento do conjunto na base da máquina de ensaio mecânico (EMIC DL 2000, São José dos Pinhais, PR, Brasil) contendo célula de carga de 20 Kgf, as fatias foram posicionadas de forma que a ponta aplicadora de carga coincidisse com o orifício da base metálica. Em seguida, foi aplicado carregamento de compressão no sentido ápice/coroa sob velocidade de 0,5 mm/min, até ocorrer a extrusão do pino. A resistência de união foi calculada em MPa dividindo-se a carga que levou a falha do sistema (N) pela área da interface de união. A área da interface de união foi calculada pela fórmula: $\mathbf{A = 2\pi rh}$, sendo **A** a área da interface de união; $\boldsymbol{\pi}$ a constante 3,14; **r** o raio do segmento do pino (mm) e **h** a espessura do segmento do pino (mm) (Goracci *et al.,* 2004; Soares *et al.,* 2008b; Soares *et al.,* 2012).

Análise estatística

A análise estatística foi realizada utilizando o programa estatístico SAS (Institute Inc., Cary, NC, EUA, Release 9,2). Os dados foram submetidos ao teste de normalidade Shapiro-Wilk. Os efeitos, na resistência de união, dos cimentos endodônticos e do envelhecimento artificial foram analisados usando ANOVA One-way em esquema de parcela subdividida, com a parcela representada pelo cimento endodôntico ou pelo envelhecimento, e a sub-parcela representada pelos terços do canal radicular (cervical, médio e apical). Comparações múltiplas foram feitas pelo teste de Tukey (α=0,05). Comparações com os grupos controles imediato e mediato foram feitas pelo teste de Dunnet (α=0,05).

Definição dos padrões de falha por Microscopia Confocal a laser de varredura

Para determinar os padrões de falha, todos os espécimes fraturados (n=360) foram secos com jato de ar e analisados em microscópio de varredura confocal a laser (Carl Zeiss Laser Scanning Systems, LSM510, META, Oberkochen, Alemanha). As imagens foram analisadas usando o Zeiss LSM Image Browser (META, Alemanha). Os padrões de falha foram classificados em seis tipos: (I) falha adesiva entre o pino e o cimento resinoso; (II) falha adesiva entre o cimento resinoso e a dentina intrarradicular; (III) falha coesiva no cimento; (IV) falha coesiva na dentina; (V) falha coesiva no pino (Castellan *et al.,* 2010) e (VI) falha mista entre pino, cimento resinoso e dentina intrarradicular (Bitter *et al.,* 2009).

4. Resultados

Parte 1

A análise de variância two-way (técnica de instrumentação X irrigante endodôntico) com sub-parcela (terço do canal radicular) dos grupos testados imediatamente mostrou diferença significante para o irrigante endodôntico (p=0,0023) e terço do canal radicular (p=<0,0001). Os valores médios de resistência de união e os desvios padrões estão na Tabela 1. O teste de Tukey indicou que a irrigação com NaOCl resultou em resistência de união maior comparada a O_3, exceto no terço apical de PNiTi no qual foi similar. A irrigação com CHX resultou em valores de resistência de união intermediários que foram estatisticamente semelhantes aos valores obtidos nos grupos irrigados com O_3 nos terços cervical/apical de PAI e cervical/médio de PNiTi, e em todos os grupos irrigados com NaOCl. Independente da técnica de preparo do canal radicular e do irrigante endodôntico, o terço cervical apresentou maiores valores de resistência de união que o terço apical.

Tabela 1. Médias de resistência de união em MPa (desvio padrão) dos grupos testados imediatamente (sem envelhecimento) e categorias estatísticas definidas pelo teste de Tukey (n = 10).

Irrigante endodôntico	Técnica de instrumentação						Total
	Instrumentos de aço inoxidável (PAI)			Instrumentos de Níquel-Titânio (PNiTi)			
	Terço radicular			Terço radicular			
	Cervical	Médio	Apical	Cervical	Médio	Apical	
NaOCl	12,90(2,41)^{Aa}	10,30(4,03)^{Ba}	7,10(3,78)^{Ca}	13,52(2,12)^{Aa}	11,39(3,26)^{ABa}	9,33(4,80)^{BCa}	10,75(4,03)^{a}
CHX	11,39(3,27)^{Aab}	9,81(3,89)^{ABa}	6,74(3,88)^{Cab}	11,46(3,84)^{Aab}	9,99(4,91)^{ABab}	7,08(5,55)^{BCa}	9,41(4,52)^{ab}
O_3	8,65(6,83)^{Ab}	6,15(5,04)^{Bb}	3,53(2,92)^{Cb}	9,49(3,39)^{Ab}	7,40(1,55)^{ABb}	6,77(1,42)^{BCa}	7,00(4,30)^{b}
Total		8,51(4,86)^{B}			9,60(4,15)^{A}		

Letras maiúsculas foram utilizadas para comparar os grupos nas linhas horizontais e letras minúsculas para comparar os grupos nas linhas verticais. Categorias estatísticas com letras iguais, definidas pelo teste Tukey, não são estatisticamente significantes entre si (p <0,05).

PAI, preparo do canal radicular com instrumentos de aço inoxidável (K-File); PNiTi, preparo do canal radicular com instrumentos de Níquel-Titânio K3); NaOCl, hipoclorito de sódio 1%; CHX, clorexidina 2%; O_3, água ozonificada 1,2%.

A análise de variância two-way (técnica de instrumentação X irrigante endodôntico) com sub-parcela (terço do canal radicular) dos grupos mediatos, testados após envelhecimento acelerado dos espécimes, mostrou diferença significante para a técnica de instrumentação (p=0,0356), irrigante endodôntico (p=<0,0001), terço do canal radicular (p=<0,0001) e para a interação entre irrigante e terço do canal radicular (p=0,0047). Os valores médios de resistência de união e os desvios padrões estão na Tabela 2. No terço apical de espécimes irrigados com NaOCl ou CHX, PNiTi resultou em maior resistência de união que PAI. Em relação ao irrigante endodôntico, o NaOCl resultou em maiores valores de resistência de união que O_3 em todos os grupos. CHX apresentou valor estatisticamente menor que NaOCl apenas no terço cervical de PAI e similaridade a NaOCl nos outros grupos. O terço cervical apresentou valores maiores que o apical, exceto nos grupos PNiTiNaOCl e PNiTiCHX nos quais foi similar.

Tabela 2. Médias de resistência de união em MPa (desvio padrão) dos grupos mediatos, testados após envelhecimento artificial em água, e categorias estatísticas definidas pelo teste de Tukey (n = 10).

Irrigante Endodôntico	Técnica de instrumentação: Instrumentos de aço inoxidável (PAI) – Terço radicular: Cervical	Médio	Apical	Instrumentos de Níquel-Titânio (PNiTi) – Terço radicular: Cervical	Médio	Apical	Total
NaOCl	24,08(5,77)^{Aa}	20,31(7,70)^{Ba}	15,46(8,63)^{Ca}	25,10(6,44)^{Aa}	22,55(6,08)^{ABa}	21,64(6,33)^{ABa}	21,52(7,31)^{a}
CHX	18,85(4,26)^{ABb}	16,16(3,99)^{Ba}	13,28(7,20)^{Ca}	21,41(3,44)^{Aab}	20,83(6,27)^{ABa}	18,35(7,67)^{ABa}	18,15(6,14)^{a}
O_3	17,36(4,84)^{Ab}	9,94(3,98)^{Bb}	6,42(3,35)^{Cb}	17,44(4,85)^{Ab}	10,99(5,34)^{Bb}	7,06(3,78)^{BCb}	11,54(6,15)^{b}
Total		15,76(7,52)^{B}			18,37(7,77)^{A}		

Letras maiúsculas foram utilizadas para comparar os grupos nas linhas horizontais e letras minúsculas para comparar os grupos nas linhas verticais. Categorias estatísticas com letras iguais, definidas pelo teste Tukey, não são estatisticamente significantes entre si (p <0,05).
PAI, preparo do canal radicular com instrumentos de aço inoxidável (K-File); PNiTi, preparo do canal radicular com instrumentos de Níquel-Titânio K3); NaOCl, hipoclorito de sódio 1%; CHX, clorexidina 2%; O_3, água ozonificada 1,2%.

A análise de variância one-way (envelhecimento artificial) com sub-parcela (terço do canal radicular) no grupo PAINaOCl mostrou significância para o envelhecimento artificial (p=<0,001) e terço do canal radicular (p=<0,001). No grupo PAICHX houve significância para o envelhecimento artificial (p=<0,001) e terço radicular (p=<0,001). No grupo PAIO$_3$ houve significância para o envelhecimento artificial (p=<0,001), terço do canal radicular (p=<0,001) e para a interação entre estes fatores (p=0,032). No grupo PNiTiNaOCl houve significância para o envelhecimento artificial (p=<0,001) e terço do canal radicular (p=0,005). No grupo PNiTiCHX houve significância para o envelhecimento artificial (p=<0,001) e terço do canal radicular (p=0,008). No grupo PNiTiO$_3$ houve significância para o envelhecimento artificial (p=0,008), terço do canal radicular (p=<0,001) e para a interação entre estes fatores (p=<0,001). Os valores médios de resistência de união e os desvios padrões dos grupos estão na Tabela 3. O teste de Tukey demonstrou um aumento significante na resistência de união após o envelhecimento artificial acelerado, exceto para os terços médio e apical de PAIO$_3$ e apical de PNiTiO$_3$ nos quais foram similares.

Tabela 3. Médias de resistência de união em MPa (desvio padrão), como resultado do envelhecimento artificial e terço radicular, e categorias estatísticas definidas pelo teste de Tukey para cada grupo (n = 10).

Grupos	Teste	Terço radicular		
		Cervical	Médio	Apical
PAINaOCl	Imediato	$12{,}90 \pm 2{,}41^{Ab}$	$10{,}30 \pm 4{,}03^{ABb}$	$7{,}10 \pm 3{,}78^{Bb}$
	Mediato	$24{,}08 \pm 5{,}77^{Aa}$	$20{,}31 \pm 7{,}70^{Ba}$	$15{,}46 \pm 8{,}63^{Ca}$
PAICHX	Imediato	$11{,}39 \pm 3{,}27^{Ab}$	$9{,}81 \pm 3{,}89^{ABb}$	$6{,}74 \pm 3{,}88^{Bb}$
	Mediato	$18{,}85 \pm 4{,}26^{Aa}$	$16{,}16 \pm 3{,}99^{ABa}$	$13{,}28 \pm 7{,}20^{Ba}$
$PAIO_3$	Imediato	$8{,}65 \pm 6{,}83^{Ab}$	$6{,}15 \pm 5{,}04^{ABa}$	$3{,}53 \pm 2{,}92^{Ba}$
	Mediato	$17{,}36 \pm 4{,}84^{Aa}$	$9{,}94 \pm 3{,}98^{Ba}$	$6{,}42 \pm 3{,}35^{Ba}$
PNiTiNaOCl	Imediato	$13{,}52 \pm 2{,}12^{Ab}$	$11{,}39 \pm 3{,}26^{ABb}$	$9{,}33 \pm 4{,}80^{Bb}$
	Mediato	$25{,}10 \pm 6{,}44^{Aa}$	$22{,}55 \pm 6{,}08^{Aa}$	$21{,}64 \pm 6{,}33^{Aa}$
PNiTiCHX	Imediato	$11{,}46 \pm 3{,}84^{Ab}$	$9{,}99 \pm 4{,}91^{ABb}$	$7{,}08 \pm 5{,}55^{Bb}$
	Mediato	$21{,}41 \pm 3{,}44^{Aa}$	$20{,}83 \pm 6{,}27^{Aa}$	$18{,}35 \pm 7{,}67^{Aa}$
$PNiTiO_3$	Imediato	$9{,}49 \pm 3{,}39^{Ab}$	$7{,}40 \pm 1{,}55^{ABb}$	$6{,}77 \pm 1{,}42^{Ba}$
	Mediato	$17{,}44 \pm 4{,}85^{Aa}$	$10{,}99 \pm 5{,}34^{Ba}$	$7{,}06 \pm 3{,}78^{Ca}$

Em cada grupo, letras maiúsculas foram utilizadas para comparar os grupos nas linhas horizontais e letras minúsculas para comparar os grupos nas linhas verticais. Categorias estatísticas com letras iguais, definidas pelo teste Tukey, não são estatisticamente significantes entre si ($p < 0{,}05$).

PAI, preparo do canal radicular com instrumentos de aço inoxidável (K-File); PNiTi, preparo do canal radicular com instrumentos de Níquel-Titânio K3); NaOCl, hipoclorito de sódio 1%; CHX, clorexidina 2%; O_3, água ozonificada 1,2%; Imediato, teste sem envelhecimento; Mediato, teste após 2 meses de envelhecimento em água a 37°C.

A distribuição e representação dos padrões de falha estão apresentadas na Tabela 4 e Figura 11, respectivamente. A prevalência de (II) falha adesiva entre o cimento resinoso e a dentina intrarradicular foi verificada em todos os grupos.

Tabela 4. Padrões de falha (%) para os grupos experimentais da parte 1.

Grupos	Adesiva: Pino e cimento (I)	Adesiva: Cimento e dentina (II)	Coesiva: Cimento (III)	Coesiva: Dentina (IV)	Coesiva: Pino (V)	Mista (VI)
PAINaOCl imediato	-	32 (53,3)	-	4 (6,7)	1 (1,7)	23 (38,3)
PAICHX imediato	1 (1, 7)	33 (55,0)	-	3 (5,0)	1 (1,7)	22 (36,7)
PAIO_3 imediato	3 (5,0)	33 (55,0)	-	-	1 (1,7)	23 (38,3)
PNiTiNaOCl imediato	2 (3,3)	33 (55,0)	-	6 (10,0)	2 (3,3)	17 (28,3)
PNiTiCHX imediato	2 (3,3)	34 (56,7)	-	2 (3,3)	2 (3,3)	20 (33,3)
PNiTiO_3 imediato	2 (3,3)	47 (78,3)	-	1 (1,7)	-	10 (16,7)
PAINaOCl mediato	2 (3,3)	27 (45,0)	-	-	11 (18,3)	20 (33,3)
PAICHX mediato	3 (5,0)	31 (51,7)	-	1 (1,7)	7 (11,7)	18 (30,0)
PAIO_3 mediato	3 (5,0)	40 (66,7)	-	-	2 (3,3)	15 (25,0)
PNiTiNaOCl mediato	1 (1,7)	20 (33,3)	-	9 (15,0)	15 (25,0)	15 (25,0)
PNiTiCHX mediato	-	42 (70,0)	-	-	10 (16,7)	8 (13,3)
PNiTiO_3 mediato	1 (1,7)	35 (58,3)	1 (1,7)	-	3 (5,0)	20 (33,3)

PAI, preparo do canal radicular com instrumentos de aço inoxidável (K-File); PNiTi, preparo do canal radicular com instrumentos de Níquel-Titânio K3); NaOCl, hipoclorito de sódio 1%; CHX, clorexidina 2%; $O_{3,}$ água ozonificada 1,2%; Imediato, teste sem envelhecimento; Mediato, teste após 2 meses de envelhecimento em água a 37℃.

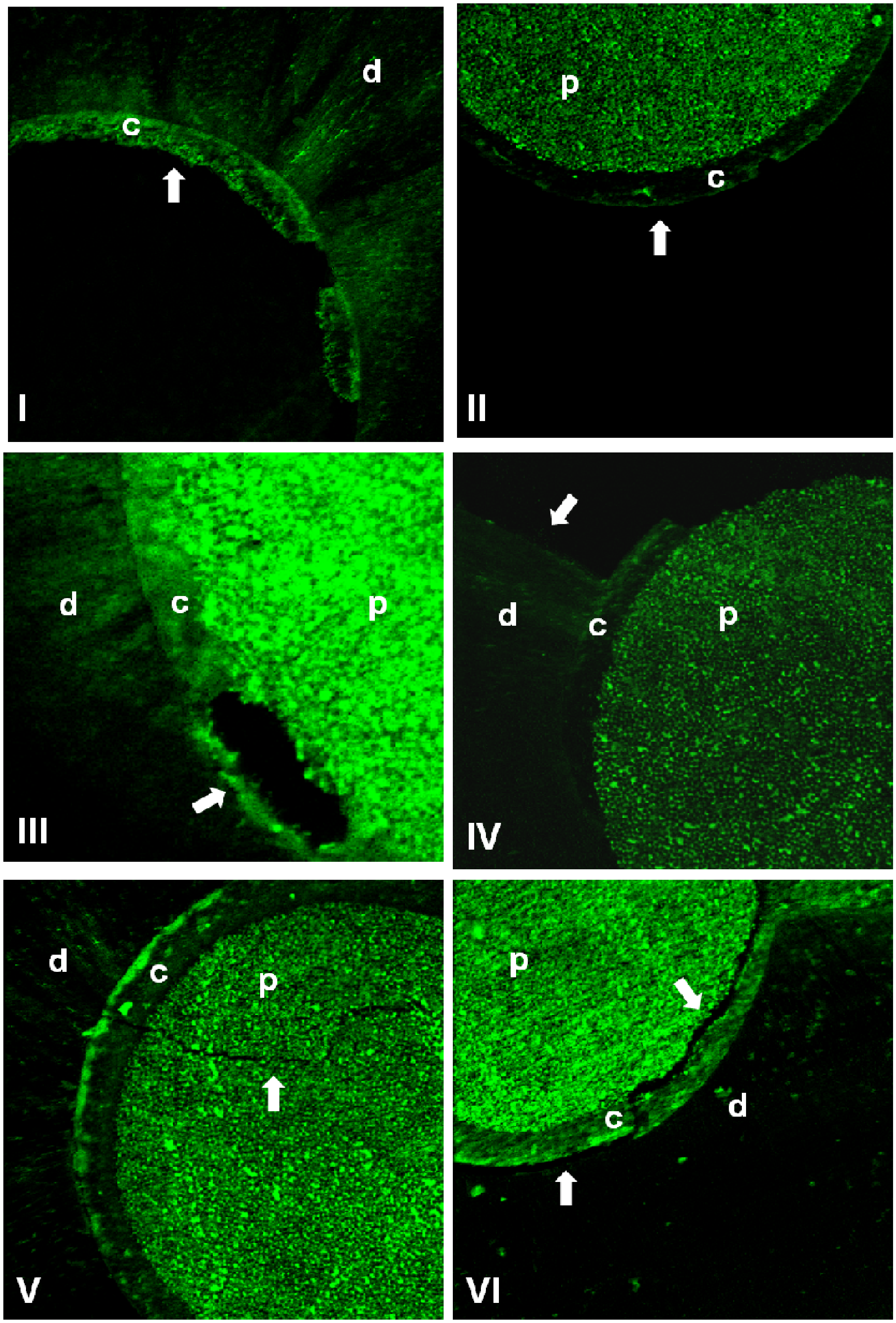

Figura 11. *d – dentina; c – cimento resinoso; p – pino de fibra de vidro.* Parte 1. Microscopias dos padrões de falha após o teste de micropush-out (aumento 10X): (I) falha adesiva entre o pino e o cimento resinoso; (II) falha adesiva entre o cimento resinoso e a dentina; (III) falha coesiva no cimento; (IV) falha coesiva na dentina; (V) falha coesiva no pino; (VI) falha mista entre pino, cimento resinoso e dentina.

Parte 2

A análise de variância one-way (cimento endodôntico) com sub-parcela (terço do canal radicular) dos grupos testados imediatamente e dos grupos mediatos (envelhecimento acelerado antes do teste) mostrou diferença significante apenas para o terço do canal radicular (p=<0,001). Os valores médios de resistência de união e os desvios padrões dos grupos imediatos e mediatos estão nas Tabelas 5 e 6, respectivamente. O teste de Tukey indicou uma redução significante nos valores de resistência de união do terço cervical para o apical, independente do cimento endodôntico.

Comparações com os grupos controles imediato e mediato estão apresentadas nas Tabelas 5 e 6, respectivamente. O teste de Dunnet mostrou que o uso do cimento endodôntico resultou em valores de resistência de união menores comparado aos grupos controles (sem obturação), com diferença estatisticamente significante nos terços médio (p=0,0294) e apical (p= 0,0207) dos grupos testados imediatamente (Tabela 5), e nos terços cervical (p=<0,0001), médio (p=<0,0001) e apical (p=<0,0001) dos grupos testados após o envelhecimento (Tabela 6).

Tabela 5. Médias de resistência de união em MPa (desvio padrão) dos grupos testados imediatamente (sem envelhecimento) e categorias estatísticas definidas pelo teste de Tukey e teste de Dunnet (n = 10).

Cimento endodôntico	Terço radicular		
	Cervical	Médio	Apical
Controle imediato	13,52±2,12	11,39±3,26	9,33±4,80
Sealapex	10,29±1,96^{Aa}	7,41±1,95^{*Ba}	5,36±1,34^{*Ba}
Sealer 26	13,83±6,64^{Aa}	8,16±4,16^{*Ba}	3,63±4,72^{*Ca}
AH Plus	12,91±2,54^{Aa}	8,08± 2,59^{*Ba}	4,77±2,96^{*Ca}

Letras maiúsculas foram utilizadas para comparar os grupos nas linhas horizontais e letras minúsculas para comparar os grupos nas linhas verticais. Categorias estatísticas com letras iguais, definidas pelo teste Tukey, não são estatisticamente significantes entre si (p <0,05).
O (*) indica diferença significante com o grupo controle pelo teste de Dunnet (p < 0.05).

Tabela 6. Médias de resistência de união em MPa (desvio padrão) dos grupos mediatos, testados após envelhecimento artificial em água, e categorias estatísticas definidas pelo teste de Tukey e teste de Dunnet (n = 10).

Cimento endodôntico	Terço radicular		
	Cervical	Médio	Apical
Controle mediato	25,10±6,44	22,55±6,08	21,64±6,33
Sealapex	10,94±5,12*^{Aa}	7,50±1,54*^{ABa}	5,47±3,96*^{Ba}
Sealer 26	14,02±1,94*^{Aa}	8,40±4,97*^{Ba}	3,47±3,91*^{Ca}
AH Plus	13,34±3,43*^{Aa}	9,12± 3,83*^{Ba}	4,87±4,02*^{Ca}

Letras maiúsculas foram utilizadas para comparar os grupos nas linhas horizontais e letras minúsculas para comparar os grupos nas linhas verticais. Categorias estatísticas com letras iguais, definidas pelo teste Tukey, não são estatisticamente significantes entre si (p <0,05).
O (*) indica diferença significante com o grupo controle pelo teste de Dunnet (p < 0.05).

A análise de variância one-way (envelhecimento artificial) com sub-parcela (terço do canal radicular) para cada cimento endodôntico (SX, S26, AH) mostrou diferença significante apenas para o terço do canal radicular (p=<0,001). Os valores médios de resistência de união e os desvios padrões para cada cimento endodôntico estão na Tabela 7. O teste de Tukey revelou uma redução significante nos valores de resistência de união do terço cervical para o apical, independente do envelhecimento artificial.

Tabela 7. Médias de resistência de união em MPa (desvio padrão), como resultado do envelhecimento artificial e terço radicular, e categorias estatísticas definidas pelo teste de Tukey para cada cimento endodôntico (n = 10).

Cimento endodôntico	Teste	Terço radicular		
		Cervical	Médio	Apical
Sealapex	Imediato	10,29±1,96^{Aa}	7,41±1,95^{ABa}	5,36±1,34^{Ba}
	Mediato	10,94±5,12^{Aa}	7,50±1,54^{ABa}	5,47±3,96^{Ba}
Sealer 26	Imediato	13,83±6,64^{Aa}	8,16±4,16^{Ba}	3,63±4,72^{Ca}
	Mediato	14,02±1,94^{Aa}	8,40±4,97^{Ba}	3,47±3,91^{Ca}
AH Plus	Imediato	12,91±2,54^{Aa}	8,08± 2,59^{Ba}	4,77±2,96^{Ba}
	Mediato	13,34±3,43^{Aa}	9,12± 3,83^{Ba}	4,87±4,02^{Ca}

Em cada cimento endodôntico, letras maiúsculas foram utilizadas para comparar os grupos nas linhas horizontais e letras minúsculas para comparar os grupos nas linhas verticais. Categorias estatísticas com letras iguais, definidas pelo teste Tukey, não são estatisticamente significantes entre si (p <0,05).

A distribuição e representação dos padrões de falha estão apresentadas na Tabela 8 e Figura 12, respectivamente. A prevalência de (II) falha adesiva entre o cimento resinoso e a dentina intrarradicular foi verificada em todos os grupos.

Tabela 8. Padrões de falha (%) para os grupos experimentais da parte 2.

Grupos (%)	Adesiva: Pino e cimento (I)	Adesiva: Cimento e dentina (II)	Coesiva: Cimento (III)	Coesiva: Dentina (IV)	Coesiva: Pino (V)	Mista (VI)
SX imediato	2 (3,3)	35 (58,3)	3 (5,0)	1 (1,7)	1 (1,7)	18 (30,0)
S26 imediato	3 (5,0)	31 (51,7)	6 (10,0)	-	3 (5,0)	17 (28,3)
AH imediato	3 (5,0)	26 (43,3)	9 (15,0)	1 (1,7)	1 (1,7)	20 (33,3)
SX mediato	2 (3,3)	42 (70,0)	7 (11,7)	-	1 (1,7)	8 (13,3)
S26 mediato	-	33 (55,0)	2 (3,3)	-	4 (6,7)	21 (35,0)
AH mediato	1 (1,7)	44 (73,3)	3 (5,0)	1 (1,7)	-	11 (18,3)

SX, Sealapex; S26, Sealer 26; AH, AH Plus; Imediato, teste sem envelhecimento; Mediato, teste após 2 meses de envelhecimento em água a 37℃).

