UNIVERSIDADE FEDERAL DE JUIZ DE FORA

FACULDADE DE ODONTOLOGIA

PROGRAMA DE PÓS-GRADUAÇÃO EM ODONTOLOGIA

ALLOMA DE SOUZA OLIVEIRA CAMPOS

ANÁLISE DE DIFERENTES SISTEMAS DE LIMA ÚNICA NO PREPARO DOS CANAIS RADICULARES: ESTUDO POR MICROTOMOGRAFIA COMPUTADORIZADA

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Dissertação de Mestrado apresentada ao Programa de Pós-Graduação em Odontologia, da Faculdade de Odontologia da Universidade Federal de Juiz de Fora, como requisito pacial para obtenção do título de Mestre em Clínica Odontológica. Área de concentração em Clínica Odontológica.

Orientador: Prof. Dr. Celso Neiva Campos

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2020

Ficha catalográfica elaborada através do programa de geração
automática da Biblioteca Universitária da UFJF,
com os dados fornecidos pelo(a) autor(a)

Campos, Alloma de Souza Oliveira.
Análise de diferentes sistemas de lima única no preparo dos canais radiculares: estudo por microtomografia computadorizada / Alloma de Souza Oliveira Campos. -- 2020.
73 p. : il.

Orientador: Celso Neiva Campos
Dissertação (mestrado acadêmico) - Universidade Federal de Juiz de Fora, Faculdade de Odontologia. Programa de Pós Graduação em Clínica Odontológica, 2020.

1. Microtomografia por Raio-X. 2. Cavidade Pulpar. 3. Endodontia. I. Campos, Celso Neiva, orient. II. Título.

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AGRADECIMENTOS

Chegar ao final de uma etapa na vida é impossível sem sentir-se grata e, sobretudo, agradecer algumas pessoas no cumprimento desta jornada.

Primeiramente agradeço à Deus, por ser meu guia, iluminar meus passos, por não deixar desistir do meu caminho nos momentos de fraqueza.

Ao meu mais que orientador, Prof. Celso, gratidão! É meu exemplo de profissional e professor exemplar. Me espelho em você! Obrigada pela orientação não somente no mestrado como na vida pessoal, me ajudando a trilhar o caminho com mais sabedoria, tentando corrigir meus erros sempre de forma paciente e amável até nos "puxões de orelha".

Gostaria de agradecer também à Profª. Maíra, que incentivou e idealizou este trabalho, além de me apoiar a todo momento. Carol, a quem sou eternamente grata por toda paciência e ajuda desde o início até o fim, e que vem se transformando em uma excelente e competente professora, tenho certeza de que será reconhecida e conquistará todos os seus objetivos. Você é um grande exemplo. Obrigada por todo o aprendizado que me proporcionou neste período. Tenho em você uma amiga, conte comigo sempre.

Ao meu marido, Felipe, obrigada pela calmaria nos momentos de desânimo e de impaciência, obrigada por sempre ser amor e paz, além de me ajudar na pesquisa sempre que lhe foi solicitado, seja traduzindo, seja me ajudando com interpretações estatísticas, sempre com didática, meu futuro professor. Amo você.

Aos meus amados pais, Regina e Clécio, agradeço a vocês por sempre me incentivarem, motivarem nos estudos e me ensinarem que nada é impossível, basta correr atrás dos objetivos. Sem vocês não estaria aqui. Muito obrigada!

Não posso deixar de agradecer também à minha querida sogra, Maria Inês, por sempre pensar à frente, sempre cuidar de mim e dar seu toque nos momentos especiais; Ao querido Cláudio, que prontamente ajuda não somente a mim como todos os discentes do Programa de Pós-Graduação, sou muito grata a todas as suas orientações!

Aos amigos que fiz no mestrado, Suelen, Michelle, Letícia e Vinícius, muito obrigada pela companhia, pelas risadas, pela amizade, pela leveza que construímos nossa amizade, sempre apoiando um ao outro. Vocês são muito especiais, obrigada!

RESUMO

A complexidade anatômica corresponde a um obstáculo considerável para o sucesso do tratamento endodôntico, pois podem permitir com que muitas áreas permaneçam intocadas após o preparo do sistema de canais radiculares. Na tentativa de sanar estes problemas, novos instrumentos têm sido constantemente desenvolvidos, como Reciproc Blue e XP-endo Shaper. O objetivo do presente estudo foi comparar o desempenho de três sistemas de lima única, Reciproc, Reciproc Blue e a XP-endo Shaper no preparo dos canais radiculares, em relação a porcentagem de paredes preparadas, transporte e centralização de canais mesiais de primeiros molares inferiores. Para tal, 30 raízes mesiais de molares inferiores foram selecionadas, pareadas de acordo com similaridades morfológicas e divididas em 3 grupos (n=10) de acordo com o instrumento utilizado e separado em terços (3, 5 e 7 mm) para análise de transporte e