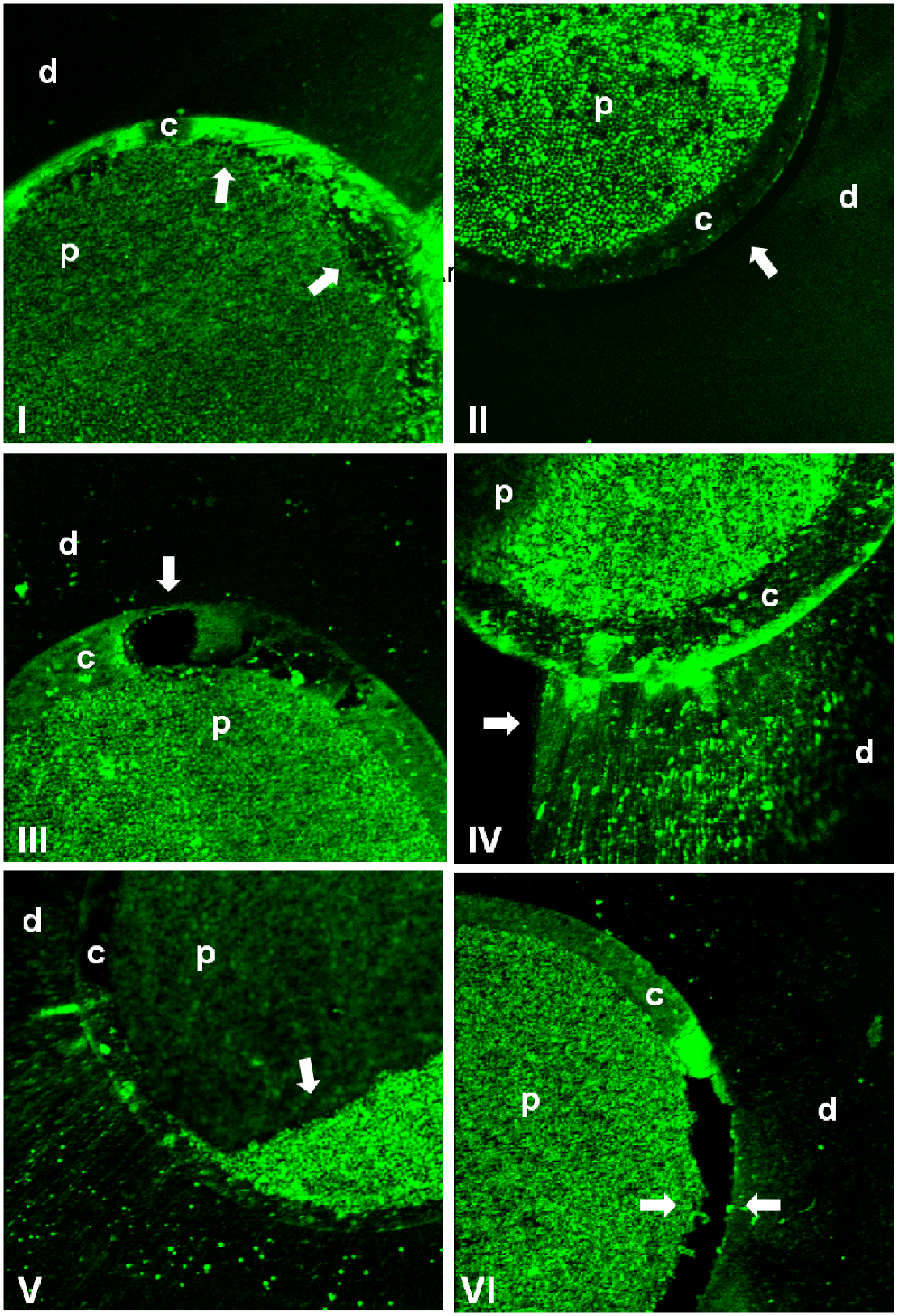

Figura 12. *d – dentina; c – cimento resinoso; p – pino de fibra de vidro.* Parte 2. Microscopias dos padrões de falha após o teste de micropush-out (aumento 10X): (I) falha adesiva entre o pino e o cimento resinoso; (II) falha adesiva entre o cimento resinoso e a dentina; (III) falha coesiva no cimento; (IV) falha coesiva na dentina; (V) falha coesiva no pino; (VI) falha mista entre pino, cimento resinoso e dentina.

5. Discussão

Parte 1

As técnicas de instrumentação do canal radicular, a composição química dos irrigantes endodônticos e o envelhecimento artificial das amostras influenciaram na resistência de união de pinos de fibra de vidro. Além disto, a união à dentina radicular foi afetada pelos diferentes terços do canal radicular. As hipóteses testadas foram aceitas.

O preparo do canal radicular apresenta como finalidade o esvaziamento, alargamento e sanificação endodôntica (Estrela *et al.,* 2007). Os instrumentos de aço-inoxidável têm sido geralmente utilizados para tal finalidade. Os instrumentos de Níquel-Titânio (NiTi) acionados a motor têm sido sugeridos com vistas a favorecer o preparo de canais curvos, devido à flexibilidade e superelasticidade (Thompson, 2000). A qualidade da modelagem, a eficiência, o menor tempo de trabalho e a diminuição do stress profissional constituem outras qualidades inerentes ao preparo com instrumentos de NiTi (Thompson, 2000; Peters *et al.,* 2001a; Peters & Paqué, 2010). O preparo com os instrumentos em aço inoxidável tem permitido que paredes não sejam tocadas pelos instrumentos (Peters *et al.,* 2001b). Considerando que estes instrumentos apresentam ação de raspar, e não de excisar dentina, como ocorre com os instrumentos de NiTi, sugere-se maior possibilidade de compactação de smear layer dentro dos túbulos dentinários, caracterizando maior presença de smear plug. Este pode ter atuado como barreira à penetração e interação do cimento com a dentina intrarradicular, o que pode estar relacionado à diminuição da resistência de união verificada em grupos preparados com instrumentos de aço inoxidável.

O NaOCl é um composto halogenado utilizado rotineiramente na endodontia (Zehnder, 2006), que possui efeito antimicrobiano (Byströn &

Sundqvist, 1981; Estrela *et al.,* 2002), capacidade de dissolução tecidual (Byströn & Sundqvist, 1981; Spanó *et al.,* 2009; Estrela *et al.,* 2002) e compatibilidade biológica aceitável em soluções menos concentradas (Estrela *et al.,* 2002, 2003, 2004). Entretanto, ele não atua na porção inorgânica da dentina, que constitui grande parte da *smear layer* (Garberolio & Becce, 1994; Cecchin *et al.,* 2010). O EDTA produz desmineralização da dentina e proporciona uma excelente limpeza das paredes do canal radicular (Spanó *et al.,* 2009), melhorando a penetração de substâncias químicas e promovendo um contato mais íntimo do material obturador com a dentina radicular (Cecchin *et al.,* 2010). Ele atua sobre os componentes inorgânicos da *smear layer*, levando à descalcificação da dentina peri e intertubular (Cecchin *et al.,* 2010).

A associação dessas substâncias é largamente empregada na terapia endodôntica porque elas atuam nas porções orgânica e inorgânica da dentina (Estrela *et al.,* 2007; Zhang *et al.,* 2010; Cecchin *et al.,* 2010), com dissolução quase completa da *smear layer*, desobstruindo os orifícios dos túbulos dentinários (Wu *et al.,* 2009). Em contrapartida, a clorexidina e a água ozonificada não possuem capacidade de dissolver tecidos orgânicos, e assim, debris podem permanecer aderidos às paredes do canal radicular obstruindo os túbulos dentinários (Menezes *et al.,* 2003; Bitter *et al.,* 2008; Bodrumlu *et al.,* 2010), o que pode influenciar negativamente na união à dentina intrarradicular, como visto no presente estudo.

Bitter *et al*. (2009) relataram que a hibridização da dentina foi detectada apenas esporadicamente com o emprego do cimento resinoso auto-adesivo RelyX Unicem (3M-ESPE). O cimento auto-adesivo usado no presente estudo, RelyX U100 (UC), e o RelyX Unicem (UN) foram desenvolvidos pelo mesmo fabricante e são comercializados sob o mesmo nome em alguns países (Viotti *et al.,* 2009). Segundo o fabricante, a única diferença entre estes produtos é o sistema de dispensar o material. Enquanto o UN requer um ativador, triturador e aplicador, o UC pode ser misturado manualmente (Viotti *et al.,* 2009). As propriedades adesivas deste cimento são baseadas em monômeros ácidos que desmineralizam e infiltram o substrato dentário, e criam retenção micromecânica e união química à hidroxiapatita (De Munck *et al.,* 2004; Gerth *et al.,* 2006; Zicari *et al.,* 2008; Bitter *et al.*, 2009; Cecchin *et al.,* 2011).

Bitter *et al.* (2009) descreveram que a penetração deste cimento nos túbulos dentinários foi encontrada apenas em alguns espécimes e concluíram que a *smear layer* não é dissolvida consistentemente na interface dentina-cimento. Estes dados confirmam os resultados de estudos conduzidos previamente que também descreveram uma interação morfológica apenas superficial (De Munck *et al.,* 2004; Al-Assaf *et al.,* 2007; Monticelli *et al.,* 2008). Assim, frente ao baixo efeito desmineralizante do cimento RelyX U100 empregado no presente estudo, a capacidade do NaOCl em remover os componentes orgânicos da dentina, principalmente colágeno, resultando em uma superfície rugosa (Hayashi *et al.,* 2005), poderia aumentar a penetração do cimento (Ari *et al.,* 2003) na estrutura de dentina parcialmente desmineralizada (Monticelli *et al.,* 2008) favorecendo a retenção micromecânica e, consequentemente, o aumento da resistência de união.

Adicionalmente, Gerth *et al.* (2006) documentaram uma intensa interação química do cimento RelyX Unicem com a hidroxiapatita. Em concordância, Bitter *et al*. (2009) relataram que interações químicas entre o cimento resinoso auto-adesivo e a hidroxiapatita podem ser efetivas no interior do canal radicular, e indicaram que esta interação pode ser mais crucial para a união à dentina radicular do que a capacidade do mesmo material em hibridizar a dentina. Então, como o NaOCl atua na dissolução da porção orgânica expondo a inorgânica, isto pode favorecer essas interações químicas entre o cimento e a hidroxiapatita, o que pode justificar os valores mais elevados de resistência de união encontrados nos grupos em que esse irrigante foi usado.

O aumento ou a ausência de efeito adverso do NaOCl na resistência de união de cimentos resinosos à dentina intrarradicular foram relatados anteriormente (Varela *et al.,* 2003; Muniz & Mathias, 2005; Hayashi *et al.,* 2005; Pelegrine *et al.,* 2010), enquanto outros estudos descreveram um efeito adverso deste irrigante na resistência de união (Morris *et al.,* 2001; Ari *et al.,* 2003; Erdemir *et al.,* 2004; Demiryürek *et al.,* 2009). O aumento foi explicado pela remoção do colágeno da *smear layer*, o que resultou em uma superfície dentinária rugosa, e a diminuição da resistência de união foi explicada pela mudança do potencial redox do substrato de união devido ao NaOCl residual. No entanto, estes estudos apresentam diferentes metodologias da utilizada no presente estudo, no que diz respeito a concentração e tempo de exposição do NaOCl, dificultando a comparação adequada com os resultados obtidos.

Em oposição aos efeitos positivos do NaOCl no presente estudo, a água ozonificada reduziu significativamente a resistência de união ao canal radicular. O ozônio (O_3) é uma forma altamente reativa de oxigênio que é gerado pela passagem de oxigênio através de alta tensão (Estrela *et al.,* 2007). Ele é um gás azul, contendo três átomos de oxigênio, e é um poderoso agente antimicrobiano, irritante, tóxico e instável (Stübinger *et al.,* 2006; Estrela *et al.,* 2007; Azarpazhooh & Limeback, 2008; Rodrigues *et al.,* 2011). No entanto, devido à sua elevada instabilidade, o ozônio rapidamente se transforma em oxigênio (Stübinger *et al.,* 2006; Estrela *et al.,* 2007; Rodrigues *et al.,* 2011), o qual pode inibir a polimerização do cimento resinoso e, assim, reduzir a resistência de união (Bitter *et al.,* 2008). Portanto, uma possível interação com os componentes iniciadores do cimento resinoso, assim como certa influência das propriedades do material (Bitter *et al.,* 2008), como a incapacidade de dissolução tecidual, poderiam explicar a redução significativa na resistência de união, encontrada no presente estudo, quando a sanificação do canal foi realizada com água ozonificada.

Apesar dos pinos de fibra cimentados em canais radiculares não estarem diretamente expostos aos fluidos bucais, o armazenamento em água é considerado um teste *in vitro* de envelhecimento acelerado para as interfaces de união (Radovic *et al.,* 2007). No presente estudo, o envelhecimento artificial em água por dois meses aumentou significativamente a retenção do pino. Este fato pode estar relacionado à habilidade de união ou polimerização aumentada durante o armazenamento em água, ao relaxamento das tensões pela expansão higroscópica como consequência da sorção de água durante o armazenamento ou expansão higroscópica dos materiais de cimentação (Sadek *et al.,* 2006; Albashaireh *et al.,* 2010). A expansão higroscópica do cimento resinoso, em particular, pode ter contribuído para uma maior adaptação do cimento ao substrato dentinário. Uma importante contribuição para a resistência de união no teste de *push-out* está prevista para ocorrer como conseqüência do atrito interfacial deslizante (Sadek *et al.,* 2006) decorrente da aplicação da força compressiva. Assim, as resistências interfaciais mais elevadas encontradas após dois meses de envelhecimento podem ter sido causadas pelo aumento no atrito interfacial, em função da maior adaptação do cimento à dentina consequente à expansão higroscópica (Sadek *et al.,* 2006; Albashaireh *et al.,* 2010). É importante ressaltar que o método aplicado é um modelo simplificado de envelhecimento acelerado, que tem sido comumente realizado para avaliação da união entre resina-dentina (De Munck *et al.,* 2005; Radovic *et al.,* 2007).

Em relação ao efeito dos diferentes níveis do canal radicular no presente estudo, a resistência de união foi predominantemente superior no terço cervical e inferior no terço apical. Isto pode ser devido a uma melhor polimerização do cimento no terço cervical pela maior proximidade da fonte de luz em relação ao terço apical; a uma melhor interação do cimento com a dentina cervical e ao acesso mais difícil ao terço apical, associado a possíveis limitações no escoamento do cimento (de Durâo Mauricio *et al.,* 2007; da Cunha *et al.,* 2010), já que o cimento empregado no presente estudo possui uma elevada viscosidade (De Munck *et al.,* 2004). Além disso, a adesão à dentina radicular também é influenciada pela concentração e direção dos túbulos dentinários nos diferentes níveis das paredes do canal radicular (Ferrari *et al.,* 2000; Ferrari *et al.,* 2001; Wang *et al.,* 2008; da Cunha *et al.,* 2010).

A análise fractográfica fornece informações importantes que ajudam a prever o desempenho do material adesivo. No presente estudo, a microscopia confocal foi empregada e ela parece ser uma alternativa viável para a análise do padrão de falha, uma vez que consome menos tempo e não requer qualquer preparo dos espécimes (Castellan *et al.,* 2010).

Como visto, o cimento auto-adesivo RelyX U100 possui uma reduzida capacidade de desmineralização e hibridização dentinária, apresentando uma interação morfológica apenas superficial (De Munck *et al.,* 2004; Gerth *et al.,* 2006; Bitter *et al.,* 2009; Al-Assaf *et al.,* 2007; Monticelli *et al.,* 2008). Esta observação pode explicar a predominância de (II) falhas adesivas entre cimento-dentina em todos os grupos do presente estudo (Tabela 4). Em geral, resistências de união mais elevadas resultaram em um percentual superior de falhas coesivas no pino. Nestes casos, a resistência de união à dentina, bem como ao pino, foi mais elevada em comparação à estabilidade do próprio pino.

Limitações do presente estudo incluem o fato de que os espécimes não foram submetidos à ciclagem térmica e mecânica, a fim de simular as condições intrabucais mais precisamente. Adicionalmente, dentes bovinos foram usados porque as preocupações bioéticas tornam difícil a coleta e utilização de dentes humanos para fins de pesquisa (Menezes *et al.,* 2008; Soares *et al.,* 2012). A coleta de dentes bovinos é mais fácil e a idade do dente pode ser melhor padronizada (Menezes *et al.,* 2008; Soares *et al.,* 2012). Além disso, diversos estudos têm demonstrado propriedades semelhantes entre os dentes humanos e bovinos (Nakamichi *et al.,* 1983; Dong *et al.,* 2003). Estudos adicionais precisam ser conduzidos para analisar os efeitos de diferentes concentrações de NaOCl; da associação de um agente antioxidante, tal como o ascorbato de sódio, com a água ozonificada; e do aumento do tempo de envelhecimento articial na resistência de união à dentina intrarradicular.

Considerando os resultados obtidos no presente estudo, sugere-se que na prática clínica a irrigação do canal com NaOCl 1% e uso do EDTA 17% seja o protocolo mais indicado no preparo e sanificação do canal radicular, quando a cimentação de um pino de fibra de vidro com cimento resinoso auto-adesivo estiver indicada.

Parte 2

A retenção de pinos de fibra de vidro cimentados com cimento resinoso auto-adesivo à dentina intrarradicular foi influenciada pelo cimento endodôntico e profundidade do canal radicular, mas não pelo envelhecimento artificial. As hipóteses testadas foram parcialmente aceitas.

Quando cimentos endodônticos são introduzidos no canal radicular e forças são aplicadas durante a obturação, é provável que os constituintes do cimento endodôntico penetrem nos túbulos dentinários (Boone *et al.,* 2001; Shokouhinejad *et al.,* 2011). A penetração do cimento endodôntico aumenta a interface entre o material e as paredes dentinárias, o que pode melhorar a retenção mecânica do material pelo embricamento do cimento endodôntico no interior dos túbulos, e potencialmente reduzir a infiltração (Mamootil & Messer, 2007; Shokouhinejad *et al.,* 2011). Além disso, a atividade antibacteriana do cimento endodôntico pode ser eficaz para matar e sepultar as bactérias que permanecem no interior dos túbulos dentinários (Heling & Chandler, 1996). A capacidade do cimento endodôntico em penetrar nos túbulos dentinários de forma consistente e eficaz é um dos muitos fatores que influenciam a escolha do material para a obturação do canal radicular (Mamootil & Messer, 2007; Shokouhinejad *et al.,* 2011).

O uso do EDTA, que é capaz de agir sobre a matriz mineral do dente e promover a remoção da *smear layer* formada durante o preparo do canal radicular, permite uma melhor penetração do cimento endodôntico nos túbulos dentinários, aumentando a superfície de contato do material de preenchimento com a dentina (Nunes *et al.,* 2008).

Assim, durante o preparo para o pino, a remoção mecânica do cimento endodôntico impregnado na dentina intrarradicular é um passo crítico na obtenção de retenção satisfatória para o pino quando um cimento resinoso é usado (Boone *et al.,* 2001). No presente estudo, houve uma diminuição significativa na retenção do pino quando os cimentos endodônticos foram empregados, em comparação aos grupos controles (sem obturação), o que pode sugerir que o preparo para o pino pode não ter removido todo o cimento endodôntico impregnado na dentina, não garantindo uma superfície "limpa" na qual o cimento resinoso pudesse aderir (Boone *et al.,* 2001).

Em concordância com este achado, Dimitrouli *et al.* (2011) revelaram que a resistência de união do pino de fibra no grupo sem obturação do canal radicular (WRF) foi maior em comparação aos outros grupos (guta-percha/AH Plus (GP); guta-percha/Guttaflow (GF); obturação do canal radicular pré-existente (PRF). Demiryürek *et al.* (2010) também mostraram que os cimentos endodônticos (AH Plus, Endofill e Sealapex) têm efeitos significativos sobre a resistência de união de pinos de fibra de vidro. Neste estudo, o grupo controle (apenas guta-percha, sem cimento endodôntico) apresentou a maior média de resistência de união pelo teste de *micropush-out*. Em contraste, Cecchin *et al.* (2011) documentaram que o AH Plus e Sealer 26 não interferiram na resistência de união de pinos de fibra de vidro comparado ao grupo controle (cones guta-percha e nenhum cimento endodôntico). Menezes *et al.* (2008) também não encontraram diferença significativa entre o grupo controle (sem obturação) e os grupos obturados com Sealer 26.

A ação de brocas utilizadas na remoção do material obturador do canal radicular, com o intuito de criar espaço para o pino, produz uma nova *smear layer* rica em cimento endodôntico e remanescentes de guta-percha plastificados pelo calor de atrito da broca (Serafino *et al.,* 2004; Demiryürek *et al.,* 2010). Independente do tipo de cimento endodôntico, esta *smear layer* pode atuar como isolante contra qualquer tipo de material adesivo destinado a promover a união à dentina intrarradicular (Dimitrouli *et al.,* 2011). Além disso, no presente estudo, os canais radiculares foram irrigados após o preparo para o pino apenas com NaOCl 1% que age seletivamente sobre a remoção de partículas orgânicas (Byströn & Sundqvist, 1981; Spanó *et al.,* 2009; Estrela *et al.,* 2002) e não pode dissolver partículas inorgânicas (Garberolio & Becce, 1994, Cecchin *et al.,* 2010). Portanto, ele não remove efetivamente a *smear layer* formada sobre as paredes do canal radicular após o preparo para o pino (Nunes *et al.,* 2008), o que pode reduzir a penetração e ação química do cimento resinoso auto-adesivo (RelyX U100, 3M-ESPE).

A influência da profundidade do canal foi observada pela diminuição da resistência de união do terço cervical para apical em todos os grupos. Este fato pode ser atribuído à dificuldade de visualização e acesso à parte apical do sistema de canais radiculares (de Durão Mauricio *et al.,* 2007; Onay *et al.,* 2010), à dificuldade em eliminar a *smear layer* ou os remanescentes de cimento endodôntico/guta-percha sobre as paredes dentinárias neste terço (Serafino *et al.,* 2004), à configuração de túbulos dentinários menos densa na porção apical do sistema de canais radiculares (Ferrari *et al.,* 2000; Ferrari *et al.,* 2001; Wang *et al.,* 2008; da Cunha *et al.,* 2010), ao fator de configuração cavitária (Goracci *et al.,* 2004; Tay *et al.,* 2005), a uma melhor polimerização do cimento no terço cervical pela maior proximidade da fonte de luz em relação ao terço apical e à restrições no escoamento do cimento resinoso à parte apical do canal radicular (de Durão Mauricio *et al.,* 2007; da Cunha *et al.,* 2010). Todos estes fatores comprometem a continuidade interfacial (Silva *et al.,* 2011) e, consequentemente, a resistência de união.

Em relação à análise fractográfica, a predominância de (II) falhas adesivas cimento-dentina em todos os grupos do presente estudo (Tabela 8) pode ser atribuída à dificuldade em eliminar a *smear layer* ou os remanescentes de cimento endodôntico/guta-percha sobre as paredes dentinárias (Serafino *et al.,* 2004; Silva *et al.,* 2011; Demiryürek *et al.,* 2010) e à reduzida capacidade de desmineralização e hibridização dentinária do cimento auto-adesivo RelyX U100 (De Munck *et al.,* 2004; Al-Assaf *et al.,* 2007; Monticelli *et al.,* 2008; Bitter *et al*., 2009).

Limitações do presente estudo incluem o fato de que os espécimes não foram submetidos à ciclagem térmica e mecânica, a fim de simular as condições intrabucais mais precisamente. Estudos adicionais precisam ser conduzidos para analisar os efeitos do uso do EDTA, após o preparo para o pino, na resistência de união à dentina intrarradicular em cada terço do canal radicular (cervical, médio e apical).

Considerando os resultados obtidos no presente estudo, observa-se que na prática clínica a remoção total da *smear layer* e dos remanescentes de cimento endodôntico/guta-percha das paredes dentinárias do canal radicular, previamente a cimentação de um pino de fibra de vidro, é um fator crítico para a união satisfatória do cimento resinoso auto-adesivo à dentina intrarradicular.

6. Conclusões

Parte 1

O preparo do canal radicular com instrumentos de NiTi associado a irrigação com NaOCl 1 % e uso do EDTA aumentou a resistência de união de pinos de fibra de vidro cimentados com cimento auto-adesivo à dentina intrarradicular.

Parte 2

Os cimentos endodônticos interferiram negativamente na união de pinos de fibra de vidro cimentados com cimento resinoso auto-adesivo à dentina intrarradicular.

7. Referências Bibliográficas

Al-Assaf K, Chakmakchi M, Palaghias G, Karanika-Kouma A, Eliades G (2007) Interfacial characteristics of adhesive luting resins and composites with dentine. *Dental Materials* **23**, 829-39.

Albashaireh ZS, Ghazal M, Kern M (2010) Effects of endodontic post surface treatment, dentin conditioning, and artificial aging on the retention of glass fiber-reinforced composite resin posts. *The Journal of Prosthetic Dentistry* **103**, 31-9.

Ari H, Yaşar E, Belli S (2003) Effects of NaOCl on bond strengths of resin cements to root canal dentin. *Journal of Endodontics* **29**, 248-51.

Azarpazhooh A, Limeback H (2008) The application of ozone in dentistry: a systematic review of literature. *Journal of Dentistry* **36**, 104-16.

Balbosh A, Ludwig K, Kern M (2005) Comparison of titanium dowel retention using four different luting agents. *The Journal of Prosthetic Dentistry* **94**, 227-33.

Baldissara P, Zicari F, Valandro LF, Scotti R (2006) Effect of root canal treatments on quartz fiber posts bonding to root dentin. *Journal of Endodontics* **32**, 985-8.

Barbin LE, Saquy PC, Guedes DF, Sousa-Neto MD, Estrela C, Pécora JD (2008) Determination of para-chloroaniline and reactive oxygen species in chlorhexidine and chlorhexidine associated with calcium hydroxide. *Journal of Endodontics* **34**:1508-14.

Bitter K, Kielbassa AM (2007) Post-endodontic restorations with adhesively uted fiber-reinforced composite post systems: a review. *American Journal of Dentistry* **20**, 353-60.

Bitter K, Noetzel J, Volk C, Neumann K, Kielbassa A (2008) Bond Strength of Fiber Posts after the Application of Erbium:Yttrium-Aluminum-Garnet Laser

Treatment and Gaseous Ozone to the Root Canal. *Journal of Endodontics* **34**, 306-9.

Bitter K, Paris S, Pfuertner C, Neumann K, Kielbassa AM (2009) Morphological and bond strength evaluation of different resin cements to root dentin. *European Journal of Oral Sciences* **117**, 326-33.

Bodrumlu E, Parlak E, Bodrumlu EH (2010) The effect of irrigation solutions on the apical sealing ability in different root canal sealers. *Brazilian Oral Research* **24**, 165-9.

Boone KJ, Murchison DF, Schindler WG, Walker WA 3rd (2001) Post retention: the effect of sequence of post-space preparation, cementation time, and different sealers. *Journal of Endodontics* **27**, 768-71.

Byströn A, Sundqvist G (1981) Bacteriologic evaluation of the efficacy of mechanical root canal instrumentation in endodontic therapy. *Scandinavian Journal of Dental Research* **89**, 321-8.

Cagidiaco MC, Goracci C, Garcia-Godoy F, Ferrari M (2008) Clinical studies of fiber posts: a literature review. *The International Journal of Prosthodontics* **21**, 328–36.

Castellan CS, Santos-Filho PC, Soares PV, Soares CJ, Cardoso PE (2010) Measuring bond strength between fiber post and root dentin: a comparison of different tests. *The Journal of Adhesive Dentistry* **12**, 477-85.

Cecchin D, Farina AP, Galafassi D, Barbizam JV, Corona SA, Carlini-Júnior B (2010) Influence of sodium hypochlorite and EDTA 2on the microtensile bond strength of a self-etching adhesive system. *Journal of Applied Oral Science* **18**, 385-9.

Cecchin D, Farina AP, Souza MA, Carlini-Júnior B, Ferraz CCR (2011) Effect of root canal sealers on bond strength of fibreglass posts cemented with self-adhesive resin cements. *International Endodontic Journal* **44**, 314–320.

Cheung W (2005) A review of the management of endodontically treated teeth. Post, core and the final restoration. *Journal of American Dental Association* **136**, 611-9.

da Cunha LF, Furuse AY, Mondelli RF, Mondelli J (2010) Compromised bond strength after root dentin deproteinization reversed with ascorbic acid. *Journal of Endodontics* **36**, 130-4.

de Durâo Mauricio PJ, González-López S, Aguilar-Mendoza JA, Félix S, González-Rodríguez MP (2007) Comparison of regional bond strength in root thirds among fiber-reinforced posts luted with different cements. *Journal of Biomedical Materials Research. Part B, Applied Biomaterials* **83**, 364-72.

De Munck J, Van Landuyt K, Peumans M, *et al.* (2005) A critical review of the durability of adhesion to tooth tissue: methods and results. *Journal of Dental Research* **84**, 118-32.

De Munck J, Vargas M, Van Landuyt K, Hikita K, Lambrechts P, Van Meerbeek B (2004) Bonding of an auto-adhesive luting material to enamel and dentin. *Dental Materials* **20**, 963–71.

Demiryürek EÖ, Külünk S, Saraç D, Yüksel G, Bulucu B (2009) Effect of different surface treatments on the push-out bond strength of fiber post to root canal dentin. *Oral surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* **108**, e74-80.

Demiryürek EO, Külünk S, Yüksel G, Saraç D, Bulucu B (2010) Effects of three canal sealers on bond strength of a fiber post. *Journal of Endodontics* **36**, 497-501.

Dimitrouli M, Günay H, Geurtsen W, Lührs AK (2011) Push-out strength of fiber posts depending on the type of root canal filling and resin cement. *Clinical Oral Investigation* **15**, 273-81.

Dong CC, McComb D, Anderson JD, Tam LE (2003) Effect of mode of polymerization of bonding agent on shear bond strength of autocured resin composite luting cements. *Journal of the Canadian Dental Association* **69**, 229–34.

Duarte MA, Ordinola-Zapata R, Bernardes RA, *et al.* (2010) Influence of calcium hydroxide association on the physical properties of AH Plus. *Journal of Endodontics* **36**, 1048-51.

Erdemir A, Ari H, Güngüneş H, Belli S (2004) Effect of medications for root canal treatment on bonding to root canal dentin. *Journal of Endodontics* **30**, 113-6.

Estrela C, Barbin EL, Spanó JCE, Marchesan S, Estrela CRA, Pécora JD (2002) Mechanism of Action of Sodium Hypochlorite. *Brazilian Dental Journal* **13**, 113-7.

Estrela C, Estrela CR, Decurcio DA, Hollanda AC, Silva JÁ (2007) Antimicrobial efficacy of ozonated water, gaseous ozone, sodium hypochlorite and chlorhexidine in infected human root canals. *International Endodontic Journal* **40**, 85-93.

Estrela C, Holland R, Bernabé PF, de Souza V, Estrela CR (2004) Antimicrobial potential of medicaments used in healing process in dogs' teeth with apical periodontitis. *Brazilian Dental Journal* **15**:181-5.

Estrela C, Sydney GB, Bammann LL, Felippe Júnior O (1995) Mechanism of action of calcium and hydroxyl ions of calcium hydroxide on tissue and bacteria. *Brazilian Dental Journal* **6**, 85-90.

Estrela CR, Estrela C, Reis C, Bammann LL, Pécora JD (2003) Control of microorganisms in vitro by endodontic irrigants. *Brazilian Dental Journal* **14**:187-92.

Ferrari M, Cagidiaco MC, Goracci C, *et al.* (2007) Long-term retrospective study of the clinical performance of fiber posts. *American Journal of Dentistry* **20**, 287–91.

Ferrari M, Mannocci F, Vichi A, Cagidiaco MC, Mjör IA (2000) Bonding to root canal: structural characteristics of the substrate. *American Journal of* Dentistry **13**, 255-60.

Ferrari M, Vichi A, Grandini S (2001) Efficacy of different adhesive techniques on bonding to root canal walls: an SEM investigation. *Dental Materials* **17**, 422-9.

Garberolio R, Becce C (1994) Smear layer removal by root canal irrigants. A comparative scanning electron microscopic study. *Oral Surgery, Oral Medicine, and Oral Pathology* **78**, 359-67.

Gerth HU, Dammaschke T, Züchner H, Schäfer E (2006) Chemical analysis and bonding reaction of RelyX Unicem and Bifix composites - a comparative study. *Dental Materials* **22**, 934-41.

Glossen CR, Haller RH, Dove SB, del Rio CE (1995) A comparison of root canal preparations using Ni-Ti hand, Ni-Ti engine-driven, and K-Flex endodontic instruments. *Journal of Endodontics* **21**, 146-51.

Gomes BP, Pedroso JA, Jacinto RC, *et al.* (2004) In vitro evaluation of the antimicrobial activity of five root canal sealers. *Brazilian Dental Journal* **15**, 30-5.

Goracci C, Tavares AU, Fabianelli A, *et al.* (2004) The adhesion between fiber posts and root canal walls: comparison between microtensile and push-out bond strength measurements. *European Journal of Oral Sciences* **112**, 353-61.

Grecca FS, Rosa AR, Gomes MS, *et al.* (2009) Effect of timing and method of post space preparation on sealing ability of remaining root filling material: in vitro microbiological study. *Journal Canadian Dental Association* **75**:583.

Hagge MS, Wong RD, Lindemuth JS (2002) Effect of three root canal sealers on the retentive strength of endodontic posts luted with a resin cement. *International Endodontic Journal* **35**, 372-8.

Hayashi M, Takahashi Y, Hirai M, Iwami Y, Imazato S, Ebisu S (2005) Effect of endodontic irrigation on bonding of resin cement to radicular dentin. *European Journal of Oral Sciences* **113**, 70-6.

Heling I, Chandler NP (1996) The antimicrobial effect within dentinal tubules of four root canal sealers. *Journal of Endodontics* **22**, 257–9.

Hems RS, Gulabivala K, Ng Y-L, Ready D, Spratt DA (2005) An in vitro evaluation of the ability of ozone to kill a strain of *Enterococcus faecalis*. *International Endodontic Journal* **38**, 22-9.

Holland R, Souza Vde (1985) Ability of a new calcium hydroxide root canal filling material induce hard tissue formation. *Journal of Endodontics* **11**,535-43.

Jongsma LA, Kleverlaan CJ, Feilzer AJ (2010). Influence of surface pretreatment of fiber posts on cement delamination. *Dental Materials* **26**, 901-7.

Kececi AD, Ureyen Kaya B, Adanir N (2008) Micro push-out bond strengths of four fiber-reinforced composite post systems and 2 luting materials. *Oral surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* **105**, 121–8.

Kontakiotis G, Nakou M, Georgopoulou M (1995) In vitro studies of the indirect action of calcium hydroxide on the anaerobic flora of the root canal. *International Endodontic Journal* **28**, 285-9.

Kopper PM, Figueiredo JA, Della Bona A, Vanni JR, Bier CA, Bopp S (2003) Comparative in vivo analysis of the sealing ability of three endodontic sealers in post-prepared root canals. *International Endodontic Journal* **36**, 857-63.

Lassila LVJ, Tanner J, Le-Bell AM, Narva K, Vallittu PK (2004) Flexural properties of fiber reinforced root canal posts. *Dental Materials* **20**, 29–36.

Mamootil K, Messer HH (2007) Penetration of dentinal tubules by endodontic sealer cements in extracted teeth and in vivo. *International Endodontic Journal* **40**, 873–81.

Mannocci F, Qualtrough AJ, Worthington HV, Watson TF, Pitt Ford TR (2005) Randomized clinical comparison of endodontically treated teeth restored with amalgam or with fiber posts and resin composite: five-year results. *Operative Dentistry* **30**, 9–15.

Menezes AC, Zanet CG, Valera MC (2003) Smear layer removal capacity of disinfectant solutions used with and without EDTA for the irrigation of canals: a SEM study. *Brazilian Oral Research* **17**, 349-55.

Menezes MS, Queiroz EC, Campos RE, Martins LRM, Soares CJ (2008) Influence of endodontic sealer cement on fiberglass post bond strength to root dentine. *International Endodontic Journal* **41**, 476-84.

Mizuno M, Banzai Y (2008) Calcium ion release from calcium hydroxide stimulated fibronectin gene expression in dental pulp cells and the differentiation of dental pulp cells to mineralized tissue forming cells by fibronectin. *International Endodontic Journal* **41**, 933-8.

Mjör IA, Smith MR, Ferrari M, Mannocci F (2001) The structure of dentine in the apical region of human teeth. *International Endodontic* Journal **34**, 346–53.

Monticelli F, Grandini S, Goracci C, Ferrari M (2003) Clinical behavior of translucent-fiber posts: a 2-year prospective study. *The International Journal of Prosthodontics* **16**, 593–6.

Monticelli F, Osorio R, Mazzitelli C, Ferrari M, Toledano M (2008) Limited decalcification/diffusion of self-adhesive cements into dentin. *Journal of Dental Research* **87**, 974-9.

Morgano SM, Rodrigues AH, Sabrosa CE (2004) Restoration of endodontically treated teeth. *Dental Clinics of North America* **48**, 397-416.

Morris MD, Lee KW, Agee KA, Bouillaguet S, Pashley DH (2001) Effects of sodium hypochlorite and RC-prep on bond strength of resin cement to endodontic surfaces. *Journal of Endodontics* **27**, 753-7.

Muniz L, Mathias P (2005) The influence of sodium hypochlorite and root canal sealers on post retention in different dentin regions. *Operative Dentistry* **30**, 533-9.

Nagayoshi M, Kitamura C, Fukuizumi T, Nishihara T, Terashita M (2004) Antimicrobial effect of ozonated water on bacteria invading dentinal tubules. *Journal of Endodontics* **30**, 778-81.

Nakamichi I, Iwaku M, Fusayama T (1983) Bovine teeth as possible substitutes in the adhesion test. *Journal of Dental Research* **62**, 1076–81.

Naves LZ, Santana FR, Castro CG, *et al.* (2011) Surface treatment of glass fiber and carbon fiber posts: SEM characterization. *Microscopy Research and Techique* **29**.

Nunes VH, Silva RG, Alfredo E, Sousa-Neto MD, Silva-Sousa YT (2008) Adhesion of Epiphany and AH Plus sealers to human root dentin treated with different solutions. *Brazilian Dental Journal* **19**, 46-50.

Okino LA, Siqueira EL, Santos M, Bombana AC, Figueiredo JÁ (2004) Dissolution of pulp tissue by aqueous solution of chlorhexidine digluconate and chlorhexidine digluconate gel. *International Endodontic Journal* **37**, 38-41.

Onay EO, Korkmaz Y, Kiremitci A (2010) Effect of adhesive system type and root region on the push-out bond strength of glass-fibre posts to radicular dentine. *International Endodontic Journal* **43**, 259-68.

Pelegrine RA, De Martin AS, Cunha RS, Pelegrine AA, da Silveira Bueno CE (2010) Influence of chemical irrigants on the tensile bond strength of an adhesive system used to cement glass fiber posts to root dentin. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontics* **110**, e73-6.

Peters OA, Paqué F (2010) Current developments in rotary root canal instrument technology and clinical use: a review. *Quintessence International* **41**, 479-88.

Peters OA, Laib A, Göhring TN, Barbakow F (2001b) Changes in root canal geometry after preparation assessed by high-resolution computed tomography. *Journal of Endodontics* **27**, 1-6.

Peters OA, Schönenberger K, Laib A (2001a) Effects of four NiTi preparation techniques on root canal geometry assessed by micro computed tomography. *International Endodontic Journal* **34**, 221-30.

Radovic I, Monticelli F, Papacchini F, *et al.* (2007) Accelerated aging of adhesive-mediated fiber post-resin composite bonds: A modeling approach. *Journal of Dentistry* **35**, 683-9.

Rodrigues PC, Souza JB, Soares CJ, Lopes LG, Estrela C (2011) Effect of ozone application on the resin-dentin microtensile bond strength. *Operative Dentistry* **36**, 537-44.

Sadek FT, Goracci C, Monticelli F, *et al.* (2006) Immediate and 24-hour evaluation of the interfacial strengths of fiber posts. *Journal of Endodontics* **32**, 1174-7.

Safavi KE, Nichols FC (1993) Effect of calcium hydroxide on bacterial lipopolysaccharide. *Journal of endodontics* **19**:76-8.

Saleh IM, Ruyter IE, Haapasalo M, Ørstavik D (2002) The effects of dentine pretreatment on the adhesion of root-canal sealers. *International Endodontic Journal* **35**, 859-66.

Santana FR, Castro CG, Simamoto-Júnior PC, *et al.* (2011) Influence of post system and remaining coronal tooth tissue on biomechanical behaviour of root filled molar teeth. *International Endodontic Journal* **44**, 386-94.

Schwartz RS (2006) Adhesive dentistry and endodontics. Part 2: bonding in the root canal system-the promise and the problems: a review. Journal *of Endodontics* **32**,1125-34.

Schwartz RS, Robbins JW (2004) Post placement and restoration of endodontically treated teeth: a literature review. *Journal of Endodontics* **30**, 289 –301.

Serafino C, Gallina G, Cumbo E, Ferrari M (2004) Surface debris of canal walls after post space preparation in endodontically treated teeth: a scanning electron microscopic study. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontics* **97**, 381-7.

Shokouhinejad N, Sabeti M, Gorjestani H, Saghiri MA, Lotfi M, Hoseini A (2011) Penetration of Epiphany, Epiphany self-etch, and AH Plus into dentinal tubules: a scanning electron microscopy study. *Journal of Endodontics* **37**, 1316-9.

Shokouhinejad N, Sharifian MR, Jafari M, Sabeti MA (2010) Push-out bond strength of Resilon/Epiphany self-etch and gutta-percha/AH26 after different irrigation protocols. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontics* **110**, e88-92.

Silva RA, Coutinho M, Cardozo PI, Silva LA, Zorzatto JR (2011) Conventional dual-cure versus self-adhesive resin cements in dentin bond integrity. *Journal of Applied Oral Science* **19**, 355-62.

Soares CJ, Pereira JC, Valdivia AD, Novais VR, Meneses MS (2012) Influence of resin cement and post configuration on bond strength to root dentine. *International Endodontic Journal* **45**, 136-45.

Soares CJ, Santana FR, Castro CG, *et al.* (2008b) Finite element analysis and bond strength of a glass post to intraradicular dentin: comparison between microtensile and push-out tests. *Dental Materials* **24**, 1405-11.

Soares CJ, Santana FR, Pereira JC, Araujo TS, Menezes MS (2008a) Influence of airborne-particle abrasion on mechanical properties and bond strength of carbon/epoxy and glass/bis-GMA fiber-reinforced resin posts. *The Journal of Prosthetic Dentistry* **99**, 444-54.

Solano F, Hartwell G, Appelstein C (2005) Comparison of apical leakage between immediate versus delayed post space preparation using AH Plus sealer. *Journal of Endodontics* **31**, 752-4.

Sousa-Neto MD, Coelho FI, Marchesan MA, Alfredo E, Silva-Sousa YTC (2005) In vitro study of the adhesion of an epoxy based sealer to human dentine submitted to irradiation with Er:YAG and Nd:YAG lasers. *International Endodontic Journal* **38**, 866-70.

Spanó JC, Silva RG, Guedes DF, Sousa-Neto MD, Estrela C, Pécora JD (2009) Atomic absorption spectrometry and scanning electron microscopy evaluation of concentration of calcium ions and smear layer removal with root canal chelators. *Journal of Endodontics* **35**, 727-30.

Stübinger S, Sader R, Filippi A (2006) The use of ozone in dentistry and maxillofacial surgery: a review. *Quintessence International* **37**, 353-9

Tang W, Wu Y, Smales RJ (2010) Identifying and reducing risks for potential fractures in endodontically treated teeth. *Journal of Endodontics* **36**, 609–17.

Tay FR, Loushine RJ, Lambrechts P, Weller RN, Pashley DH (2005) Geometric factors affecting dentin bonding in root canals: a theoretical modeling approach. *Journal of Endodontics* **31**, 584–9.

Teixeira CS, Alfredo E, Thomé LH, Gariba-Silva R, Silva-Sousa YT, Sousa-Neto MD (2009) Adhesion of an endodontic sealer to dentin and gutta-percha: shear and push-out bond strength measurements and SEM analysis. *Journal of Applied Oral Science* **17**, 129-35.

Teixeira CS, Pasternak-Junior B, Borges AH, Paulino SM, Sousa-Neto MD (2008) Influence of endodontic sealers on the bond strength of carbon fiber posts. *Journal of biomedical materials research. Part B, Applied biomaterials* **84**, 430-5.

Thompson SA (2000) An overview of Nickel-Titanium alloys used in dentistry. *International Endodontic Journal* **33**, 297-310.

Varela SG, Rábade LB, Lombardero PR, Sixto JM, Bahillo JD, Park AS (2003) In vitro study of endodontic post cementation protocols that use resin cements. *The Journal of Prosthetic Dentistry* **89**, 146-53.

Viotti RG, Kasaz A, Pena CE, Alexandre RS, Arrais CA, Reis AF (2009) Microtensile bond strength of new self-adhesive luting agents and conventional multistep systems. *The Journal of Prosthetic Dentistry* **102**, 306-12.

Waltimo TM, Boiesen J, Eriksen HM, Ørstavik D (2001) Clinical performance of 3 endodontic sealers. *Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics* **92**, 89-92.

Wang VJ, Chen YM, Yip KH, Smales RJ, Meng QF, Chen L (2008) Effect of two fiber post types and two luting cement systems on regional post retention using the push-out test. *Dental Materials* **24**, 372-7.

Wu H, Hayashi M, Okamura K, *et al.* (2009) Effects of light penetration and smear layer removal on adhesion of post-cores to root canal dentin by self-etching adhesives. *Dental Materials* **25**, 1484-92.

Zehnder M (2006) Root canal irrigants. *Journal of Endodontics* **32**:389-98.

Zhang K, Kim YK, Cadenaro M, *et al.* (2010) Effects of different exposure times and concentrations of sodium hypochlorite /ethylenediaminetetraacetic acid on the structural integrity of mineralized dentin. *Journal of Endodontics* **36**, 105-9.

Zicari F, Couthino E, De Munck J, Poitevin A, Scotti R, Naert I, Van Meerbeek B (2008) Bonding effectiveness and sealing ability of fiber-post bonding. *Dental Materials* **24**, 967-77.

8. Publicações

Artigo 1:

Influence of endodontic therapy and artificial accelerated aging on fibreglass post bond strength to intraradicular dentine. Part 1. Instrumentation techniques and endodontic irrigants

Autores:

Fernanda Ribeiro Santana, DDS, MSc;
Carlos José Soares, DDS, MSc, PhD;
Julio Almeida Silva, DDS, MSc, PhD;
Ana Helena Gonçalves de Alencar, DDS, MSc, PhD;
Sara Rodrigues Renovato, DDS, MSc;
Lawrence Gonzaga Lopes, DDS, MSc, PhD;
Carlos Estrela, DDS, MSc, PhD.

Revista (Submetido):

International Endodontic Journal

Influence of endodontic therapy and artificial accelerated aging on fibreglass post bond strength to intraradicular dentine. Part 1. Instrumentation techniques and endodontic irrigants

Santana F.R.[1]

Soares C.J.[2]

Silva J.A.[1]

Alencar A.H.G.[1]

Renovato S.R.[1]

Lopes L.G.[3]

Estrela C.[1]

[1] Department of Stomatologic Sciences, School of Dentistry, Federal University of Goiás, GO, Brazil

[2] Operative Dentistry and Dental Materials Department, School of Dentistry, Federal University of Uberlândia, Uberlândia, MG, Brazil

[3] Department of Prevention and Oral Rehabilitation, School of Dentistry, Federal University of Goiás, GO, Brazil

Running title (no more than 30 letters and spaces)

Post bond strength to dentine

Key words: fibreglass post, bond strength, root dentine, instrumentation, irrigants, aging.

Address correspondence and offprint requests to:

Prof. Dr. Carlos Estrela

Department of Stomatologic Sciences,

Federal University of Goiás,

Praça Universitária s/n

Sector Universitário CEP: 74605-220, Goiânia, GO, Brazil

E-mail: estrela3@terra.com.br

Abstract

Aim To evaluate *in vitro* the influence of instrumentation techniques, endodontic irrigants and specimens aging on fibreglass post bond strength to bovine intraradicular dentine. **Methodology** 120 teeth were divided into 12 groups (n=10) resulting from the interaction among 3 study factors: instrumentation technique (SS- root canal preparation with stainless steel instruments - K-File; and NiTi- root canal preparation with K3 Nickel-Titanium instruments); endodontic irrigant (NaOCl- 1% sodium hypochlorite; CHX- 2% chlorhexidine; and O_3- 1.2% ozonated water) and specimens aging (Immediate, test with no aging; and Mediate, test performed after 2 months of water storage at 37°C). After root canal preparation, endodontic filling was not performed. Posts were cemented with self-adhesive resin cement (RelyX U100) and roots were cross-sectioned to obtain two slices of each third. Samples were submitted to push-out test and bond strength values were analysed by ANOVA in a split-plot arrangement and Tukey's test ($\alpha = 0.05$). Failure modes were evaluated under a confocal microscope. **Results** In specimens submitted to water artificial aging, NiTi presented higher bond strength values than SS in apical third irrigated with NaOCl or CHX. Irrigation with NaOCl resulted in higher bond strength than O_3. Artificial aging resulted in significant bond strength increase, except for middle and apical thirds of SSO_3 and apical of $NiTiO_3$. Was verified the prevalence of adhesive cement-dentine failure for all groups. **Conclusions** Root canal preparation with NiTi instruments associated with NaOCl irrigation and EDTA increased the bond strength of fibreglass posts cemented with self-adhesive resin cement to intraradicular dentine.

Introduction

The restoration of endodontically treated teeth represent a challenge in function of they often have insufficient coronal structure to retain the restorative material (Menezes *et al*. 2008, Santana *et al*. 2011). On occasions, they require the use of a post to provide sufficient retention for the core (Morgano *et al*. 2004, Cheung 2005, Tang *et al*. 2010, Santana *et al*. 2011).

Fibreglass posts in combination with composite core foundation materials are widely accepted as alternative to cast posts in the restoration of endodontically treated teeth (Schwartz & Robbins 2004, Bitter & Kielbassa 2007, Naves *et al*. 2011). Fibreglass posts have a high flexural strength and elasticity modulus similar to that of dentine, which minimize the transmission of stresses to root canal walls and decrease the possibility of fractures (Lassila *et al*. 2004, Schwartz & Robbins 2004, Cecchin *et al*. 2011). Furthermore, they can also be cemented in the root canal using adhesive techniques (Kececi *et al*. 2008, Bitter *et al*. 2009, Cecchin *et al*. 2011).

An optimal bond between post-cement and cement-dentine is necessary for the success of the restorative procedure in endodontically treated teeth (Soares *et al*. 2008a), however, debonding is the most common mode of failure of the fibre-reinforced composite post restoration (Ferrari *et al.* 2007, Cagidiaco *et al.* 2008, Albashaireh *et al.* 2010, Jongsma *et al.* 2010). This occurs probably to poor visibility, anatomical features (Mjör *et al.* 2001, Bitter *et al.* 2008, Pelegrine *et al.* 2010) and limited capacity to dissipate polymerization shrinkage stresses in long narrow post spaces, exhibiting a highly unfavourable configuration factor (Tay *et al*. 2005, Pelegrine *et al.* 2010), and was found to be less effective than bonding to coronal dentine (Bitter *et al*. 2009).

Endodontic procedures performed before the luting of posts also may interfere on bonding to intraradicular dentine (Ari *et al.* 2003, Erdemir *et al.* 2004, Hayashi *et al.* 2005, Muniz & Mathias 2005, Bitter *et al.* 2008, Pelegrine *et al.* 2010). In endodontic therapy, the process of sanitizing infected root canals begins with the mechanical action of instruments and chemical action of endodontic irrigants (Estrela *et al.* 2003, Estrela *et al.* 2004), what can induce chemical and structural changes of dentine surface and affect the interaction with restorative materials (Cecchin *et al*. 2010, Shokouhinejad *et al.* 2010).

An effective irrigating solution in root canal preparation is essential for the sanitization process, because it favours cleaning, shaping and neutralizes necrotic content, which favours root canal enlargement for subsequent filling. Different auxiliary chemical agents for root canal preparation have been proposed and the selection of an ideal irrigant depends on its action on microorganisms and periapical tissues. Sodium hypochlorite and chlorhexidine are antimicrobial agents frequently used in the treatment of endodontic infections (Zehnder 2006, Estrela *et al.* 2003, 2004, 2007).

Sodium hypochlorite (NaOCl) is the most used irrigating solution for endodontic treatment, because its mechanism of action causes biosynthetic alterations in cellular metabolism and phospholipid destruction, formation of chloramines that interfere in cellular metabolism, oxidative action with irreversible enzymatic inactivation in bacteria, and lipid and fatty acid degradation (Estrela *et al.* 2002). Chlorhexidine (CHX) is a potent antiseptic with a broad-spectrum antimicrobial action, substantivity (Okino *et al.* 2004, Pelegrine *et al.* 2010) and ability of decomposition (Barbin *et al.* 2008), however, is unable to dissolve pulp tissue (Okino *et al.* 2004, Pelegrine *et al.* 2010). Ozonated water (O_3) in endodontic infection treatment has been studied (Nagayoshi *et al.* 2004, Hems *et al.* 2005, Estrela *et al.* 2007, Bitter *et al.* 2008). Ozone (O_3) is a powerful oxidizing agent and has been used in the water industry for many years to kill bacteria. The antimicrobial effect of ozone results from oxidation of microbial cellular components (Estrela *et al.* 2007).

Nonetheless, there is no consensus in the literature about the possible effects of the chemical agents commonly used during the biomechanical preparation of root canals regarding bonding to intraradicular dentine (Morris *et al.* 2001, Ari *et al.* 2003, Varela *et al.* 2003, Erdemir *et al.* 2004, Muniz & Mathias 2005, Hayashi *et al.* 2005, Bitter *et al.* 2008, Demiryürek *et al.* 2009, Pelegrine *et al.* 2010), since these depend on the dentine bonding system used (Hayashi *et al.* 2005, Bitter *et al.* 2008). Thus, the compatibility among different materials used in endodontic therapy with the luting of fibre-reinforced posts to root canal is an important aspect to be considered for a successful restoration. Moreover, the quality of bonding to root dentine may be affected by the density and orientation of dentine tubules at different levels of the root canal walls (Ferrari *et al.* 2000, Goracci *et al.* 2004) and the ease of access to the root canal thirds (Ferrari *et al.* 2000, Ferrari *et al.* 2001, Goracci *et al.* 2004, Wang *et al.* 2008, da Cunha *et al.* 2010).

The aim of the present study was to evaluate the effects of endodontic therapy (instrumentation technique and endodontic irrigant), artificial accelerated aging of specimens and depth of root canal on bond strength of adhesively cemented (RelyX U100; 3M-ESPE, St. Paul, MN, USA) fibreglass posts in root canal of bovine incisor teeth. The hypothesis tested was that (i) the instrumentation techniques of root canal, (ii) the chemical composition of the endodontic irrigants and (iii) the artificial accelerated aging of specimens influence on fibreglass post bond strength to intraradicular dentine, depending on the depth of the root canal.

Materials and methods

From among 700 freshly extracted bovine incisor teeth, 120 were selected (approved by the Federal University of Goiás Ethics Committee, # 256/10). The selection criterion used was the similarity of the external and internal anatomical morphology and a root canal diameter smaller than 1mm. Roots 15 mm in length were produced after removing the coronal portion. Roots were randomly divided into 12 groups (n=10) resulting from the interaction among three study factors: instrumentation technique of root canal (SS- root canal preparation with stainless steel instruments - K-File; NiTi- root canal preparation with K3 Nickel-Titanium instruments), endodontic irrigant (NaOCl - 1% sodium hypochlorite; CHX- 2% chlorhexidine; O_3- 1.2% ozonated water) and specimens aging (Immediate, test with no aging; Mediate, test performed after artificial accelerated aging - 2 months of water storage at 37°C).

Root canals were prepared 1 mm from the apex by the crown-down technique. In groups SS, root canal preparation was carried out using size # 1,2 Gates Glidden burs (Dentsply Maillefer, Ballaigues, Switzerland) (Working Length - WL 10mm), size # 2 Largo burs (Dentsply Maillefer) (WL 10mm) and stainless steel instruments (K-File; Dentsply Maillefer) up to # 45 K-File (WL 14mm). In groups NiTi, roots canals were prepared with size # 1,2 Gates Glidden burs (Dentsply Maillefer) (WL 10mm) and K3 Nickel-Titanium instruments (SybronEndo, Optimum, São Paulo, SP, Brazil) in the following sequence: # 25 .10 taper (WL 10mm); # 15-25 .02 taper (WL 14mm); # 25 .04 taper (WL 14mm); # 25 .06 taper (WL 14mm); # 30-45 .02 taper (WL 14mm).

During instrumentation, at each change of file, root canals were irrigated with 2 mL of one of the irrigant solutions tested in the present study: NaOCl- 1% sodium hypochlorite (Fitofarma, Goiânia, GO, Brazil); CHX- 2% chlorhexidine (Fitofarma); O_3- 1.2% ozonated water. Ozone was produced by electric discharge through oxygen current (PXZ3507, Eaglesat Tecnologia em Sistemas Ltda., São José dos Campos, SP, Brazil) and bubbled into 1 L sterile distilled water at 7g/h ozone flow rate (1.2%) (Estrela *et al.* 2007). In all groups, 3 mL of 17% EDTA (Biodinâmica Química e Farmacêutica Ltda., Ibiporã, PR, Brazil) was used for 5 min to remove the smear layer. The final irrigation was performed with 5 mL of the same solution used in root canal preparation. After root canal preparation, endodontic filling was not performed.

Post space was prepared using size # 3-5 Largo burs (Dentsply Maillefer) (WL 10mm) corresponding to the fibreglass parallel-sided and serrated post 1.5-mm-diameter (Reforpost # 3; Angelus, Londrina, PR, Brazil). Root canals were irrigated, at each change of burs and after the preparation, with 2 mL of the same irrigant solution used previously and dried with absorbent paper points. All roots were covered externally with utility wax to avoid lateral polymerization (Soares *et al.* 2012).

Fibreglass posts were cleaned with 70% alcohol, then in a single application using a microbrush, and after drying, a silane agent was applied for 1 min (Silano; Angelus). The self-adhesive resin cement (RelyX U100; 3M-ESPE, St. Paul, MN, USA) was manipulated in accordance with the manufacturer's instructions, introduced into the canal with K-File and placed on the post. The post was seated to full depth by finger pressure. Excess cement was removed after 1 min. After 5 min, the resin cement was light-cured with 1200 mW cm^{-2} (Radii-Cal; SDI, Bayswater, Australia) for 40 s each on the cervical face of the root, in the direction of the long axis of the root, and obliquely to the buccal and lingual surfaces, totalling 120 s. The interface post-cement-dentine on the cervical face was then sealed with composite resin and the roots were stored in distilled water at 37°C for 24h. After 24 h, each root was serial sectioned perpendicular to its long axis with a double face diamond disc (4" Diameter x 0.012" Thickness x 1/2" Arbor, Extec, Enfield, CT, USA) at low speed under water cooling (Isomet 1000, Buehler, Lake Bluff, IL, USA) to obtain two slices, approximately 1 mm thick, of each root third (cervical, middle and apical), totalling six slices per root.

In immediate groups, slices were submitted immediately (with no aging) to push-out test, while in mediate groups, slices were stored in distilled water at 37℃ for 2 months (artificial accelerated aging) prior to testing. The push-out test was performed in a testing machine (EMIC DL 2000, São José dos Pinhais, PR, Brazil) by applying a compressive load at 0.5 mm min^{-1} in the apical-coronal direction until post segment extrusion. The bond strength was calculated in MPa by dividing the load at failure (in N) by the area of the bonded interface. The area of the bonded interface was calculated as follows: $A = 2\pi rh$, where A is the area of the bonded interface, $\pi = 3.14$, r is the radius of post segment (mm) and h is the thickness of the post segment (mm) (Goracci *et al.* 2004, Soares *et al.* 2008b, Soares *et al.* 2012).

Statistical analysis was performed using SAS statistical program (Institute Inc., Cary, NC, USA). Data were submitted to the Shapiro-Wilk test of normality. The effects, on bond strength, of instrumentation technique, endodontic irrigant and depth of root canal were analysed using two-way analysis of variance in a split-plot arrangement, with the plot represented by the factors instrumentation technique, endodontic irrigant and their interaction, and the sub-plot represented by the root canal thirds (cervical, middle and apical). Comparisons with respect the artificial aging was performed by one-way analysis of variance with the plot represented by this factor and the sub-plot represented by the root canal thirds. Multiple comparisons were made using Tukey's test ($\alpha = 0.05$).

To determine the failure modes, all fractured specimens were air dried and analysed under a confocal laser scanning microscope (Carl Zeiss Laser Scanning Systems, LSM510, META, Oberkochen, Germany). Images were analysed using Zeiss LSM Image Browser (META, Germany). The failure modes were classified into six types: (I) adhesive between the post and resin cement; (II) adhesive between resin cement and intraradicular dentine; (III) cohesive in cement; (IV) cohesive in dentine; (V) cohesive in post (Castellan *et al.* 2010) and (VI) mixed, among post, resin cement and intraradicular dentine (Bitter *et al.* 2009).

Results

Two-way analysis of variance (instrumentation technique X endodontic irrigant) with sub-plot (root canal third) of immediate groups showed significant difference for endodontic irrigant (*P*=.0023) and root canal third (*P*=<.0001). The mean push-out bond strengths and standard deviations are in Table 1. Tukey's test indicated that irrigation with NaOCl resulted in higher bond strength than with O_3, except in the apical third of NiTi that was similar. The irrigation with CHX resulted on intermediate values that were statistically similar to values obtained in groups irrigated with O_3 in thirds cervical/apical of SS and cervical/middle of NiTi, and in all groups irrigated with NaOCl. Regardless of root canal preparation and endodontic irrigant, cervical third had higher bond strength values than apical third.

Two-way analysis of variance (instrumentation technique X endodontic irrigant) with sub-plot (root canal third) of mediate groups, artificial accelerated aging prior to testing, showed significant difference for instrumentation technique (*P*=.0356*)*, endodontic irrigant (*P*=<.0001), root canal third (*P*=<.0001) and the interaction between irrigant and root canal third (*P*=.0047). The mean push-out bond strengths and standard deviations are in Table 2. In apical third of specimens irrigated with NaOCl or CHX, NiTi resulted on higher bond strength than SS. Regarding the endodontic irrigant, NaOCl resulted on higher bond strength values than O_3 in all groups. CHX presented statistically lower value than NaOCl only in cervical third of SS and similarity to NaOCl in the other groups. Cervical third presented higher values than apical third, except in groups NiTiNaOCl and NiTiCHX that were similar.

One-way analysis of variance (artificial aging) with sub-plot (root canal third) in group SSNaOCl showed significance for artificial aging (*P*<.001) and root canal third (*P*<.001). In group SSCHX there was significance for artificial aging (*P*<.001) and root canal third (*P*<.001). In group SSO_3 there was significance for artificial aging (*P*=.006), root canal third (*P*<.001) and interaction between the factors (*P*=.032). In group NiTiNaOCl there was significance for artificial aging (*P*<.001) and root canal third (*P*=.005). In group NiTiCHX there was significance for artificial aging (*P*<.001) and root canal third (*P*=.008). In group $NiTiO_3$ there was significance for artificial aging (*P*=.008), root canal third

(P<.001) and interaction between the factors (P<.001). The mean push-out bond strengths and standard deviations of all groups are in Table 3. Tukey's test demonstrated a significant bond strength increase after artificial accelerated aging, except for middle and apical thirds of SSO_3 and apical of $NiTiO_3$ that was similar.

Failure modes of tested specimens and its distribution are presented in Figure 1 and Table 4, respectively. The prevalence of (II) adhesive cement-dentine failure was verified in all groups.

Discussion

The instrumentation techniques of root canal, the chemical composition of endodontic irrigants and the artificial accelerated aging of samples influenced on fibreglass post bond strength. Moreover, bond to root dentine was affected by the different thirds of root canal. The tested hypothesis was accepted.

Various mechanical methods have been used to measure *in* vitro the bond strength of fibreglass post to intraradicular dentine, as microtensile bond strength and push-out tests (Soares *et al.* 2008b). The push-out method was shown to have fewer premature specimen failures, a lower data distribution variability (Goracci *et al.* 2004, Soares *et al.* 2008b) and a more homogenous stress distribution (Soares *et al.* 2008b) compared to microtensile method during the bond strength evaluation of fibreglass posts to intraradicular dentin. The push-out laboratory test would seem to be safer than the microtensile test (Goracci et al. 2004) and a more appropriate methodology for the evaluation of fibreglass posts bonded to intraradicular dentine (Soares *et al.* 2008b).

Root canal preparation aims the emptying, enlargement and endodontic sanitizing (Estrela *et al.* 2007). The stainless-steel instruments have generally been used for this purpose. The motor driven nickel-titanium instruments have been suggested in order to facilitate the preparation of curved canals, due to the flexibility and super-elasticity (Thompson 2000). The quality of modelling, efficiency, less time of work and decrease of stress professional are other qualities inherent in the preparation with NiTi instruments (Thompson 2000, Peters *et al.* 2001a, Peters & Paqué 2010). The preparation with stainless steel instruments has allowed that walls have not been touched by the instruments (Peters *et al.* 2001b). Since these instruments act as crapers, and not by excision of dentine, as occur with NiTi instruments, it can be suggested a greater possibility of compaction of smear layer into dentinal tubules, featuring greater presence of smear plug. This may have acted as a barrier to penetration and interaction of cement with intraradicular dentine, which may be related to the decrease on bond strength observed in groups prepared with stainless steel instruments in the present study.

NaOCl is a halogenated compound routinely used in endodontics (Zehnder 2006), which has antimicrobial effect (Byströn & Sundqvist 1981, Estrela *et al.* 2002), tissue dissolution capacity (Byströn & Sundqvist 1981, Spanó *et al.* 2009, Estrela *et al.* 2002) and acceptable biologic compatibility in less concentrated solutions (Estrela *et al.* 2002, Estrela *et al.* 2002,2003,2004). However, it does not act on the inorganic portion of dentine, which constitutes great part of the smear layer (Garberolio & Becce 1994, Cecchin *et al.* 2010). EDTA produces dentine demineralization and provides an excellent cleaning of the root canal walls (Spanó *et al.* 2009), improving the penetration of chemical substances and promoting a more intimate contact of the filling material with the root dentine (Cecchin *et al.* 2010). It acts on the inorganic components of the smear layer, leading to decalcification of the peri- and intertubular dentine (Cecchin *et al.* 2010).

The association of both substances is largely used in endodontic therapy because they act in organic and inorganic portion of dentine (Estrela *et al.* 2007, Zhang *et al.* 2010, Cecchin *et al.* 2010), with almost complete dissolution of the smear layer and exposition of the dentinal tubules (Wu *et al.* 2009). Chlorhexidine and ozonated water, however, do not have the ability to dissolve organic tissues, and debris can remain adhered to root canal walls obstructing the dentinal tubules (Menezes *et al.* 2003, Bitter *et al.* 2008, Bodrumlu *et al.* 2010), which can negatively influence the bond to root dentine, as seen in the present study.

Bitter *et al*. (2009) related that hybridization of dentine was only detected sporadically for the self-adhesive cement RelyX Unicem (3M-ESPE). The self-adhesive cement RelyX U100 (UC) used in the present study and the RelyX Unicem (UN) were developed by the same manufacturer and are marketed under the same name in some countries (Viotti *et al.* 2009). According to the manufacturer, the only difference between these products is the delivery system. While UN requires an activator, triturator and applicator, UC can be hand mixed (Viotti *et al.* 2009). The adhesive properties of this cement is claimed to be based upon acidic monomers that demineralize and infiltrate the tooth substrate, and create micromechanical retention and chemical adhesion to hydroxyapatite (De Munck *et al.* 2004, Gerth *et al.* 2006, Zicari *et al.* 2008, Bitter *et al*. 2009, Cecchin *et al.* 2011).

Bitter *et al*. (2009) reported that the penetration of this cement into the dentinal tubules was found in only a few specimens and concluded that the smear layer did not dissolve consistently at the dentine-cement interface. This finding corroborates with the results of investigations conducted previously that also described a superficial morphological interaction (De Munck *et al.* 2004, Al-Assaf *et al.* 2007, Monticelli *et al.* 2008). Since the RelyX U100 has low desmineralization capacity, the ability of NaOCl to remove the organic components of dentine may result in a rough surface (Hayashi *et al.* 2005). Probably, this fact may increase the penetration of the cement (Ari *et al.* 2003) into the partially demineralized dentine structure (Monticelli *et al.* 2008) favouring the micromechanical retention and increasing the bond strength.

Moreover, an intense chemical interaction of RelyX Unicem with hydroxyapatite has been documented (Gerth *et al.* 2006). Chemical interactions between the self-adhesive resin cement and hydroxyapatite may be effective inside the root canal, and indicate that this interaction might be more crucial for root dentine bonding than the ability of the same material to hybridize dentine (Bitter *et al.* 2009). As NaOCl acts on organic portion dissolution exposing the inorganic, this action may favour the chemical interactions between hydroxyapatite and cement, justifying the highest bond strength values found when this irrigant was used.

The effect of NaOCl on the bond strength of resin cements to intraradicular dentine is controversious, several studies has demonstrated benefit when this irrigant is used (Varela *et al.* 2003, Muniz & Mathias 2005, Hayashi *et al.* 2005, Pelegrine *et al.* 2010), whereas other studies described an adverse effect of this irrigant on bonding (Morris *et al.* 2001, Ari *et al.* 2003, Erdemir *et al.* 2004, Demiryürek *et al.* 2009). The increase has been explained by the removal of the collagen of the smear layer, which resulted in the rough surface of the dentine. On the other hand, the decrease of bond strength has been explained by the change of the redox potential of bonding substrate due to the residual NaOCl. However, these studies present different methodologies from that used on the present study, as regarding concentration and exposure time of NaOCl, hindering appropriate comparison with the obtained results.

Ozonated water reduced significantly the bond strength to root canal. Ozone (O_3) is a highly reactive form of oxygen that is generated by passing oxygen through high-voltage (Estrela *et al.* 2007). It is a blue gas, containing three oxygen atoms, and it is a power antimicrobial agent, irritant, toxic and unstable (Stübinger *et al.* 2006, Estrela *et al.* 2007, Azarpazhooh & Limeback 2008, Rodrigues *et al.* 2011). However, because of its high instability, ozone rapidly turns into oxygen (Stübinger *et al.* 2006, Estrela *et al.* 2007, Rodrigues *et al.* 2011), which may inhibit the polymerization of the resin cement and thus reduce bond strength (Bitter *et al.* 2008). Therefore, a possible interaction with initiator components of resin cements as well as a certain influence of the material properties (Bitter *et al.* 2008), such as the inability to dissolve organic tissue, may explain the significant reduction in bond strength.

Although fiber posts luted in root canals are not directly exposed to oral fluids, water storage is considered as *in vitro* accelerated aging test for bonded interfaces (Radovic *et al.* 2007). In the present study, water artificial aging for two months significantly increased post retention. Increases in interfacial strength may be related to enhanced bonding ability or setting during water storage, stress relaxation by hygroscopic expansion as a consequence of water sorption during storage or hygroscopic expansion of luting materials (Sadek *et al.* 2006, Albashaireh *et al.* 2010). The hygroscopic expansion of the resin cement, in particular, could have contributed to a greater adaptation of the cement to dentine substrate. A major contribution to retentive strength in push-out test is expected to occur as a consequence of the interfacial sliding friction (Sadek *et al.* 2006) resulting from application of a compressive force. Thus, the higher 2-months interfacial strengths achieved may have been caused by the increase in interfacial friction, due to the greater adaptation of the cement to dentine consequent to hygroscopic expansion (Sadek *et al.* 2006, Albashaireh *et al.* 2010). It is important to emphasize that the applied method is a simplified model of accelerated aging which has been commonly performed for challenging resin-dentine adhesion (De Munck *et al.* 2005, Radovic *et al.* 2007).

In relation to the effect of the different levels of root canal in the present study, bond strength was predominantly higher in cervical third and lower in apical third. This may be due to a better interaction of the cement with cervical dentine and to the more difficult access to the apical third, associated with possible limitations of cement flow (de Durâo Mauricio *et al.* 2007, da Cunha *et al.* 2010), as the cement used in the present study has a high viscosity (De Munck *et al.* 2004). In addition, bond to root dentine is also influenced by the concentration and direction of dentine tubules at different levels of the root canal walls (Ferrari *et al.* 2000, Ferrari *et al.* 2001, Wang *et al.* 2008, da Cunha *et al.* 2010), being the cervical third with higher density and diameter of dentinal tubules (Ferrari *et al.* 2000).

Fractographic analysis provides important information that helps to predict the adhesive material performance. In the present study, confocal microscopy was used and appears to be a noteworthy alternative for failure modes analysis, since it is less time consuming and does not require any preparation of the specimens (Castellan *et al.* 2010). The RelyX U100 has a superficial morphological interaction (De Munck *et al.* 2004, Gerth *et al.* 2006, Bitter *et al.* 2009, Al-Assaf *et al.* 2007, Monticelli *et al.* 2008). This observation may explain the predominance of adhesive cement-dentine failures in all groups of the present study (Table 4).

Limitations from the present study include the fact that the specimens were not submitted to thermal and mechanical cycling, in order to simulate intra-oral situations more precisely. Further, bovine teeth were used because bioethical concerns make it difficult to collect and utilize human teeth for research purposes (Menezes *et al.* 2008, Soares *et al.* 2012). Bovine teeth collecting is easier and tooth age can be standardized (Menezes *et al.* 2008, Soares *et al.* 2012). Further, several studies have demonstrated similar properties between human and bovine teeth (Nakamichi *et al.* 1983, Dong *et al.* 2003). Further studies need to be conducted to analyse the effects of different concentrations of NaOCl; the association of a reversal agent such as ascorbic or sodium ascorbate with ozonated water in order to reverse the oxidized dentin; and the increase of the artificial aging time on bond strength to intraradicular dentine.

Conclusions

Root canal preparation with NiTi instruments associated with NaOCl irrigation and EDTA increased the bond strength of fibreglass posts cemented with self-adhesive resin cement to intraradicular dentine.

Acknowledgements

The authors are indebted to Federal University of Uberlândia (Integrated Laboratory for Dental Research/UFU, Brazil) and Prof. Dr. Marcelo Emilio Beletti (Laboratory of Image Analysis, Histological Techniques and Microscopy/UFU, Brazil) for technical support. This study was supported by grants from the CAPES, FAPEMIG and CNPq (CNPq grants # 306394/2011-1).

References

Al-Assaf K, Chakmakchi M, Palaghias G, Karanika-Kouma A, Eliades G (2007) Interfacial characteristics of adhesive luting resins and composites with dentine. *Dental Materials* **23**, 829-39.

Albashaireh ZS, Ghazal M, Kern M (2010) Effects of endodontic post surface treatment, dentin conditioning, and artificial aging on the retention of glass fiber-reinforced composite resin posts. *The Journal of Prosthetic Dentistry* **103**, 31-9.

Ari H, Yaşar E, Belli S (2003) Effects of NaOCl on bond strengths of resin cements to root canal dentin. *Journal of Endodontics* **29**, 248-51.

Azarpazhooh A, Limeback H (2008) The application of ozone in dentistry: a systematic review of literature. *Journal of Dentistry* **36**, 104-16.

Barbin LE, Saquy PC, Guedes DF, Sousa-Neto MD, Estrela C, Pécora JD (2008) Determination of para-chloroaniline and reactive oxygen species in chlorhexidine and chlorhexidine associated with calcium hydroxide. *Journal of Endodontics* **34**:1508-14.

Bitter K, Kielbassa AM (2007) Post-endodontic restorations with adhesively luted fiber-reinforced composite post systems: a review. *American Journal of Dentistry* **20**, 353-60.

Bitter K, Noetzel J, Volk C, Neumann K, Kielbassa A (2008) Bond Strength of Fiber Posts after the Application of Erbium:Yttrium-Aluminum-Garnet

Laser Treatment and Gaseous Ozone to the Root Canal. *Journal of Endodontics* **34**, 306-9.

Bitter K, Paris S, Pfuertner C, Neumann K, Kielbassa AM (2009) Morphological and bond strength evaluation of different resin cements to root dentin. *European Journal of Oral Sciences* **117**, 326-33.

Bodrumlu E, Parlak E, Bodrumlu EH (2010) The effect of irrigation solutions on the apical sealing ability in different root canal sealers. *Brazilian Oral Research* **24**, 165-9.

Byströn A, Sundqvist G (1981) Bacteriologic evaluation of the efficacy of 2mechanical root canal instrumentation in endodontic therapy. *Scandinavian Journal of Dental Research* **89**,321-8.

Cagidiaco MC, Goracci C, Garcia-Godoy F, Ferrari M (2008) Clinical studies of fiber posts: a literature review. *The International Journal of Prosthodontics* **21**, 328–36.

Castellan CS, Santos-Filho PC, Soares PV, Soares CJ, Cardoso PE (2010) Measuring bond strength between fiber post and root dentin: a comparison of different tests. *The Journal of Adhesive Dentistry* **12**, 477-85.

Cecchin D, Farina AP, Galafassi D, Barbizam JV, Corona SA, Carlini-Júnior B (2010) Influence of sodium hypochlorite and EDTA on the microtensile bond strength of a self-etching adhesive system. *Journal of Applied Oral Science* **18**, 385-9.

Cecchin D, Farina AP, Souza MA, Carlini-Júnior B, Ferraz CCR (2011) Effect of root canal sealers on bond strength of fibreglass posts cemented with self-adhesive resin cements. *International Endodontic Journal* **44**, 314–320.

Cheung W (2005) A review of the management of endodontically treated teeth. Post, core and the final restoration. *Journal of American Dental Association* **136**, 611-9.

da Cunha LF, Furuse AY, Mondelli RF, Mondelli J (2010) Compromised bond strength after root dentin deproteinization reversed with ascorbic acid. *Journal of Endodontics* **36**, 130-4.

de Durâo Mauricio PJ, González-López S, Aguilar-Mendoza JA, Félix S, González-Rodríguez MP (2007) Comparison of regional bond strength in root thirds among fiber-reinforced posts luted with different cements. *Journal of Biomedical Materials Research. Part B, Applied Biomaterials* **83**, 364-72.

De Munck J, Van Landuyt K, Peumans M, *et al.* (2005) A critical review of the durability of adhesion to tooth tissue: methods and results. *Journal of Dental Research* **84**, 118-32.

De Munck J, Vargas M, Van Landuyt K, Hikita K, Lambrechts P, Van Meerbeek B (2004) Bonding of an auto-adhesive luting material to enamel and dentin. *Dental Materials* **20**, 963–71.

Demiryürek EÖ, Külünk S, Saraç D, Yüksel G, Bulucu B (2009) Effect of different surface treatments on the push-out bond strength of fiber post to root canal dentin. *Oral surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* **108**, e74-80.

Dong CC, McComb D, Anderson JD, Tam LE (2003) Effect of mode of polymerization of bonding agent on shear bond strength of autocured resin composite luting cements. *Journal of the Canadian Dental Association* **69**, 229–34.

Erdemir A, Ari H, Güngüneş H, Belli S (2004) Effect of medications for root canal treatment on bonding to root canal dentin. *Journal of Endodontics* **30**, 113-6.

Estrela C, Barbin EL, Spanó JCE, Marchesan S, Estrela CRA, Pécora JD (2002) Mechanism of Action of Sodium Hypochlorite. *Brazilian Dental Journal* **13**, 113-7.

Estrela C, Estrela CR, Decurcio DA, Hollanda AC, Silva JA (2007) Antimicrobial efficacy of ozonated water, gaseous ozone, sodium hypochlorite and chlorhexidine in infected human root canals. *International Endodontic Journal* **40**, 85-93.

Estrela CR, Estrela C, Reis C, Bammann LL, Pécora JD (2003) Control of microorganisms in vitro by endodontic irrigants. *Brazilian Dental Journal* **14**:187-92.

Estrela C, Holland R, Bernabé PF, de Souza V, Estrela CR (2004) Antimicrobial potential of medicaments used in healing process in dogs' teeth with apical periodontitis. *Brazilian Dental Journal* **15**:181-5.

Ferrari M, Cagidiaco MC, Goracci C, *et al.* (2007) Long-term retrospective study of the clinical performance of fiber posts. *American Journal of Dentistry* **20**, 287–91.

Ferrari M, Mannocci F, Vichi A, Cagidiaco MC, Mjör IA (2000) Bonding to root canal: structural characteristics of the substrate. *American Journal of* Dentistry **13**, 255-60.

Ferrari M, Vichi A, Grandini S (2001) Efficacy of different adhesive techniques on bonding to root canal walls: an SEM investigation. *Dental Materials* **17**, 422-9.

Garberolio R, Becce C (1994) Smear layer removal by root canal irrigants. A comparative scanning electron microscopic study. *Oral Surgery, Oral Medicine, and Oral Pathology* **78**, 359-67.

Gerth HU, Dammaschke T, Züchner H, Schäfer E (2006) Chemical analysis and bonding reaction of RelyX Unicem and Bifix composites - a comparative study. *Dental Materials* **22**, 934-41.

Goracci C, Tavares AU, Fabianelli A, *et al.* (2004) The adhesion between fiber posts and root canal walls: comparison between microtensile and push-out bond strength measurements. *European Journal of Oral Sciences* **112**, 353-61.

Hayashi M, Takahashi Y, Hirai M, Iwami Y, Imazato S, Ebisu S (2005) Effect of endodontic irrigation on bonding of resin cement to radicular dentin. *European Journal of Oral Sciences* **113**, 70-6.

Hems RS, Gulabivala K, Ng Y-L, Ready D, Spratt DA (2005) An in vitro evaluation of the ability of ozone to kill a strain of *Enterococcus faecalis*. *International Endodontic Journal* **38**, 22-9.

Jongsma LA, Kleverlaan CJ, Feilzer AJ (2010). Influence of surface pretreatment of fiber posts on cement delamination. *Dental Materials* **26**, 901-7.

Kececi AD, Ureyen Kaya B, Adanir N (2008) Micro push-out bond strengths of four fiber-reinforced composite post systems and 2 luting materials. *Oral surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics* **105**, 121–8.

Lassila LVJ, Tanner J, Le-Bell AM, Narva K, Vallittu PK (2004) Flexural properties of fiber reinforced root canal posts. *Dental Materials* **20**, 29–36.

Menezes AC, Zanet CG, Valera MC (2003) Smear layer removal capacity of disinfectant solutions used with and without EDTA for the irrigation of canals: a SEM study. *Brazilian Oral Research* **17**, 349-55.

Menezes MS, Queiroz EC, Campos RE, Martins LRM, Soares CJ (2008) Influence of endodontic sealer cement on fiberglass post bond strength to root dentine. *International Endodontic Journal* **41**, 476-84.

Mjör IA, Smith MR, Ferrari M, Mannocci F (2001) The structure of dentine in the apical region of human teeth. *International Endodontic* Journal **34**, 346–53.

Monticelli F, Osorio R, Mazzitelli C, Ferrari M, Toledano M (2008) Limited decalcification/diffusion of self-adhesive cements into dentin. *Journal of Dental Research* **87**, 974-9.

Morgano SM, Rodrigues AH, Sabrosa CE (2004) Restoration of endodontically treated teeth. *Dental Clinics of North America* **48**, 397-416.

Morris MD, Lee KW, Agee KA, Bouillaguet S, Pashley DH (2001) Effects of sodium hypochlorite and RC-prep on bond strength of resin cement to endodontic surfaces. *Journal of Endodontics* **27**, 753-7.

Muniz L, Mathias P (2005) The influence of sodium hypochlorite and root canal sealers on post retention in different dentin regions. *Operative Dentistry* **30**, 533-9.

Nagayoshi M, Kitamura C, Fukuizumi T, Nishihara T, Terashita M (2004) Antimicrobial effect of ozonated water on bacteria invading dentinal tubules. *Journal of Endodontics* **30**, 778-81.

Nakamichi I, Iwaku M, Fusayama T (1983) Bovine teeth as possible substitutes in the adhesion test. *Journal of Dental Research* **62**, 1076–81.

Naves LZ, Santana FR, Castro CG, *et al.* (2011) Surface treatment of glass fiber and carbon fiber posts: SEM characterization. *Microscopy Research and Techique* **29**.

Okino LA, Siqueira EL, Santos M, Bombana AC, Figueiredo JÁ (2004) Dissolution of pulp tissue by aqueous solution of chlorhexidine digluconate and chlorhexidine digluconate gel. *International Endodontic Journal* **37**, 38-41.

Pelegrine RA, De Martin AS, Cunha RS, Pelegrine AA, da Silveira Bueno CE (2010) Influence of chemical irrigants on the tensile bond strength of an adhesive system used to cement glass fiber posts to root dentin. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontics* **110**, e73-6.

Peters OA, Paqué F (2010) Current developments in rotary root canal instrument technology and clinical use: a review. *Quintessence International* **41**, 479-88.

Peters OA, Laib A, Göhring TN, Barbakow F (2001b) Changes in root canal geometry after preparation assessed by high-resolution computed tomography. *Journal of Endodontics* **27**, 1-6.

Peters OA, Schönenberger K, Laib A (2001a) Effects of four NiTi preparation techniques on root canal geometry assessed by micro computed tomography. *International Endodontic Journal* **34**, 221-30.

Radovic I, Monticelli F, Papacchini F, *et al.* (2007) Accelerated aging of adhesive-mediated fiber post-resin composite bonds: A modeling approach. *Journal of Dentistry* **35**, 683-9.

Rodrigues PC, Souza JB, Soares CJ, Lopes LG, Estrela C (2011) Effect of ozone application on the resin-dentin microtensile bond strength. *Operative Dentistry* **36**, 537-44.

Sadek FT, Goracci C, Monticelli F, *et al.* (2006) Immediate and 24-hour evaluation of the interfacial strengths of fiber posts. *Journal of Endodontics* **32**, 1174-7.

Santana FR, Castro CG, Simamoto-Júnior PC, *et al.* (2011) Influence of post system and remaining coronal tooth tissue on biomechanical behaviour of root filled molar teeth. *International Endodontic Journal* **44**, 386-94.

Schwartz RS, Robbins JW (2004) Post placement and restoration of endodontically treated teeth: a literature review. *Journal of Endodontics* **30**, 289 –301.

Shokouhinejad N, Sharifian MR, Jafari M, Sabeti MA (2010) Push-out bond strength of Resilon/Epiphany self-etch and gutta-percha/AH26 after different irrigation protocols. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontics* **110**, e88-92.

Soares CJ, Pereira JC, Valdivia AD, Novais VR, Meneses MS (2012) Influence of resin cement and post configuration on bond strength to root dentine. *International Endodontic Journal* **45**, 136-45.

Soares CJ, Santana FR, Castro CG, *et al.* (2008b) Finite element analysis and bond strength of a glass post to intraradicular dentin: comparison between microtensile and push-out tests. *Dental Materials* **24**, 1405-11.

Soares CJ, Santana FR, Pereira JC, Araujo TS, Menezes MS (2008a) Influence of airborne-particle abrasion on mechanical properties and bond strength of carbon/epoxy and glass/bis-GMA fiber-reinforced resin posts. *The Journal of Prosthetic Dentistry* **99**, 444-54.

Spanó JC, Silva RG, Guedes DF, Sousa-Neto MD, Estrela C, Pécora JD (2009) Atomic absorption spectrometry and scanning electron microscopy evaluation of concentration of calcium ions and smear layer removal with root canal chelators. *Journal of Endodontics* **35**, 727-30.

Stübinger S, Sader R, Filippi A (2006) The use of ozone in dentistry and maxillofacial surgery: a review. *Quintessence International* **37**, 353-9

Tang W, Wu Y, Smales RJ (2010) Identifying and reducing risks for potential fractures in endodontically treated teeth. *Journal of Endodontics* **36**, 609–17.

Tay FR, Loushine RJ, Lambrechts P, Weller RN, Pashley DH (2005) Geometric factors affecting dentin bonding in root canals: a theoretical modeling approach. *Journal of Endodontics* **31**, 584–9.

Thompson SA (2000) An overview of Nickel-Titanium alloys used in dentistry. *International Endodontic Journal* **33**, 297-310.

Varela SG, Rábade LB, Lombardero PR, Sixto JM, Bahillo JD, Park AS (2003) In vitro study of endodontic post cementation protocols that use resin cements. *The Journal of Prosthetic Dentistry* **89**, 146-53.

Viotti RG, Kasaz A, Pena CE, Alexandre RS, Arrais CA, Reis AF (2009) Microtensile bond strength of new self-adhesive luting agents and conventional multistep systems. *The Journal of Prosthetic Dentistry* **102**, 306-12.

Wang VJ, Chen YM, Yip KH, Smales RJ, Meng QF, Chen L (2008) Effect of two fiber post types and two luting cement systems on regional post retention using the push-out test. *Dental Materials* **24**, 372–7.

Wu H, Hayashi M, Okamura K, *et al.* (2009) Effects of light penetration and smear layer removal on adhesion of post-cores to root canal dentin by self-etching adhesives. *Dental Materials* **25**, 1484-92.

Zehnder M (2006) Root canal irrigants. *Journal of Endodontics* **32**:389-98.

Zhang K, Kim YK, Cadenaro M, *et al.* (2010) Effects of different exposure times and concentrations of sodium hypochlorite/ ethylenediaminetetraacetic acid on the structural integrity of mineralized dentin. *Journal of Endodontics* **36**, 105-9.

Zicari F, Couthino E, De Munck J, *et al.* (2008) Bonding effectiveness and sealing ability of fiber-post bonding. *Dental Materials* **24**, 967-77.

Table 1 Bond strength means in MPa (standard deviation) of groups tested immediately (no aging) and statistical categories defined by Tukey's test (n = 10).

Endodontic irrigant	Instrumentation technique						Total
	SS			NiTi			
	Root canal third			Root canal third			
	Cervical	Middle	Apical	Cervical	Middle	Apical	
NaOCl	12.9 (2.4)^{Aa}	10.3 (4.0)^{Ba}	7.10 (3.8)^{Ca}	13.5 (2.1)^{Aa}	11.4 (3.3)^{ABa}	9.3 (4.8)^{BCa}	10.8 (4.0)^{a}
CHX	11.4 (3.3)^{Aab}	9.8 (3. 9)^{ABa}	6.7 (3.9)^{Cab}	11.5 (3.8)^{Aab}	10.0 (4.9)^{ABab}	7.1 (5.6)^{BCa}	9.4 (4.5)^{ab}
O_3	8.7 (6.8)^{Ab}	6.2 (5.0)^{Bb}	3.5 (2.9)^{Cb}	9.5 (3.4)^{Ab}	7.4 (1.6)^{ABb}	6.8 (1.4)^{BCa}	7.0 (4.3)^{b}
Total	8.5 (4.9)^{B}			9.6 (4.2)^{A}			

Capital letters were used to compare groups in the horizontal lines and lower-case letters were used to compare groups in the vertical lines. Tukey categories with same letters are not statistically significant from each other ($P < 0.05$).

SS, root canal preparation with stainless steel instruments - K-File; NiTi, root canal preparation with K3 Nickel-Titanium instruments; NaOCl, 1% sodium hypochlorite; CHX, 2% chlorhexidine; O_3- 1.2% ozonated water.

Table 2 Bond strength means in MPa (standard deviation) of groups tested after water artificial accelerated aging and statistical categories defined by Tukey's test (n = 10).

Endodontic Irrigant	Instrumentation technique						Total
	SS			NiTi			
	Root canal third			Root canal third			
	Cervical	Middle	Apical	Cervical	Middle	Apical	
NaOCl	24.1 (5.8)^{Aa}	20.3 (7.7)^{Ba}	15.5 (8.6)^{Ca}	25.1 (6.4)^{Aa}	22.6 (6.1)^{ABa}	21.6 (6.3)^{ABa}	21.5(7.3)^{a}
CHX	18.9 (4.3)^{ABb}	16.2 (4.0)^{Ba}	13.3 (7.2)^{Ca}	21.4 (3.4)^{Aab}	20.8 (6.3)^{ABa}	18.4 (7.7)^{ABa}	18.2(6.1)^{a}
O_3	17.4 (4.9)^{Ab}	9.9 (4.0)^{Bb}	6.4 (3.4)^{Cb}	17.4 (4.9)^{Ab}	11.0 (5.3)^{Bb}	7.1 (3. 8)^{BCb}	11.5(6.2)^{b}
Total	15.8 (7.5)^{B}			18.4 (7.8)^{A}			

Capital letters were used to compare groups in the horizontal lines and lower-case letters were used to compare groups in the vertical lines.
Tukey categories with same letters are not statistically significant from each other ($P < 0.05$).
SS, root canal preparation with stainless steel instruments - K-File; NiTi, root canal preparation with K3 Nickel-Titanium instruments; NaOCl, 1% sodium hypochlorite; CHX, 2% chlorhexidine; O_3- 1.2% ozonated water.

Table 3 Bond strength means in MPa (standard deviation), as a result of artificial accelerated aging and root canal third, and statistical categories defined by Tukey's test for each group (n = 10).

Groups	Test	Root canal third		
		Cervical	Middle	Apical
SSNaOCl	Immediate	12.9 (2.4)^{Ab}	10.3 (4.0)^{ABb}	7.1 (3.8)^{Bb}
	Mediate	24.1 (5.8)^{Aa}	20.3 (7.7)^{Ba}	15.5 (8.6)^{Ca}
SSCHX	Immediate	11.4 (3.3)^{Ab}	9.8 (3.9)^{ABb}	6.7 (3.9)^{Bb}
	Mediate	18.8 (4.3)^{Aa}	16.2 (4.0)^{ABa}	13.3 (7.2)^{Ba}
SSO_3	Immediate	8.7 (6.8)^{Ab}	6.2 (5.0)^{ABa}	3.5 (2.9)^{Ba}
	Mediate	17.4 (4.9)^{Aa}	9.9 (4.0)^{Ba}	6.4 (3.4)^{Ba}
NiTiNaOCl	Immediate	13.5 (2.1)^{Ab}	11.4 (3.3)^{ABb}	9.3 (4.8)^{Bb}
	Mediate	25.1 (6.4)^{Aa}	22.6 (6.1)^{Aa}	21.6 (6.3)^{Aa}
NiTiCHX	Immediate	11.5 (3.8)^{Ab}	10.0 (4.9)^{ABb}	7.1 (5.6)^{Bb}
	Mediate	21.4 (3.4)^{Aa}	20.8 (6.3)^{Aa}	18.4 (7.7)^{Aa}
$NiTiO_3$	Immediate	9.5 (3.4)^{Ab}	7.4 (1.6)^{ABb}	6.8 (1.4)^{Ba}
	Mediate	17.4 (4.9)^{Aa}	11.0 (5.3)^{Ba}	7.1 (3.8)^{Ca}

In each group, capital letters were used to compare values in the horizontal lines and lower-case letters were used to compare values in the vertical lines. Tukey categories with same letters are not statistically significant from each other ($P < 0.05$).

SS, root canal preparation with stainless steel instruments - K-File; NiTi, root canal preparation with K3 Nickel-Titanium instruments; NaOCl, 1% sodium hypochlorite; CHX, 2% chlorhexidine; O_3- 1.2% ozonated water.

Table 4 Failure modes (%) for experimental groups.

Groups	Adhesive: post and cement (I)	Adhesive: cement and dentine (II)	Cohesive: Cement (III)	Cohesive: Dentine (IV)	Cohesive: Post (V)	Mixed (VI)
SSNaOCl Immediate	-	32 (53.3)	-	4 (6.7)	1 (1. 7)	23 (38.3)
SSCHX Immediate	1 (1.7)	33 (55.0)	-	3 (5.0)	1 (1.7)	22 (36.7)
SSO_3 Immediate	3 (5.0)	33 (55.0)	-	-	1 (1.7)	23 (38.3)
NiTiNaOCl Immediate	2 (3.3)	33 (55.0)	-	6 (10.0)	2 (3.3)	17 (28.3)
NiTiCHX Immediate	2 (3.3)	34 (56.7)	-	2 (3.3)	2 (3.3)	20 (33.3)
$NiTiO_3$ Immediate	2 (3.3)	47 (78.3)	-	1 (1.7)	-	10 (16.7)
SSNaOCl Mediate	2 (3.3)	27 (45.0)	-	-	11 (18.3)	20 (33.3)
SSCHX Mediate	3 (5.0)	31 (51.7)	-	1 (1.7)	7 (11.7)	18 (30.0)
SSO_3 Mediate	3 (5.0)	40 (66.7)	-	-	2 (3.3)	15 (25.0)
NiTiNaOCl Mediate	1 (1.7)	20 (33.3)	-	9 (15.0)	15 (25.0)	15 (25.0)
NiTiCHX Mediate	-	42 (70.0)	-	-	10 (16.7)	8 (13.3)
$NiTiO_3$ Mediate	1 (1.7)	35 (58.3)	1 (1.7)	-	3 (5.0)	20 (33.3)

SS, root canal preparation with stainless steel instruments - K-File; NiTi, root canal preparation with K3 Nickel-Titanium instruments; NaOCl, 1% sodium hypochlorite; CHX, 2% chlorhexidine; O_3- 1.2% ozonated water; Immediate, test with no aging; Mediate, test performed after 2 months of water storage at 37℃.

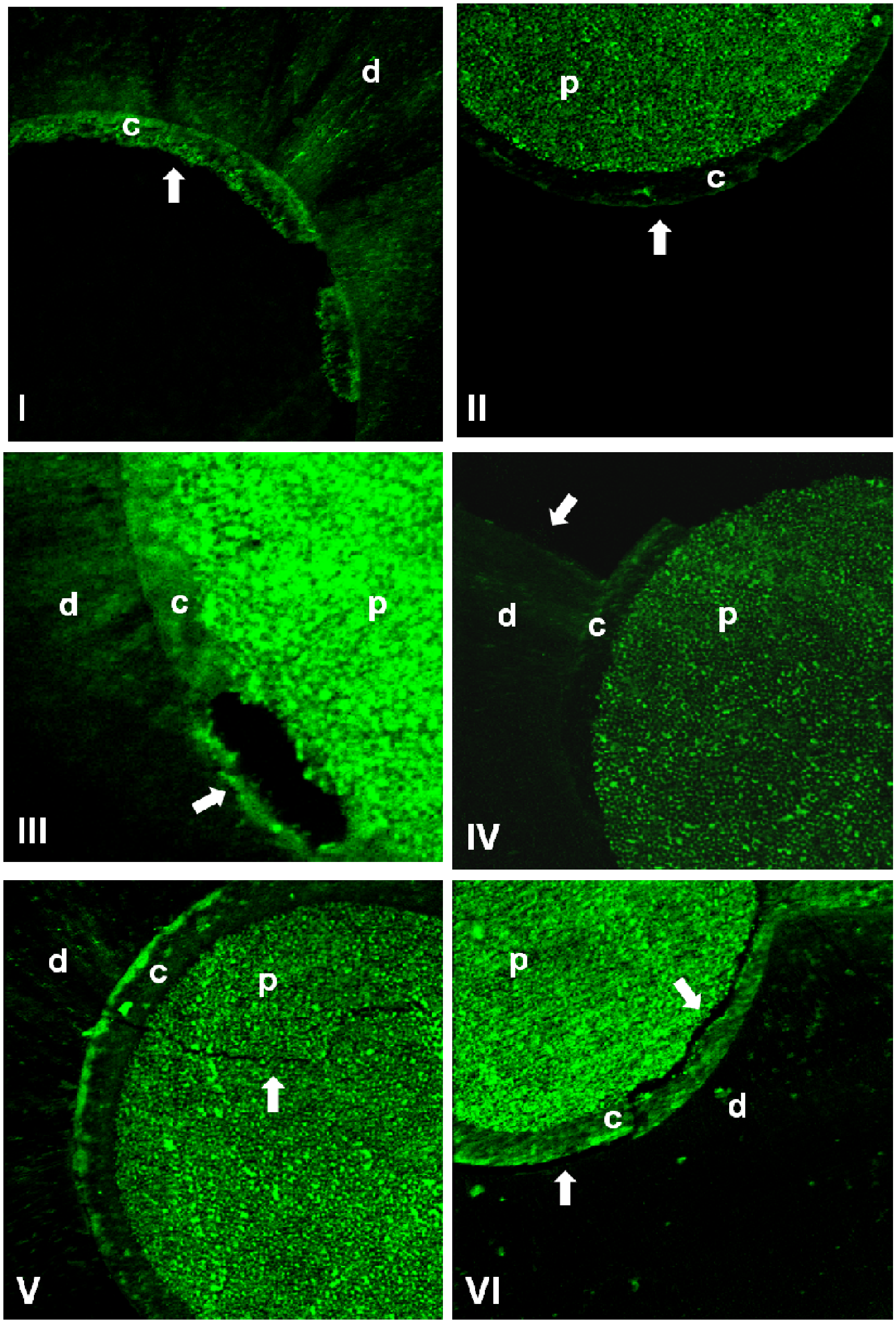

Figure 1. *d – dentine; c – resin cement; p – fibreglass post*. Microscopic images of failure modes after micropush-out test (magnification 10X): (I) adhesive between the post and resin cement; (II) adhesive between resin cement and intraradicular dentine; (III) cohesive in cement; (IV) cohesive in dentine; (V) cohesive in post; (VI) mixed among post, resin cement and intraradicular dentine.

Artigo 2:

Influence of endodontic therapy and artificial accelerated aging on fibreglass post bond strength to intraradicular dentine. Part 2. Endodontic sealers

Autores:

Fernanda Ribeiro Santana, DDS, MSc;
Carlos José Soares, DDS, MSc, PhD;
Josemar Martins Ferreira, DDS, MSc;
Andrea Dolores Correia Miranda Valdivia, DDS, MSc;
João Batista de Souza, DDS, MSc, PhD;
Carlos Estrela, DDS, MSc, PhD.

Revista (Submetido):

International Endodontic Journal

Influence of endodontic therapy and artificial accelerated aging on fibreglass post bond strength to intraradicular dentine. Part 2. Endodontic sealers

Santana F.R.[1]

Soares C.J.[2]

Ferreira J.M.[1]

Valdivia A.D.C.M.[3]

Souza J.B.[4]

Estrela C.[1]

[1] Department of Stomatologic Sciences, School of Dentistry, Federal University of Goiás, GO, Brazil

[2] Operative Dentistry and Dental Materials Department, School of Dentistry, Federal University of Uberlândia, Uberlândia, MG, Brazil

[3] Post-graduate student, School of Dentistry, Federal University of Uberlândia, MG, Brazil

[4] Department of Prevention and Oral Rehabilitation, School of Dentistry, Federal University of Goiás, GO, Brazil

Running title (no more than 30 letters and spaces)

Post bond strength to dentine

Key words: fibreglass post, bond strength, root dentine, endodontic sealer, aging.

Address correspondence and offprint requests to:

Prof. Dr. Carlos Estrela

Department of Stomatologic Sciences,

Federal University of Goiás,

Praça Universitária s/n

Sector Universitário CEP: 74605-220, Goiânia, GO, Brazil

E-mail: estrela3@terra.com.br

Abstract

Aim To evaluate *in vitro* the influence of endodontic sealers and specimens aging on fibreglass post bond strength to bovine intraradicular dentine.

Methodology 80 teeth were divided into 8 groups (n=10), 2 controls and 6 experimental groups resulting from the interaction between 2 study factors: endodontic sealer (SX- Sealapex; S26- Sealer 26; AH- AH Plus) and specimens aging (Immediate, test with no aging; Mediate, test performed after 2 months of water storage at 37℃). Root canals were prepared with K3 Nickel-Titanium-instruments associated with 1% NaOCl and 17% EDTA. In control groups (immediate and mediate), after root canal preparation, endodontic filling was not performed. In experimental groups, root canals were filled with gutta-percha and the specific sealer for each group. In all groups, posts were cemented with self-adhesive resin cement (RelyX U100). Roots were cross-sectioned to obtain two slices of each third. Samples were submitted to push-out test and data were analysed by ANOVA in a split-plot arrangement and Tukey's test ($\alpha = 0.05$). Comparisons with controls were made using Dunnet test ($\alpha = 0.05$). Failure modes were evaluated under a confocal microscope.

Results No significant difference was detected among endodontic sealers, however they presented significantly lower bond strength values than controls, except in cervical third of groups tested immediately. Artificial aging did not interfere on bond strength to intraradicular dentine. The prevalence of adhesive cement-dentine failure was verified in all groups.

Conclusions Endodontic sealers interfered negatively on bonding of fibreglass posts cemented with self-adhesive resin cement to intraradicular dentine.

Introduction

Root canal filling is an important step in the last phase of endodontic treatment, which is completed with coronal restoration. The correct sealing aims to prevent reinfection of the root canal and promote the process of biological sealing (Estrela *et al.* 2007). This procedure is achieved with the association of a solid filling material, such as gutta-percha, and endodontic sealer. One of the key roles of the endodontic sealer is to aggregate the root filling material and maintain it as compact mass with no gaps, which adheres to the canal walls and provides a single block configuration that seals hermetically the canal space (Schwartz 2006, Teixeira *et al.* 2009). This adhesion process involves mechanical forces that yield the intertwining of the material with dentine structures and may result in a greater sealing ability, thus reducing the risk of root canal microleakage and maintaining a cohesive filling mass (Saleh *et al.* 2002, Teixeira *et al.* 2009).

There has been an ongoing search for an endodontic sealer that meets the ideal physicochemical properties of sealing, radiopacity, setting time and flow as well as tissue tolerance over the last few years (Duarte *et al.* 2010, Holland & Souza 1985). Sealapex is an endodontic sealer containing calcium oxide which has the capacity to stimulate the formation of mineralized tissue (Holland & Souza 1985). Sealer 26 is an endodontic sealer that incorporates calcium hydroxide into a epoxy resin-based sealer (Gomes *et al.* 2004, Nunes *et al.* 2008, Demiryürek *et al.* 2010). AH Plus is an epoxy resin-based sealer with good physicochemical properties (Kopper *et al.* 2003, Solano *et al.* 2005, Grecca *et al.* 2009, Demiryürek *et al.* 2010) and good adhesion (Sousa-Neto *et al.* 2005, Nunes *et al.* 2008).

The compatibility among different materials used in endodontic therapy with luting material to cement fibre posts is an important aspect to be considered for a successful restoration of root treated teeth. Depending on its composition, the endodontic sealer might interfere with the bonding of a post to root dentine (Hagge *et al.* 2002, Muniz & Mathias 2005, Baldissara *et al.* 2006, Menezes *et al.* 2008, Teixeira *et al.* 2008, Demiryürek *et al.* 2010, Cecchin *et al.* 2011, Dimitrouli *et al.* 2011). Moreover, the quality of bonding to root dentine may be affected by the density and orientation of dentine tubules at different levels of the root canal walls (Ferrari *et al.* 2000, Goracci *et al.* 2004) and the real access to the root canal thirds (Ferrari *et al.* 2000, Ferrari *et al.* 2001, Goracci *et al.* 2004, Wang *et al.* 2008*,* da Cunha *et al.* 2010).

The aim of this study was to evaluate the effects of the endodontic sealer and artificial accelerated aging of specimens on bond strength of adhesively cemented fibreglass posts in root canal of bovine teeth, depending on the depth of the root canal. The hypothesis tested was that (i) the chemical composition of endodontic sealers and (ii) the artificial accelerated aging of specimens influence on fibreglass post bond strength to root dentine, depending on the depth of the root canal.

Materials and methods

From among 300 freshly extracted bovine incisor teeth, 80 were selected (approved by the Federal University of Goiás Ethics Committee, # 256/10). The selection criterion used was the similarity of the external and internal anatomical morphology and a root canal diameter smaller than 1mm. Roots 15 mm in length were produced after removing the coronal portion. Roots were randomly divided into eight groups (n=10), two controls and six experimental groups resulting from the interaction between two study factors: endodontic sealer (SX- Sealapex, Kerr Corporation, Orange, EUA; S26- Sealer 26, Dentsply Maillefer, Petrópolis, RJ, Brazil; AH- AH Plus, Dentsply DeTrey GmbH, Konstanz, Germany) and specimens aging (Immediate, test with no aging; Mediate, test performed after artificial accelerated aging - 2 months of water storage at 37°C). Root canals were prepared 1 mm from the apex by the crown-down technique with size # 1,2 Gates Glidden burs (Dentsply Maillefer) (WL 10mm) and K3 Nickel-Titanium instruments (SybronEndo, Optimum, São Paulo, SP, Brazil) in the following sequence: # 25 .10 taper (WL 10mm); # 15-25 .02 taper (WL 14mm); # 25 .04 taper (WL 14mm); # 25 .06 taper (WL 14mm); # 30-45 .02 taper (WL 14mm). During instrumentation, at each change of file, root canals were irrigated with 2 mL of 1% sodium hypochlorite (NaOCl) (Fitofarma, Goiânia, GO, Brazil). In all groups, 3 mL of 17% EDTA (Biodinâmica Química e Farmacêutica Ltda., Ibiporã, PR, Brazil) was used for 5 min to remove the smear layer. The final irrigation was performed with 5 mL of 1% NaOCl (Fitofarma).

In control groups (immediate and mediate control group), after root canal preparation, endodontic filling was not performed. In the six experimental groups, roots canals were dried with absorbent paper points and filled with gutta-percha (Dentsply Maillefer) and the specific endodontic sealer prepared and used according to manufacturers' instructions, using the lateral compaction technique. After root filling, root canal openings were filled with glass ionomer cement (Vidrion R; SSWhite, Rio de Janeiro, RJ, Brazil) and samples were stored in distilled water at 37°C for 24 h. After 24 h, the filling material was removed with Gates Glidden burs to a depth of 10 mm with 5 mm of apical seal maintained.

In all groups post space was prepared using size # 3-5 Largo burs (Dentsply Maillefer) (WL 10mm) corresponding to the fibreglass parallel-sided and serrated post 1.5-mm-diameter (Reforpost # 3; Angelus, Londrina, PR, Brazil). Root canals were irrigated, at each change of burs and after the preparation, with 2 mL of 1% NaOCl and dried with absorbent paper points. All roots were covered externally with utility wax to avoid lateral polymerization (Soares *et al.* 2012).

Fibreglass posts were cleaned with 70% alcohol, then in a single application using a microbrush, and after drying, a silane agent was applied for 1 min (Silano; Angelus). The self-adhesive resin cement (RelyX U100; 3M-ESPE, St. Paul, MN, USA) was manipulated in accordance with the manufacturer's instructions, introduced into the canal with K-File and placed on the post. The post was seated to full depth by finger pressure. Excess cement was removed after 1 min. After 5 min, the resin cement was light-cured with 1200 mW cm^{-2} (Radii-Cal; SDI, Bayswater, Australia) for 40 s each on the cervical face of the root, in the direction of the long axis of the root, and obliquely to the buccal and lingual surfaces, totalling 120 s. The interface post-cement-dentine on the cervical face was then sealed with composite resin and the roots were stored in distilled water at 37℃ for 24h. After 24 h, each root was serial sectioned perpendicular to its long axis with a double face diamond disc (4" Diameter x 0.012" Thickness x 1/2" Arbor, Extec, Enfield, CT, USA) at low speed under water cooling (Isomet 1000, Buehler, Lake Bluff, IL, USA) to obtain two slices, approximately 1 mm thick, of each root third (cervical, middle and apical), totalling six slices per root.

In immediate groups, slices were submitted immediately (with no aging) to push-out test, while in mediate groups, slices were stored in distilled water at 37℃ for 2 months (artificial accelerated aging) prior to testing. The push-out test was performed in a testing machine (EMIC DL 2000, São José dos Pinhais, PR, Brazil) by applying a compressive load at 0.5 mm min^{-1} in the apical-coronal direction until post segment extrusion. The bond strength was calculated in MPa by dividing the load at failure (in N) by the area of the bonded interface. The area of the bonded interface was calculated as follows: $A = 2\pi rh$, where A is the area of the bonded interface, $\pi = 3.14$, r is the radius of post segment (mm) and h is the thickness of the post segment (mm) (Goracci *et al.* 2004, Soares *et al.* 2008, Soares *et al.* 2012).

Statistical analysis was performed using SAS statistical program (Institute Inc., Cary, NC, USA, Release 9.2). Data was submitted to the Shapiro-Wilk test of normality. The effects, on bond strength, of endodontic sealers and artificial accelerated aging of specimens were analysed using One-way analysis of variance in a split-plot arrangement, with the plot represented by the endodontic sealer or the aging, and the sub-plot represented by the root canal thirds (cervical, middle and apical). Multiple comparisons were made using Tukey's test ($\alpha = 0.05$). Comparisons with control groups (immediate control and mediate control) were made using Dunnet test ($\alpha = 0.05$).

To determine the failure modes, all fractured specimens were air dried and analysed under a confocal laser scanning microscope (Carl Zeiss Laser Scanning Systems, LSM510, META, Oberkochen, Germany). Images were analyzed using Zeiss LSM Image Browser (META, Germany). The failure modes were classified into six types: (I) adhesive between the post and resin cement; (II) adhesive between resin cement and intraradicular dentine; (III) cohesive in cement; (IV) cohesive in dentine; (V) cohesive in post (Castellan *et al.* 2010) and (VI) mixed, among post, resin cement and intraradicular dentine (Bitter *et al.* 2009).

Results

One-way analysis of variance (endodontic sealer) with sub-plot (root canal third) of immediate groups and mediate groups (aging prior to testing) showed significant difference only for root canal third ($P < .001$). The mean push-out bond strengths and standard deviations are shown in Tables 1,2. Significant reduction on bond strength values from the cervical to apical third, regardless of the endodontic sealer was found.

Comparisons with immediate and mediate control groups are presented in Tables 1 and 2, respectively. Dunnet test showed that the use of an endodontic sealer resulted on lower bond strength values than control groups (without filling), with statistically significant difference in middle ($P = .0294$) and apical thirds ($P = .0207$) of groups tested immediately (Table 1), and in cervical ($P = <.0001$), middle ($P = <.0001$) and apical ($P = <.0001$) thirds of groups tested after aging (Table 2).

One-way analysis of variance (artificial accelerated aging) with sub-plot (root canal region) for each endodontic sealer (SX, S26, AH) showed significance only for root canal third ($P = <.001$). The mean micropush-out bond strengths and standard deviations for each endodontic sealer are in Table 3. Tukey's test revealed a significant reduction on bond strength values from cervical to apical third, regardless of the artificial aging.

Failure modes of tested specimens and its distribution are presented in Figure 1 and Table 4, respectively. The prevalence of (II) adhesive cement-dentine failure was verified in all groups.

Discussion

The retention of fibreglass post luted with self-adhesive resin cement to root dentine was influenced by the endodontic sealer and the depth of root canal, but not by the artificial accelerated aging. The tested hypothesis was partially accepted.

Various mechanical methods have been used to measure the bond strength of a fibreglass post to intraradicular dentine, as microtensile bond strength and push-out tests (Soares *et al.* 2008), however the push-out laboratory test would seem to be safer than the microtensile test (Goracci et al. 2004) and a more appropriate methodology for the evaluation of fibreglass posts bonded to intraradicular dentine (Soares *et al.* 2008).

When endodontic sealers are introduced in root canal and obturation forces are applied, it is likely that endodontic sealer constituents penetrate into the dentinal tubules (Boone *et al.* 2001, Shokouhinejad *et al.* 2011). Endodontic sealer penetration increases the interface between material and dentinal walls, what may improve the mechanical retention of the material by interlocking of the endodontic sealer plug inside the tubules and potentially reduces leakage (Mamootil & Messer 2007, Shokouhinejad *et al.* 2011). Furthermore, the endodontic sealer's antibacterial activity can be effective for killing and entombing bacteria that remain inside the dentinal tubules (Heling & Chandler 1996). The ability of the endodontic sealer to penetrate dentinal tubules consistently and effectively is one of many factors influencing the choice of material for root canal filling (Mamootil & Messer 2007, Shokouhinejad *et al.* 2011).

The use of EDTA, that is able to act on tooth mineral matrix and promote removal of the smear layer formed during root canal preparation, allows a better penetration of endodontic sealers into the dentinal tubules, increasing the contact surface of the filling material with dentine (Nunes *et al.* 2008). The mechanical removal of the endodontic sealer, impregnated in the root dentine, during post-space preparation is a critical step in achieving optimum post retention when resin cement is used (Boone *et al.* 2001). In the present study there was a significant decrease on post retention for all endodontic sealers compared to control groups, in which no endodontic sealer was used, what can suggest that post-space preparation may not have removed all endodontic sealer-impregnated in dentine; not ensuring a “freshened” surface in which resin cement could bond (Boone *et al.* 2001).

In agreement with this finding, previous study revealed that fibre post bond strength in the group without root canal filling was higher compared to the other groups that use gutta-percha/AH Plus, gutta-percha/Guttaflow and pre-existing root canal filling (Dimitrouli *et al.* 2011). Other study showed that endodontic sealers (AH Plus, Endofill and Sealapex) have significant negative effects on fibreglass post bond strength (Demiryürek *et al.* 2010). In contrast, other study reported that AH Plus and Sealer 26 did not interfere on the adhesive bond of fibreglass posts compared to control group that used only gutta-percha points (Cecchin *et al.* 2011). Menezes *et al.* (2008) also did not find significant difference between control group (unfilled) and groups filled with Sealer 26.

The action of drills used to remove the root filling material to create post space produces a new smear layer rich in endodontic sealer and gutta-percha remnants plasticized by the friction heat of the drill (Serafino *et al.* 2004, Demiryürek *et al.* 2010). Independently from the type of endodontic sealer, this smear layer can act as insulation against any kind of adhesive material intended to bond to intraradicular dentine (Dimitrouli *et al.* 2011). Moreover, in the present study, root canals were irrigated after post preparation only with 1% NaOCl that acts selectively on the removal of organic particles (Byströn & Sundqvist 1981, Spanó *et al.* 2009, Estrela *et al.* 2002) and cannot dissolve inorganic particles (Garberolio & Becce 1994, Cecchin *et al.* 2010). Therefore, it does not effectively remove the smear layer formed on root canal walls after post mechanical preparation (Nunes *et al.* 2008), what may reduce the penetration and chemical action of the self-adhesive resin cement (RelyX U100, 3M-ESPE).

The influence of canal depth was observed as the bond strength decreased from the cervical to apical third in all groups. The explanation for this result can be attributed to various factors such as the difficulty of visualization and access to the apical part of the root canal system (de Durâo Mauricio *et al.* 2007, Onay *et al.* 2010), the difficulty to eliminate the smear layer or remaining endodontic sealer/gutta-percha covering dentine walls in this third (Serafino *et al.* 2004), the less dense dentinal tubule configuration in the apical portion of the root canal system (Ferrari *et al.* 2000, Ferrari *et al.* 2001, Wang *et al.* 2008, da Cunha *et al.* 2010), the cavity configuration factor (Goracci *et al.* 2004, Tay *et al.* 2005) and restrictions in the flow of the resin cement to this part of the root canal (de Durâo Mauricio *et al.* 2007, da Cunha *et al.* 2010). All these factors compromise the interfacial continuity (Silva *et al.* 2011) and, consequently, the bond strength.

The predominance of adhesive cement-dentine failures in all groups observed in the present study (Table 4) may be attributed to the difficulty to eliminate the smear layer or remaining endodontic sealer/gutta-percha covering dentine walls (Serafino *et al.* 2004, Silva *et al.* 2011, Demiryürek *et al.* 2010) and to the reduced ability of dentine demineralization and hybridization of the self-adhesive cement RelyX U100 (De Munck *et al.* 2004, Al-Assaf *et al.* 2007, Monticelli *et al.* 2008, Bitter *et al.* 2009).

Limitations of the present study include the fact that the specimens were not submitted to thermal and mechanical cycling, in order to simulate intra-oral situations more precisely. Further studies need to be conducted to analyse the effects of the use of EDTA, after post space preparation, on the bond strength to intraradicular dentin at each third of the root canal.

Conclusions

Endodontic sealers, Sealapex, Sealer 26 and AH Plus, interfered negatively on bonding of fibreglass posts luted with self-adhesive resin cement to intraradicular dentine irrespective of root depth.

Acknowledgements

The authors are indebted to Federal University of Uberlândia (Integrated Laboratory for Dental Research/UFU, Brazil) and Prof. Dr. Marcelo Emilio Beletti (Laboratory of Image Analysis, Histological Techniques and Microscopy/UFU, Brazil) for technical support. This study was supported by grants from the CAPES, FAPEMIG and CNPq (CNPq grants # 306394/2011-1).

References

Al-Assaf K, Chakmakchi M, Palaghias G, Karanika-Kouma A, Eliades G (2007) Interfacial characteristics of adhesive luting resins and composites with dentine. *Dental Materials* **23**, 829-39.

Baldissara P, Zicari F, Valandro LF, Scotti R (2006) Effect of root canal treatments on quartz fiber posts bonding to root dentin. *Journal of Endodontics* **32**, 985-8.

Bitter K, Paris S, Pfuertner C, Neumann K, Kielbassa AM (2009) Morphological and bond strength evaluation of different resin cements to root dentin. *European Journal of Oral Sciences* **117**, 326-33.

Boone KJ, Murchison DF, Schindler WG, Walker WA 3rd (2001) Post retention: the effect of sequence of post-space preparation, cementation time, and different sealers. *Journal of Endodontics* **27**, 768-71.

Byströn A, Sundqvist G (1981) Bacteriologic evaluation of the efficacy of mechanical root canal instrumentation in endodontic therapy. *Scandinavian Journal of Dental Research* **89**, 321-8.

Castellan CS, Santos-Filho PC, Soares PV, Soares CJ, Cardoso PE (2010) Measuring bond strength between fiber post and root dentin: a comparison of different tests. *The Journal of Adhesive Dentistry* **12**, 477-85.

Cecchin D, Farina AP, Galafassi D, Barbizam JV, Corona SA, Carlini-Júnior B (2010) Influence of sodium hypochlorite and EDTA on the microtensile bond strength of a self-etching adhesive system. *Journal of Applied Oral Science* **18**, 385-9.

Cecchin D, Farina AP, Souza MA, Carlini-Júnior B, Ferraz CCR (2011) Effect of root canal sealers on bond strength of fibreglass posts cemented with self-adhesive resin cements. *International Endodontic Journal* **44**, 314–320.

da Cunha LF, Furuse AY, Mondelli RF, Mondelli J (2010) Compromised bond strength after root dentin deproteinization reversed with ascorbic acid. *Journal of Endodontics* **36**, 130-4.

de Durâo Mauricio PJ, González-López S, Aguilar-Mendoza JA, Félix S, González-Rodríguez MP (2007) Comparison of regional bond strength in root thirds among fiber-reinforced posts luted with different cements. *Journal of Biomedical Materials Research. Part B, Applied Biomaterials* **83**, 364-72.

De Munck J, Vargas M, Van Landuyt K, Hikita K, Lambrechts P, Van Meerbeek B (2004) Bonding of an auto-adhesive luting material to enamel and dentin. *Dental Materials* **20**, 963–71.

Demiryürek EO, Külünk S, Yüksel G, Saraç D, Bulucu B (2010) Effects of three canal sealers on bond strength of a fiber post. *Journal of Endodontics* **36**, 497-501.

Dimitrouli M, Günay H, Geurtsen W, Lührs AK (2011) Push-out strength of fiber posts depending on the type of root canal filling and resin cement. *Clinical Oral Investigation* **15**, 273-81.

Duarte MA, Ordinola-Zapata R, Bernardes RA, *et al.* (2010) Influence of calcium hydroxide association on the physical properties of AH Plus. *Journal of Endodontics* **36**, 1048-51.

Estrela C, Barbin EL, Spanó JCE, Marchesan S, Estrela CRA, Pécora JD (2002) Mechanism of Action of Sodium Hypochlorite. *Brazilian Dental Journal* **13**, 113-7.

Estrela C, Estrela CR, Decurcio DA, Hollanda AC, Silva JÁ (2007) Antimicrobial efficacy of ozonated water, gaseous ozone, sodium hypochlorite and chlorhexidine in infected human root canals. *International Endodontic Journal* **40**, 85-93.

Ferrari M, Mannocci F, Vichi A, Cagidiaco MC, Mjör IA (2000) Bonding to root canal: structural characteristics of the substrate. *American Journal of* Dentistry **13**, 255-60.

Ferrari M, Vichi A, Grandini S (2001) Efficacy of different adhesive techniques on bonding to root canal walls: an SEM investigation. *Dental Materials* **17**, 422-9.

Garberolio R, Becce C (1994) Smear layer removal by root canal irrigants. A comparative scanning electron microscopic study. *Oral Surgery, Oral Medicine, and Oral Pathology* **78**, 359-67.

Gomes BP, Pedroso JA, Jacinto RC, *et al.* (2004) In vitro evaluation of the antimicrobial activity of five root canal sealers. *Brazilian Dental Journal* **15**, 30-5.

Goracci C, Tavares AU, Fabianelli A, *et al.* (2004) The adhesion between fiber posts and root canal walls: comparison between microtensile and push-out bond strength measurements. *European Journal of Oral Sciences* **112**, 353-61.

Grecca FS, Rosa AR, Gomes MS, *et al.* (2009) Effect of timing and method of post space preparation on sealing ability of remaining root filling material: in vitro microbiological study. *Journal Canadian Dental Association* **75**:583.

Hagge MS, Wong RD, Lindemuth JS (2002) Effect of three root canal sealers on the retentive strength of endodontic posts luted with a resin cement. *International Endodontic Journal* **35**, 372-8.

Heling I, Chandler NP (1996) The antimicrobial effect within dentinal tubules of four root canal sealers. *Journal of Endodontics* **22**, 257–9.

Holland R, Souza Vde (1985) Ability of a new calcium hydroxide root canal filling material induce hard tissue formation. *Journal of Endodontics* **11**,535-43.

Kopper PM, Figueiredo JA, Della Bona A, Vanni JR, Bier CA, Bopp S (2003) Comparative in vivo analysis of the sealing ability of three endodontic sealers in post-prepared root canals. *International Endodontic Journal* **36**, 857-63.

Mamootil K, Messer HH (2007) Penetration of dentinal tubules by endodontic sealer cements in extracted teeth and in vivo. *International Endodontic Journal* **40**, 873–81.

Menezes MS, Queiroz EC, Campos RE, Martins LRM, Soares CJ (2008) Influence of endodontic sealer cement on fiberglass post bond strength to root dentine. *International Endodontic Journal* **41**, 476-84.

Monticelli F, Osorio R, Mazzitelli C, Ferrari M, Toledano M (2008) Limited decalcification/diffusion of self-adhesive cements into dentin. *Journal of Dental Research* **87**, 974-9.

Muniz L, Mathias P (2005) The influence of sodium hypochlorite and root canal sealers on post retention in different dentin regions. *Operative Dentistry* **30**, 533-9.

Nunes VH, Silva RG, Alfredo E, Sousa-Neto MD, Silva-Sousa YT (2008) Adhesion of Epiphany and AH Plus sealers to human root dentin treated with different solutions. *Brazilian Dental Journal* **19**, 46-50.

Onay EO, Korkmaz Y, Kiremitci A (2010) Effect of adhesive system type and root region on the push-out bond strength of glass-fibre posts to radicular dentine. *International Endodontic Journal* **43**, 259-68.

Saleh IM, Ruyter IE, Haapasalo M, Ørstavik D (2002) The effects of dentine pretreatment on the adhesion of root-canal sealers. *International Endodontic Journal* **35**, 859-66.

Schwartz RS (2006) Adhesive dentistry and endodontics. Part 2: bonding in the root canal system-the promise and the problems: a review. Journal *of Endodontics* **32**,1125-34.

Serafino C, Gallina G, Cumbo E, Ferrari M (2004) Surface debris of canal walls after post space preparation in endodontically treated teeth: a scanning electron microscopic study. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontics* **97**, 381-7.

Shokouhinejad N, Sabeti M, Gorjestani H, Saghiri MA, Lotfi M, Hoseini A (2011) Penetration of Epiphany, Epiphany self-etch, and AH Plus into dentinal tubules: a scanning electron microscopy study. *Journal of Endodontics* **37**, 1316-9.

Silva RA, Coutinho M, Cardozo PI, Silva LA, Zorzatto JR (2011) Conventional dual-cure versus self-adhesive resin cements in dentin bond integrity. *Journal of Applied Oral Science* **19**, 355-62.

Soares CJ, Pereira JC, Valdivia AD, Novais VR, Meneses MS (2012) Influence of resin cement and post configuration on bond strength to root dentine. *International Endodontic Journal* **45**, 136-45.

Soares CJ, Santana FR, Castro CG, *et al.* (2008) Finite element analysis and bond strength of a glass post to intraradicular dentin: comparison between microtensile and push-out tests. *Dental Materials* **24**, 1405-11.

Solano F, Hartwell G, Appelstein C (2005) Comparison of apical leakage between immediate versus delayed post space preparation using AH Plus sealer. *Journal of Endodontics* **31**, 752-4.

Sousa-Neto MD, Coelho FI, Marchesan MA, Alfredo E, Silva-Sousa YTC (2005) In vitro study of the adhesion of an epoxy based sealer to human dentine submitted to irradiation with Er:YAG and Nd:YAG lasers. *International Endodontic Journal* **38**, 866-70.

Spanó JC, Silva RG, Guedes DF, Sousa-Neto MD, Estrela C, Pécora JD (2009) Atomic absorption spectrometry and scanning electron microscopy evaluation of concentration of calcium ions and smear layer removal with root canal chelators. *Journal of Endodontics* **35**, 727-30.

Tay FR, Loushine RJ, Lambrechts P, Weller RN, Pashley DH (2005) Geometric factors affecting dentin bonding in root canals: a theoretical modeling approach. *Journal of Endodontics* **31**, 584–9.

Teixeira CS, Alfredo E, Thomé LH, Gariba-Silva R, Silva-Sousa YT, Sousa-Neto MD (2009) Adhesion of an endodontic sealer to dentin and gutta-percha: shear and push-out bond strength measurements and SEM analysis. *Journal of Applied Oral Science* **17**, 129-35.

Teixeira CS, Pasternak-Junior B, Borges AH, Paulino SM, Sousa-Neto MD (2008) Influence of endodontic sealers on the bond strength of carbon fiber posts. *Journal of biomedical materials research. Part B, Applied biomaterials* **84**, 430-5.

Wang VJ, Chen YM, Yip KH, Smales RJ, Meng QF, Chen L (2008) Effect of two fiber post types and two luting cement systems on regional post retention using the push-out test. *Dental Materials* **24**, 372-7.

Table 1 Bond strength means in MPa (standard deviation) of groups tested immediately (no aging) and statistical categories defined by Tukey's test and Dunnet test (n = 10).

Endodontic sealer	Root canal third		
	Cervical	Middle	Apical
Immediate control	13.5 (2.1)	11.4 (3.3)	9.3 (4.8)
Sealapex	10.3 (2.0)^{Aa}	7.4 (2.0)^{*Ba}	5.4 (1.3)^{*Ba}
Sealer 26	13.8 (6.6)^{Aa}	8.2 (4.2)^{*Ba}	3.6 (4.7)^{*Ca}
AH Plus	12.9 (2.5)^{Aa}	8.1 (2.6)^{*Ba}	4.8 (3.0)^{Ca}

Capital letters were used to compare groups in the horizontal lines and lower-case letters were used to compare groups in the vertical lines. Tukey categories with same letters are not statistically significant from each other ($P < 0.05$).
The (*) indicate significant difference compared with control group by Dunnet test ($P < 0.05$).

Table 2 Bond strength means in MPa (standard deviation) of groups tested after water artificial accelerated aging and statistical categories defined by Tukey's test and Dunnet test (n = 10).

Endodontic sealer	Root canal third		
	Cervical	Middle	Apical
Mediate control	25.1 (6.4)	22.6 (6.1)	21.6 (6.3)
Sealapex	10.9 (5.1)^{*Aa}	7.5 (1.5)^{*ABa}	5.5 (4.0)^{*Ba}
Sealer 26	14.0 (1.9)^{*Aa}	8.4 (5.0)^{*Ba}	3.5 (3.9)^{*Ca}
AH Plus	13.3 (3.4)^{*Aa}	9.2 (3.8)^{*Ba}	4.9 (4.0)^{*Ca}

Capital letters were used to compare groups in the horizontal lines and lower-case letters were used to compare groups in the vertical lines. Tukey categories with same letters are not statistically significant from each other ($P < 0.05$).
The (*) indicate significant difference with control group by Dunnet test ($P < 0.05$).

Table 3 Bond strength means in MPa (standard deviation) as a result of artificial accelerated aging and root canal third, and statistical categories defined by Tukey's test for each endodontic sealer (n = 10).

Endodontic sealer	Test moment	Root canal third		
		Cervical	Middle	Apical
Sealapex	Immediate	10.3 (2.0)^{Aa}	7.4 (2.0)^{ABa}	5.4 (1.3)^{Ba}
	Mediate	10.9 (5.1)^{Aa}	7.5 (1.5)^{ABa}	5.5 (4.0)^{Ba}
Sealer 26	Immediate	13.8 (6.6)^{Aa}	8.2 (4.2)^{Ba}	3.6 (4.7)^{Ca}
	Mediate	14.2 (1.9)^{Aa}	8.4 (5.0)^{Ba}	3.5 (3.9)^{Ca}
AH Plus	Immediate	12.9 (2.5)^{Aa}	8.08 (2.6)^{Ba}	4.8 (3.0)^{Ba}
	Mediate	13.3 (3.4)^{Aa}	9.12 (3.8)^{Ba}	4.9 (4.0)^{Ca}

In each sealer, capital letters were used to compare values in the horizontal lines and lower-case letters were used to compare values in the vertical lines. Tukey categories with same letters are not statistically significant from each other ($P < 0.05$).

Table 4 Failure modes (%) for experimental groups.

Groups	Adhesive: post and cement (I)	Adhesive: cement and dentine (II)	Cohesive: Cement (III)	Cohesive: Dentine (IV)	Cohesive: Post (V)	Mixed (VI)
SX immediate	2 (3.3)	35 (58.3)	3 (5.0)	1 (1.7)	1 (1.7)	18 (30.0)
S26 immediate	3 (5.0)	31 (51.7)	6 (10.0)	-	3 (5.0)	17 (28.3)
AH immediate	3 (5.0)	26 (43.3)	9 (15.0)	1 (1.7)	1 (1.7)	20 (33.3)
SX mediate	2 (3.3)	42 (70.0)	7 (11.7)	-	1 (1.7)	8 (13.3)
S26 mediate	-	33 (55.0)	2 (3.3)	-	4 (6.7)	21 (35.0)
AH mediate	1 (1.7)	44 (73.3)	3 (5.0)	1 (1.7)	-	11 (18.3)

SX, Sealapex; S26, Sealer 26; AH, AH Plus; Immediate, test with no aging; Mediate, test performed after 2 months of water storage at 37°C.

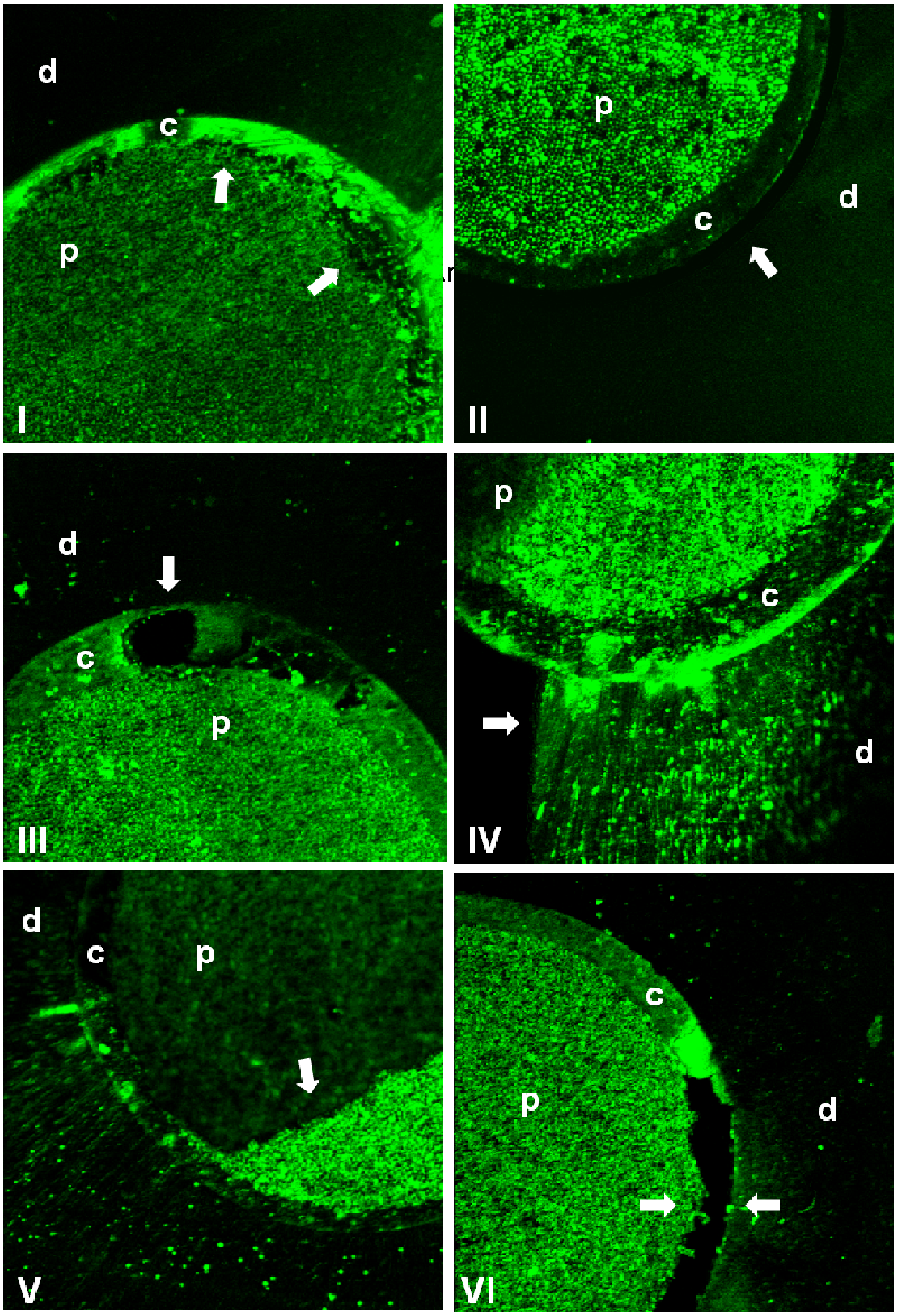

Figure 1. *d – dentine; c – resin cement; p – fibreglass post.* Microscopic images of failure modes after micropush-out test (magnification 10X): (I) adhesive between the post and resin cement; (II) adhesive between resin cement and intraradicular dentine; (III) cohesive in cement; (IV) cohesive in dentine; (V) cohesive in post; (VI) mixed among post, resin cement and intraradicular dentine.

9. Anexos

Anexo 1. Publicações no triênio 2010/2011/2012.

Artigos científicos publicados em periódicos internacionais, com corpo editorial:

1) Castro CG, Santana FR, Roscoe MG, Simamoto PC Jr, Santos-Filho PC, Soares CJ. Fracture resistance and mode of failure of various types of root filled teeth. Int Endod J. 2012 Mar 8.
2) Santana FR, Castro CG, Simamoto-Júnior PC, Soares PV, Quagliatto PS, Estrela C, Soares CJ. Influence of post system and remaining coronal tooth tissue on biomechanical behaviour of root filled molar teeth. Int Endod J. 2011 May;44(5):386-94.
3) Naves LZ, Santana FR, Castro CG, Valdivia AD, Da Mota AS, Estrela C, Correr-Sobrinho L, Soares CJ. Surface treatment of glass fiber and carbon fiber posts: SEM characterization. Microsc Res Tech. 2011 Dec;74(12):1088-92.
4) Soares CJ, Roscoe MG, Castro CG, Santana FR, Raposo LH, Quagliatto PS, Novais VR. Effect of gamma irradiation and restorative material on the biomechanical behaviour of root filled premolars. Int Endod J. 2011 Nov; 44(11):1047-54.
5) Soares CJ, Barbosa LM, Santana FR, Soares PB, Mota AS, Silva GR. Fracture strength of composite fixed partial denture using bovine teeth as a substitute for human teeth with or without fiber-reinforcement. Braz Dent J. 2010;21(3):235-40.

Artigos científicos enviados para publicação em periódicos nacionais e internacionais, com corpo editorial:

1) Renovato SR , Santana FR, Ferreira JM, Souza JB, Soares CJ, Estrela C. Influence of Calcium Hydroxide and Endodontic Irrigants on Fibreglass Post Bond Strength to Root Canal Dentine. International Endodontic Journal.
2) Ferreira JM, Santana FR, Renovato SR, Soares CJ, Estrela C. Effect of internal bleaching agents on fibreglass post bond strength to root dentin. International Endodontic Journal.
3) Soares CJ, Valdivia ADCM, Silva GR, Santana FR, Menezes MS. Longitudinal clinical evaluation of post systems: A literature review. Brazilian Dental Journal.
4) Fabiana Ribeiro Santana, Fernanda Ribeiro Santana, Giselle Vieira dos Anjos, Thiago Vieira Campos, Patrícia Carla Teixeira Lima, Mayara Maia Lopes, Rafaela Pereira de Lima, Normalene Sena de Oliveira, Claci Fátima Weirich, Cinira Magali Fortuna. Ações de saúde na estratégia saúde da família à luz da integralidade: município goiano. Revista Eletrônica de Enfermagem.

Trabalhos concluídos em fase de elaboração de artigo científico para publicação em periódico internacional, com corpo editorial:

1) Santana FR, Castro CG, Naves LZ, Valdivia ADCM, Mota AS, Estrela C, Soares CJ. Push-out Bond strength between glass fibre and carbon fibre posts with composite resin core: effect of post surface treatments. Operative Dentistry.
2) Guimarães RM, Santana FR, Silveira RE, Moreira FCL, Estrela C, Torres EM, Fonseca RB, Lopes LG, Souza JB. Influence of surface treatment on bond strength of repair resin-based silorane: analysis after aging. Operative Dentistry.
3) Silveira RE, Santana FR, Guimarães RM, Moreira FCL, Estrela C, Torres EM, Fonseca RB, Lopes LG, Souza JB. Influence of surface treatment on bond strength of repair resin-based silorane: immediate analysis. Operative Dentistry.

Anexo 2. Normas de publicação do periódico

INTERNATIONAL ENDODONTIC JOURNAL

Edited By: PMH Dummer

Impact Factor: 2.383

ISI Journal Citation Reports © Ranking: 2010: 11/74 (Dentistry Oral Surgery & Medicine)

Online ISSN: 1365-2591

Author Guidelines

Content of Author Guidelines: 1. General, 2. Ethical Guidelines, 3. Manuscript Submission Procedure, 4. Manuscript Types Accepted, 5. Manuscript Format and Structure, 6. After Acceptance

Relevant Documents: Copyright Form

Useful Websites: Submission Site, Articles published in *International Endodontic Journal*, Author Services, Wiley-Blackwell's Ethical Guidelines, Guidelines for Figures

The journal to which you are submitting your manuscript employs a plagiarism detection system. By submitting your manuscript to this journal you accept that your manuscript may be screened for plagiarism against previously published works.

1. GENERAL

International Endodontic Journal publishes original scientific articles, reviews, clinical articles and case reports in the field of Endodontology; the branch of dental sciences dealing with health, injuries to and diseases of the pulp and periradicular region, and their relationship with systemic well-being and health. Original scientific articles are published in the areas of biomedical science, applied materials science, bioengineering, epidemiology and social science relevant to endodontic disease and its management, and to the restoration of root-treated teeth. In addition, review articles, reports of clinical cases, book reviews, summaries and abstracts of scientific meetings and news items are accepted.

Please read the instructions below carefully for details on the submission of manuscripts, the journal's requirements and standards as well as information concerning the procedure after a manuscript has been accepted for publication in *International Endodontic Journal*. Authors are encouraged to visit Wiley-Blackwell Author Services for further information on the preparation and submission of articles and figures.

2. ETHICAL GUIDELINES

International Endodontic Journal adheres to the below ethical guidelines for publication and research.

2.1. Authorship and Acknowledgements

Authors submitting a paper do so on the understanding that the manuscript has been read and approved by all authors and that all authors agree to the submission of the manuscript to the Journal.

International Endodontic Journal adheres to the definition of authorship set up by The International Committee of Medical Journal Editors (ICMJE). According to the ICMJE, authorship criteria should be based on 1) substantial contributions to conception and design of, or acquisiation of data or analysis and interpretation of data, 2) drafting the article or revising it critically for important intellectual content and 3) final approval of the version to be published. Authors should meet conditions 1, 2 and 3.

It is a requirement that all authors have been accredited as appropriate upon submission of the manuscript. Contributors who do not qualify as authors should be mentioned under Acknowledgements. **Acknowledgements**: Under acknowledgements please specify contributors to the article other than the authors accredited. Please also include specifications of the source of funding for the study and any potential conflict of interests if appropriate.

2.2. Ethical Approvals

Experimentation involving human subjects will only be published if such research has been conducted in full accordance with ethical principles, including the World Medical Association Declaration of Helsinki (version 2008) and the additional requirements, if any, of the country where the research has been carried out. Manuscripts must be accompanied by a statement that the experiments were undertaken with the understanding and written consent of each subject and according to the above mentioned principles. A statement regarding the fact that the study has been independently reviewed and approved by an ethical board should also be included. Editors reserve the right to reject papers if there are doubts as to whether appropriate procedures have been used.

When experimental animals are used the methods section must clearly indicate that adequate measures were taken to minimize pain or discomfort. Experiments should be carried out in accordance with the Guidelines laid down by the National Institute of Health (NIH) in the USA regarding the care and use of animals for experimental procedures or with the European Communities Council Directive of 24 November 1986 (86/609/EEC) and in accordance with local laws and regulations.

All studies using human or animal subjects should include an explicit statement in the Material and Methods section identifying the review and ethics committee approval for each study, if applicable. Editors reserve the right to reject papers if there is doubt as to whether appropriate procedures have been used.

2.3 Clinical Trials

Clinical trials should be reported using the CONSORT guidelines available at www.consort-statement.org. A CONSORT checklist should also be included in the submission material.

The International Endodontic Journal encourages authors submitting manuscripts reporting from a clinical trial to register the trials in any of the following free, public clinical trials registries: www.clinicaltrials.gov, http://clinicaltrials.ifpma.org/clinicaltrials/, http://isrctn.org/. The clinical trial registration number and name of the trial register will then be published with the paper.

2.4 DNA Sequences and Crystallographic Structure Determinations

Papers reporting protein or DNA sequences and crystallographic structure determinations will not be accepted without a Genbank or Brookhaven accession number, respectively. Other supporting data sets must be made available on the publication date from the authors directly.

2.5 Conflict of Interest and Source of Funding

International Endodontic Journal requires that all sources of institutional, private and corporate financial support for the work within the manuscript must be fully acknowledged, and any potential conflicts of interest noted. Grant or contribution numbers may be acknowledged, and principal grant holders should be listed. Please include the information under Acknowledgements.

2.6 Appeal of Decision

The decision on a paper is final and cannot be appealed.

2.7 Permissions

If all or parts of previously published illustrations are used, permission must be obtained from the copyright holder concerned. It is the author's responsibility to obtain these in writing and provide copies to the Publishers.

2.8 Copyright Assignment

Authors submitting a paper do so on the understanding that the work and its essential substance have not been published before and is not being considered for publication elsewhere. The submission of the manuscript by the authors means that the authors automatically agree to assign exclusive copyright to Wiley-Wiley-Blackwell if and when the manuscript is accepted for publication. The work shall not be published elsewhere in any language without the written consent of the publisher. The articles published in this journal are protected by copyright, which covers translation rights and the exclusive right to reproduce and distribute all of the articles printed in the journal. No material published in the journal may be stored on microfilm or videocassettes or in electronic database and the like or reproduced photographically without the prior written permission of the publisher.

A completed Copyright Transfer Agreement Form (CTA), found at interscience.wiley.com/journal/iej must be received by the Editorial Office before any manuscript can be published.

Correspondence to the journal is accepted on the understanding that the contributing author licences the publisher to publish the letter as part of the journal or separately from it, in the exercise of any subsidiary rights relating to the journal and its contents.

For questions concerning copyright, please visit Wiley-Blackwell's Copyright FAQ

2.9 OnlineOpen
OnlineOpen is available to authors of primary research articles who wish to make their article available to non-subscribers on publication, or whose funding agency requires grantees to archive the final version of their article. With OnlineOpen, the author, the author's funding agency, or the author's institution pays a fee to ensure that the article is made available to non-subscribers upon publication via Wiley Online Library, as well as deposited in the funding agency's preferred archive. For the full list of terms and conditions, see http://wileyonlinelibrary.com/onlineopen#OnlineOpen_Terms

Any authors wishing to send their paper OnlineOpen will be required to complete the payment form available from our website at: https://authorservices.wiley.com/bauthor/onlineopen_order.asp

Prior to acceptance there is no requirement to inform an Editorial Office that you intend to publish your paper OnlineOpen if you do not wish to. All OnlineOpen articles are treated in the same way as any other article. They go through the journal's standard peer-review process and will be accepted or rejected based on their own merit.

3. MANUSCRIPT SUBMISSION PROCEDURE
Manuscripts should be submitted electronically via the online submission site http://mc.manuscriptcentral.com/iej. The use of an online submission and peer review site enables immediate distribution of manuscripts and consequentially speeds up the review process. It also allows authors to track the status of their own manuscripts. Complete instructions for submitting a paper is available o3nline and below. Further assistance can be obtained from iejeditor@cardiff.ac.uk.

3.1. Getting Started
• Launch your web browser (supported browsers include Internet Explorer 5.5 or higher, Safari 1.2.4, or Firefox 1.0.4 or higher) and go to the journal's online Submission Site: http://mc.manuscriptcentral.com/iej
• Log-in, or if you are a new user, click on 'register here'.
• If you are registering as a new user.
- After clicking on 'register here', enter your name and e-mail information and click 'Next'. Your e-mail information is very important.
- Enter your institution and address information as appropriate, and then click 'Next.'
- Enter a user ID and password of your choice (we recommend using your e-mail address as your user ID), and then select your areas of expertise. Click 'Finish'.
• If you are registered, but have forgotten your log in details, please enter your e-mail address under 'Password Help'. The system will send you an automatic user ID and a new temporary password.
• Log-in and select 'Author Centre '

3.2. Submitting Your Manuscript
• After you have logged into your 'Author Centre', submit your manuscript by clicking on the submission link under 'Author Resources'.
• Enter data and answer questions as appropriate. You may copy and paste directly from your manuscript and you may upload your pre-prepared covering letter.
• Click the 'Next' button on each screen to save your work and advance to the next screen.
• You are required to upload your files.
- Click on the 'Browse' button and locate the file on your computer.
- Select the designation of each file in the drop down next to the Browse button.

- When you have selected all files you wish to upload, click the 'Upload Files' button.
• Review your submission (in HTML and PDF format) before completing your submission by sending it to the Journal. Click the 'Submit' button when you are finished reviewing.

3.3. Manuscript Files Accepted
Manuscripts should be uploaded as Word (.doc) or Rich Text Format (.rft) files (not write-protected) plus separate figure files. GIF, JPEG, PICT or Bitmap files are acceptable for submission, but only high-resolution TIF or EPS files are suitable for printing. The files will be automatically converted to HTML and PDF on upload and will be used for the review process. The text file must contain the abstract, main text, references, tables, and figure legends, but no embedded figures or Title page. The Title page should be uploaded as a separate file. In the main text, please reference figures as for instance 'Figure 1', 'Figure 2' etc to match the tag name you choose for the individual figure files uploaded. Manuscripts should be formatted as described in the Author Guidelines below. Please note that any manuscripts uploaded as Word 2007 (.docx) will be automatically rejected. Please save any .docx file as .doc before uploading.

3.4. Blinded Review
Manuscript that do not conform to the general aims and scope of the journal will be returned immediately without review. All other manuscripts will be reviewed by experts in the field (generally two referees). International Endodontic Journal aims to forward referees´ comments and to inform the corresponding author of the result of the review process. Manuscripts will be considered for fast-track publication under special circumstances after consultation with the Editor.
International Endodontic Journal uses double blinded review. The names of the reviewers will thus not be disclosed to the author submitting a paper and the name(s) of the author(s) will not be disclosed to the reviewers.

To allow double blinded review, please submit (upload) your main manuscript and title page as separate files.

Please upload:
• Your manuscript without title page under the file designation 'main document'
• Figure files under the file designation 'figures'
• The title page and Acknowledgements where applicable, should be uploaded under the file designation 'title page'

All documents uploaded under the file designation 'title page' will not be viewable in the html and pdf format you are asked to review in the end of the submission process. The files viewable in the html and pdf format are the files available to the reviewer in the review process.

3.5. Suspension of Submission Mid-way in the Submission Process
You may suspend a submission at any phase before clicking the 'Submit' button and save it to submit later. The manuscript can then be located under 'Unsubmitted Manuscripts' and you can click on 'Continue Submission' to continue your submission when you choose to.

3.6. E-mail Confirmation of Submission
After submission you will receive an e-mail to confirm receipt of your manuscript. If you do not receive the confirmation e-mail after 24 hours, please check your e-mail address carefully in the system. If the e-mail address is correct please contact your IT department. The error may be caused by some sort of spam filtering on your e-mail server. Also, the e-mails should be received if the IT department adds our e-mail server (uranus.scholarone.com) to their whitelist.

3.7. Manuscript Status
You can access ScholarOne Manuscripts any time to check your 'Author Centre' for the status of your manuscript. The Journal will inform you by e-mail once a decision has been made.

3.8. Submission of Revised Manuscripts
To submit a revised manuscript, locate your manuscript under 'Manuscripts with Decisions' and click on 'Submit a Revision'. Please remember to delete any old files uploaded when you upload your revised manuscript.

4. MANUSCRIPT TYPES ACCEPTED

Original Scientific Articles: must describe significant and original experimental observations and provide sufficient detail so that the observations can be critically evaluated and, if necessary, repeated. Original Scientific Articles must conform to the highest international standards in the field.

Review Articles: are accepted for their broad general interest; all are refereed by experts in the field who are asked to comment on issues such as timeliness, general interest and balanced treatment of controversies, as well as on scientific accuracy. Reviews should generally include a clearly defined search strategy and take a broad view of the field rather than merely summarizing the authors´ own previous work. Extensive or unbalanced citation of the authors´ own publications is discouraged.

Mini Review Articles: are accepted to address current evidence on well-defined clinical, research or methodological topics. All are refereed by experts in the field who are asked to comment on timeliness, general interest, balanced treatment of controversies, and scientific rigor. A clear research question, search strategy and balanced synthesis of the evidence is expected. Manuscripts are limited in terms of word-length and number of figures.

Clinical Articles: are suited to describe significant improvements in clinical practice such as the report of a novel technique, a breakthrough in technology or practical approaches to recognised clinical challenges. They should conform to the highest scientific and clinical practice standards.

Case Reports: illustrating unusual and clinically relevant observations are acceptable but they must be of sufficiently high quality to be considered worthy of publication in the Journal. On rare occasions, completed cases displaying non-obvious solutions to significant clinical challenges will be considered. Illustrative material must be of the highest quality and healing outcomes, if appropriate, should be demonstrated.

Supporting Information: *International Endodontic Journal* encourages submission of adjuncts to printed papers via the supporting information website (see submission of supporting information below). It is encouraged that authors wishing to describe novel procedures or illustrate cases more fully with figures and/or video may wish to utilise this facility.

Letters to the Editor: are also acceptable.

Meeting Reports: are also acceptable.

5. MANUSCRIPT FORMAT AND STRUCTURE

5.1. Format

Language: The language of publication is English. It is preferred that manuscript is professionally edited. A list of independent suppliers of editing services can be found at http://authorservices.wiley.com/bauthor/english_language.asp. All services are paid for and arranged by the author, and use of one of these services does not guarantee acceptance or preference for publication.

Presentation: Authors should pay special attention to the presentation of their research findings or clinical reports so that they may be communicated clearly. Technical jargon should be avoided as much as possible and clearly explained where its use is unavoidable. Abbreviations should also be kept to a minimum, particularly those that are not standard. The background and hypotheses underlying the study, as well as its main conclusions, should be clearly explained. Titles and abstracts especially should be written in language that will be readily intelligible to any scientist.

Abbreviations: International Endodontic Journal adheres to the conventions outlined in Units, Symbols and Abbreviations: A Guide for Medical and Scientific Editors and Authors. When non-standard terms appearing 3 or more times in the manuscript are to be abbreviated, they should be written out completely in the text when first used with the abbreviation in parenthesis.

5.2. Structure

All manuscripts submitted to *International Endodontic Journal* should include Title Page, Abstract, Main Text, References and Acknowledgements, Tables, Figures and Figure Legends as appropriate

Title Page: The title page should bear: (i) Title, which should be concise as well as descriptive; (ii) Initial(s) and last (family) name of each author; (iii) Name and address of department, hospital or institution to which work should be attributed; (iv) Running title (no more than 30 letters and spaces); (v) No more than six keywords (in alphabetical order); (vi) Name, full postal address, telephone, fax number and e-mail address of author responsible for correspondence.

Abstract for Original Scientific Articles should be no more than 250 words giving details of what was done using the following structure:
• **Aim**: Give a clear statement of the main aim of the study and the main hypothesis tested, if any.
• **Methodology**: Describe the methods adopted including, as appropriate, the design of the study, the setting, entry requirements for subjects, use of materials, outcome measures and statistical tests.
• **Results**: Give the main results of the study, including the outcome of any statistical analysis.
• **Conclusions**: State the primary conclusions of the study and their implications. Suggest areas for further research, if appropriate.

Abstract for Review Articles should be non-structured of no more than 250 words giving details of what was done including the literature search strategy.

Abstract for Mini Review Articles should be non-structured of no more than 250 words, including a clear research question, details of the literature search strategy and clear conclusions.

Abstract for Case Reports should be no more than 250 words using the following structure:
• **Aim**: Give a clear statement of the main aim of the report and the clinical problem which is addressed.
• **Summary**: Describe the methods adopted including, as appropriate, the design of the study, the setting, entry requirements for subjects, use of materials, outcome measures and analysis if any.
• **Key learning points**: Provide up to 5 short, bullet-pointed statements to highlight the key messages of the report. All points must be fully justified by material presented in the report.

Abstract for Clinical Articles should be no more than 250 words using the following structure:
• **Aim:** Give a clear statement of the main aim of the report and the clinical problem which is addressed.
• **Methodology:** Describe the methods adopted.
• **Results:** Give the main results of the study.
• **Conclusions:** State the primary conclusions of the study.

Main Text of Original Scientific Article should include Introduction, Materials and Methods, Results, Discussion and Conclusion

Introduction: should be focused, outlining the historical or logical origins of the study and gaps in knowledge. Exhaustive literature reviews are not appropriate. It should close with the explicit statement of the specific aims of the investigation, or hypothesis to be tested.

Material and Methods: must contain sufficient detail such that, in combination with the references cited, all clinical trials and experiments reported can be fully reproduced.

(i) Clinical Trials should be reported using the CONSORT guidelines available at www.consort-statement.org. A CONSORT checklist should also be included in the submission material.

(ii) Experimental Subjects: experimentation involving human subjects will only be published if such research has been conducted in full accordance with ethical principles, including the World Medical Association Declaration of Helsinki (version 2008) and the additional requirements, if any, of the country where the research has been carried out. Manuscripts must be accompanied by a statement that the experiments were undertaken with the understanding and written consent of each subject and according to the above mentioned principles. A statement regarding the fact that the study has been independently reviewed and approved by an ethical board should also be included. Editors reserve the right to reject papers if there are doubts as to whether appropriate procedures have been used.

When experimental animals are used the methods section must clearly indicate that adequate measures were taken to minimize pain or discomfort. Experiments should be carried out in accordance with the Guidelines laid down by the National Institute of Health (NIH) in the USA regarding the care and use of animals for experimental procedures or with the European Communities Council Directive of 24 November 1986 (86/609/EEC) and in accordance with local laws and regulations.

All studies using human or animal subjects should include an explicit statement in the Material and Methods section identifying the review and ethics committee approval for each study, if applicable. Editors reserve the right to reject papers if there is doubt as to whether appropriate procedures have been used.

(iii) Suppliers: Suppliers of materials should be named and their location (Company, town/city, state, country) included.

Results: should present the observations with minimal reference to earlier literature or to possible interpretations. Data should not be duplicated in Tables and Figures.

Discussion: may usefully start with a brief summary of the major findings, but repetition of parts of the abstract or of the results section should be avoided. The Discussion section should progress with a review of the methodology before discussing the results in light of previous work in the field. The Discussion should end with a brief conclusion and a comment on the potential clinical relevance of the findings. Statements and interpretation of the data should be appropriately supported by original references.

Conclusion: should contain a summary of the findings.

Main Text of Review Articles should be divided into Introduction, Review and Conclusions. The Introduction section should be focused to place the subject matter in context and to justify the need for the review. The Review section should be divided into logical sub-sections in order to improve readability and enhance understanding. Search strategies must be described and the use of state-of-the-art evidence-based systematic approaches is expected. The use of tabulated and illustrative material is encouraged. The Conclusion section should reach clear conclusions and/or recommendations on the basis of the evidence presented.

Main Text of Mini Review Articles should be divided into Introduction, Review and Conclusions. The Introduction section should briefly introduce the subject matter and justify the need and timeliness of the literature review. The Review section should be divided into logical sub-sections to enhance readability and understanding and may be supported by up to 5 tables and figures. Search strategies must be described and the use of state-of-the-art evidence-based systematic approaches is expected. The Conclusions section should present clear statements/recommendations and suggestions for further work. The manuscript, including references and figure legends should not normally exceed 4000 words.

Main Text of Clinical Reports and Clinical Articles should be divided into Introduction, Report, Discussion and Conclusion,. They should be well illustrated with clinical images, radiographs, diagrams and, where appropriate, supporting tables and graphs. However, all illustrations must be of the highest quality

Acknowledgements: *International Endodontic Journal* requires that all sources of institutional, private and corporate financial support for the work within the manuscript must be fully acknowledged, and any potential conflicts of interest noted. Grant or contribution numbers may be acknowledged, and principal grant holders should be listed. Acknowledgments should be brief and should not include thanks to anonymous referees and editors. See also above under Ethical Guidelines.

5.3. References

It is the policy of the Journal to encourage reference to the original papers rather than to literature reviews. Authors should therefore keep citations of reviews to the absolute minimum.

We recommend the use of a tool such as EndNote or Reference Manager for reference management and formatting. EndNote reference styles can be searched for here: www.endnote.com/support/enstyles.asp. Reference Manager reference styles can be searched for here: www.refman.com/support/rmstyles.asp

In the text: single or double authors should be acknowledged together with the year of publication, e.g. (Pitt Ford & Roberts 1990). If more than two authors the first author followed by *et al.* is sufficient, e.g. (Tobias *et al.* 1991).

Reference list: All references should be brought together at the end of the paper in alphabetical order and should be in the following form.

(i) Names and initials of up to six authors. When there are seven or more, list the first three and add *et al.*
(ii)Year of publication in parentheses
(iii) Full title of paper followed by a full stop (.)
(iv) Title of journal in full (in italics)
(v) Volume number (bold) followed by a comma (,)
(vi) First and last pages

Examples of correct forms of reference follow:

Standard journal article
Bergenholtz G, Nagaoka S, Jontell M (1991) Class II antigen-expressing cells in experimentally induced pulpitis. *International Endodontic Journal* **24**, 8-14.
Corporate author
British Endodontic Society (1983) Guidelines for root canal treatment. *International Endodontic Journal* **16**, 192-5.
Journal supplement
Frumin AM, Nussbaum J, Esposito M (1979) Functional asplenia: demonstration of splenic activity by bone marrow scan (Abstract). *Blood* **54** (Suppl. 1), 26a.
Books and other monographs
Personal author(s)
Gutmann J, Harrison JW (1991) *Surgical Endodontics*, 1st edn Boston, MA, USA: Blackwell Scientific Publications.
Chapter in a book
Wesselink P (1990) Conventional root-canal therapy III: root filling. In: Harty FJ, ed. *Endodontics in Clinical Practice*, 3rd edn; pp. 186-223. London, UK: Butterworth.
Published proceedings paper
DuPont B (1974) Bone marrow transplantation in severe combined immunodeficiency with an unrelated MLC compatible donor. In: White HJ, Smith R, eds. Proceedings of the Third Annual Meeting of the International Society for Experimental Rematology; pp. 44-46. Houston, TX, USA: International Society for Experimental Hematology.
Agency publication
Ranofsky AL (1978) Surgical Operations in Short-Stay Hospitals: United States-1975. DHEW publication no. (PHS) 78-1785 (Vital and Health Statistics; Series 13; no. 34.) Hyattsville, MD, USA: National Centre for Health Statistics.8
Dissertation or thesis
Saunders EM (1988) In vitro and in vivo investigations into root-canal obturation using thermally softened gutta-percha techniques (PhD Thesis). Dundee, UK: University of Dundee.
URLs
Full reference details must be given along with the URL, i.e. authorship, year, title of document/report and URL. If this information is not available, the reference should be removed and only the web address cited in the text.
Smith A (1999) Select committee report into social care in the community [WWW document]. URL http://www.dhss.gov.uk/reports/report015285.html
[accessed on 7 November 2003]

5.4. Tables, Figures and Figure Legends

Tables: Tables should be double-spaced with no vertical rulings, with a single bold ruling beneath the column titles. Units of measurements must be included in the column title.

Figures: All figures should be planned to fit within either 1 column width (8.0 cm), 1.5 column widths (13.0 cm) or 2 column widths (17.0 cm), and must be suitable for photocopy reproduction from the printed version of the manuscript. Lettering on figures should be in a clear, sans serif typeface (e.g. Helvetica); if possible, the same typeface should be used for all figures in a paper. After reduction for publication, upper-case text and numbers should be at least 1.5-2.0 mm high (10 point Helvetica). After reduction, symbols should be at least 2.0-3.0 mm high (10 point). All half-tone photographs should be submitted at final reproduction size. In general, multi-part figures should be arranged as they would appear in the final version. Reduction to the scale that will be used on the page is not necessary, but any special requirements (such as the separation distance of stereo pairs) should be clearly specified.

Unnecessary figures and parts (panels) of figures should be avoided: data presented in small tables or histograms, for instance, can generally be stated briefly in the text instead. Figures should not contain more than one panel unless the parts are logically connected; each panel of a multipart figure should be sized so that the whole figure can be reduced by the same amount and reproduced on the printed page at the smallest size at which essential details are visible.
Figures should be on a white background, and should avoid excessive boxing, unnecessary colour, shading and/or decorative effects (e.g. 3-dimensional skyscraper histograms) and highly pixelated computer drawings. The vertical axis of histograms should not be truncated to exaggerate small differences. The line spacing should be wide enough to remain clear on reduction to the minimum acceptable printed size.
Figures divided into parts should be labelled with a lower-case, boldface, roman letter, a, b, and so on, in the same typesize as used elsewhere in the figure. Lettering in figures should be in lower-case type, with the first letter capitalized. Units should have a single space between the number and the unit, and follow SI nomenclature or the nomenclature common to a particular field. Thousands should be separated by a thin space (1 000). Unusual units or abbreviations should be spelled out in full or defined in the legend. Scale bars should be used rather than magnification factors, with the length of the bar defined in the legend rather than on the bar itself. In general, visual cues (on the figures themselves) are preferred to verbal explanations in the legend (e.g. broken line, open red triangles etc.)

Figure legends: Figure legends should begin with a brief title for the whole figure and continue with a short description of each panel and the symbols used; they should not contain any details of methods.

Permissions: If all or part of previously published illustrations are to be used, permission must be obtained from the copyright holder concerned. This is the responsibilty of the authors before submission.

Preparation of Electronic Figures for Publication: Although low quality images are adequate for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit EPS (lineart) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented programmes. Scans (TIFF only) should have a resolution of 300 dpi (halftone) or 600 to 1200 dpi (line drawings) in relation to the reproduction size (see below). EPS files should be saved with fonts embedded (and with a TIFF preview if possible). For scanned images, the scanning resolution (at final image size) should be as follows to ensure good reproduction: lineart: >600 dpi; half-tones (including gel photographs): >300 dpi; figures containing both halftone and line images: >600 dpi.

Further information can be obtained at Wiley-Blackwell's guidelines for figures: http:/authorservices.wiley.com/bauthor/illustration.asp.

Check your electronic artwork before submitting it: http://authorservices.wiley.com/bauthor/eachecklist.asp.

5.5. Supporting Information

Publication in electronic formats has created opportunities for adding details or whole sections in the electronic version only. Authors need to work closely with the editors in developing or using such new publication formats.
Supporting information, such as data sets or additional figures or tables, that will not be published in the print edition of the journal, but which will be viewable via the online edition, can be submitted. It should be clearly stated at the time of submission that the supporting information is intended to be made available through the online edition. If the size or format of the supporting information is such that it cannot be accommodated on the journal's website, the author agrees to make the supporting information available free of charge on a permanent Web site, to which links will be set up from the journal's website. The author must advise Wiley-Blackwell if the URL of the website where the supporting information is located changes. The content of the supporting information must not be altered after the paper has been accepted for publication.

The availability of supporting information should be indicated in the main manuscript by a paragraph, to appear after the References, headed 'Supporting Information' and providing titles of figures, tables, etc. In order to protect reviewer anonymity, material posted on the authors Web site cannot be reviewed. The supporting information is an integral part of the article and will be reviewed accordingly.

Preparation of Supporting Information: Although provision of content through the web in any format is straightforward, supporting information is best provided either in web-ready form or in a form that can be conveniently converted into one of the standard web publishing formats:

• Simple word-processing files (.doc or .rtf) for text.
• PDF for more complex, layout-dependent text or page-based material. Acrobat files can be distilled from Postscript by the Publisher, if necessary.
• GIF or JPEG for still graphics. Graphics supplied as EPS or TIFF are also acceptable.
• MPEG or AVI for moving graphics.

Subsequent requests for changes are generally unacceptable, as for printed papers. A charge may be levied for this service.

Video Imaging: For the on-line version of the Journal the submission of illustrative video is encouraged. Authors proposing the use such media should consult with the Editor during manuscript preparation.

6. AFTER ACCEPTANCE
Upon acceptance of a paper for publication, the manuscript will be forwarded to the Production Editor who is responsible for the production of the journal.

6.1. Figures
Hard copies of all figures and tables are required when the manuscript is ready for publication. These will be requested by the Editor when required. Each Figure copy should be marked on the reverse with the figure number and the corresponding author’s name.

6.2 Proof Corrections
The corresponding author will receive an email alert containing a link to a web site. A working email address must therefore be provided for the corresponding author. The proof can be downloaded as a PDF (portable document format) file from this site. Acrobat Reader will be required in order to read this file. This software can be downloaded (free of charge) from the following Web site: www.adobe.com/products/acrobat/readstep2.html. This will enable the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof. Hard copy proofs will be posted if no e-mail address is available; in your absence, please arrange for a colleague to access your e-mail to retrieve the proofs. Proofs must be returned to the Production Editor within three days of receipt. As changes to proofs are costly, we ask that you only correct typesetting errors. Excessive changes made by the author in the proofs, excluding typesetting errors, will be charged separately. Other than in exceptional circumstances, all illustrations are retained by the publisher. Please note that the author is responsible for all statements made in his work, including changes made by the copy editor.

6.3 Early Online Publication Prior to Print
International Endodontic Journal is covered by Wiley-Blackwell's Early View service. Early View articles are complete full-text articles published online in advance of their publication in a printed issue. Early View articles are complete and final. They have been fully reviewed, revised and edited for publication, and the authors' final corrections have been incorporated. Because they are in final form, no changes can be made after online publication. The nature of Early View articles means that they do not yet have volume, issue or page numbers, so Early View articles cannot be cited in the traditional way. They are therefore given a Digital Object Identifier (DOI), which allows the article to be cited and tracked before it is allocated to an issue. After print publication, the DOI remains valid and can continue to be used to cite and access the article.

6.4 Online Production Tracking
Online production tracking is available for your article through Blackwell's Author Services. Author Services enables authors to track their article - once it has been accepted - through the production process to publication online and in print. Authors can check the status of their articles online and choose to receive automated e-mails at key stages of production. The author will receive an e-mail with a unique link that enables them to register and have their article automatically added to the system. Please ensure that a complete e-mail address is provided when submitting the manuscript. Visit http://authorservices.wiley.com/bauthor/ for more details on online production tracking and for a wealth of resources including FAQs and tips on article preparation, submission and more.

6.5 Author Material Archive Policy
Please note that unless specifically requested, Wiley-Blackwell will dispose of all hardcopy or electronic material submitted two months after publication. If you require the return of any material submitted, please inform the editorial office or production editor as soon as possible.

6.6 Offprints
Free access to the final PDF offprint of your article will be available via Author Services only. Please therefore sign up for Author Services if you would like to access your article PDF offprint and enjoy the many other benefits the service offers.
Additional paper offprints may be ordered online. Please click on the following link, fill in the necessary details and ensure that you type information in all of the required fields: Offprint Cosprinters. If you have queries about offprints please email offprint@cosprinters.com
The corresponding author will be sent complimentary copies of the issue in which the paper is published (one copy per author).

6.7 Author Services
For more substantial information on the services provided for authors, please see Wiley-Blackwell Author Services

6.8 Note to NIH Grantees: Pursuant to NIH mandate, Wiley-Blackwell will post the accepted version of contributions authored by NIH grant-holders to PubMed Central upon acceptance. This accepted version will be made publicly available 12 months after publication. For further information, see www.wiley.com/go/nihmandate

7 Guidelines for reporting of DNA microarray data
The *International Endodontic Journal* gives authors notice that, with effect from 1st January 2011, submission to the *International Endodontic Journal* requires the reporting of microarray data to conform to the MIAME guidelines. After this date, submissions will be assessed according to MIAME standards. The complete current guidelines are available at http://www.mged.org/Workgroups/MIAME/miame_2.0.html. Also, manuscripts will be published only after the complete data has been submitted into the public repositories, such as GEO (http://www.ncbi.nlm.nih.gov/geo/) or ArrayExpress (http://www.ebi.ac.uk/microarray/submissions_overview.html), in MIAME compliant format, with the data accession number (the identification number of the data set in the database) quoted in the manuscript. Both databases are committed to keeping the data private until the associated manuscript is published, if requested.

Prospective authors are also encouraged to search for previously published microarray data with relevance to their own data, and to report whether such data exists. Furthermore, they are encouraged to use the previously published data for qualitative and/or quantitative comparison with their own data, whenever suitable. To fully acknowledge the original work, an appropriate reference should be given not only to the database in question, but also to the original article in which the data was first published. This open approach will increase the availability and use of these large-scale data sets and improve the reporting and interpretation of the findings, and in increasing the comprehensive understanding of the physiology and pathology of endodontically related tissues and diseases, result eventually in better patient care.

Anexo 3. Parecer do Comitê de Ética em Pesquisa - UFG

SERVIÇO PÚBLICO FEDERAL
UNIVERSIDADE FEDERAL DE GOIÁS
PRÓ-REITORIA DE PESQUISA E PÓS-GRADUAÇÃO

UFG

COMITÊ DE ÉTICA EM PESQUISA

Goiânia, 27/ 09/10

PARECER CONSUBSTANCIADO REFERENTE AO PROJETO DE PESQUISA, PROTOCOLADO NESTE COMITÊ SOB O N.: 256/10

I – Identificação

– Título do projeto: Influência da terapia endodôntica na resistência adesiva de pinos de fibra à dentina radicular
– Pesquisador Responsável: Carlos Estrela
- Pesquisadores participantes: Fernanda Ribeiro Santana; Lawrence Gonzaga Lopes;
– Instituição onde será realizado o estudo: Faculdade de Odontologia - UFG
– Data de apresentação ao CEP/UFG: 02/09/10
– Área Temática: Grupo III, Ciência da Saúde - Odontologia

Comentários do relator frente à Resolução CNS 196/96 e complementares em particular sobre:

II – Estrutura do Protocolo

CD; Ficha de protocolo do projeto de pesquisa com assinatura do responsável pela pesquisa e do responsável pela instituição; Declaração de disponibilidade e viabilidade de infra-estrutura e equipamento; Termo de responsabilidade assinado por todos os componentes da pesquisa; TCLE da doação dos dentes bovinos do frigorífico JBS- Friboi; Certidão de ATA do Conselho Diretor da FO-UFG de aprovação da pesquisa. Projeto de Pesquisa.

III – Projeto de pesquisa

OBJETIVO GERAL: Analisar diferentes parâmetros da terapia endodôntica que podem exercer influência na resistência adesiva de retentores intra-radiculares de fibra à dentina radicular. Em Específico: - Avaliar a influência dos materiais e técnicas utilizados na terapia endodôntica na resistência adesiva de pinos de fibra à dentina intra-radicular, em função dos diferentes terços do canal radicular, por meio de ensaio mecânico de *micropush-out* e análise em MEV, variando:1) - Técnica de preparo do canal radicular: Preparo com instrumentos de aço inoxidável e com níquel-titânio. 2)- Sanificação do canal radicular com Hipoclorito de sódio 2,5%; Clorexidina 2%; Gás ozônio; EDTA 17%; 3) Obturação do canal radicular utilizando: Cimento contendo óxido de cálcio (Sealapex); contendo óxido de zinco e eugenol (EndoFill) e à base de resina epóxica (AH Plus).

Análise das questões éticas: Nesta pesquisa não será realizada nenhuma intervenção no animal. **Serão utilizados apenas dentes bovinos que serão extraídos de mandíbulas provenientes de animais que já foram abatidos em frigorífico**. Assim, o abate destes animais se dá por razões que não as envolvidas nesta pesquisa e, para a extração dos dentes, os pesquisadores terão contato apenas com as mandíbulas provenientes dos animais já abatidos no frigorífico. Utilizar-se-á 220 dentes incisivos inferiores bovinos. O projeto será desenvolvido de forma seqüencial e as raízes distribuídas aleatoriamente nos grupos.
- Quanto a Descrição do alojamento/alimentação e hidratação/temperatura/umidade, não se aplica, pois não será realizada nenhuma intervenção no animal, uma vez que os dentes bovinos a serem utilizados serão provenientes de mandíbulas de animais já abatidos em frigorífico, cuja carne é destinada ao consumo humano.

- Os dentes bovinos serão armazenados em solução aquosa tamponada de timol a 0,2% após a extração. Os dentes serão limpos e a parte coronária será removida sob refrigeração em água, a fim de permanecer remanescente radicular de 15mm a partir da porção apical de cada raiz
- Considerações sobre o sofrimento imposto aos animais: Não se aplica

Prédio da Reitoria - Térreo - Campus II - CEP-74001-970 - Goiânia-GO - Fones: 0 XX62 3521-1076 - Fax:3521-1163
Homepage: www.prppg.ufg.br - E_mail: prppg@prppg.ufg.br

SERVIÇO PÚBLICO FEDERAL
UNIVERSIDADE FEDERAL DE GOIÁS
PRÓ-REITORIA DE PESQUISA E PÓS-GRADUAÇÃO

UFG

COMITÊ DE ÉTICA EM PESQUISA

- Descrição do método de eutanásia e destino dos animais após a experimentação: Não se aplica a esta pesquisa, uma vez que para a extração dos dentes bovinos os pesquisadores terão contato apenas com as mandíbulas provenientes de animais já abatidos no frigorífico. Assim, o próprio frigorífico possui os seus protocolos de abate e destino de resíduos.

- Riscos aos pesquisadores/alunos (físicos, biológicos, psicológicos, sociais): Para a obtenção dos dentes existirão riscos físicos e biológicos, uma vez que terão contato com material biológico e utilizarão instrumentos pérfuro-cortantes. Assim, para a extração, atenderão aos princípios de biossegurança por meio da utilização de barreiras ou equipamentos de proteção individual (luvas, avental impermeável, gorro, máscara e óculos de proteção), com o objetivo de prevenir a exposição ao sangue, e tomarão os devidos cuidados para prevenir acidentes com os instrumentos pérfuro-cortantes. Os instrumentos necessários serão previamente esterilizados. Ressalta-se que os pesquisadores envolvidos são cirurgiões-dentistas, sendo assim capacitados para a realização das extrações dentárias nas mandíbulas reservadas pelo frigorífico. As extrações serão realizadas em ambiente reservado no próprio frigorífico com supervisão do veterinário, e, após a coleta dos dentes bovinos, as mandíbulas permanecerão no frigorífico.

- Análise do Termo de consentimento dos responsáveis por animais: Segue assinado por Osvaldo Caetano de Abreu, Fiscal Federal Agropecuário, Médico Veterinário CRMV-GO 0328 a autorização para extração dos dentes bovinos junto ao frigorífico acima mencionado.

- Cronograma: Adequado

- Análise da metodologia e sua adequação aos objetivos da pesquisa: A metodologia encontra-se adequada e relatam que estes dentes serão utilizados exclusivamente neste experimento

- Verificação das condições para realização da pesquisa. Condições adequadas e os currículos dos pesquisadores são compatíveis com a pesquisa proposta.

V– Parecer do CEP

Protocolo "APROVADO":

VI – Data da reunião: 27/09/2010

Assinatura do(a) relator(a):

Assinatura do(a) Coordenador(a)/ CEP/UFG:

Prof. João Carlos da Rocha Medrado
Coordenador do Comitê de Ética em Pesquisa
Pró-Reitoria de Pesquisa e Pós-Graduação/UFG

Prédio da Reitoria - Térreo - Campus II - CEP-74001-970 - Goiânia-GO - Fones: 0 XX62 3521-1076 - Fax:3521-1163
Homepage: www.prppg.ufg.br - E_mail: prppg@prppg.ufg.br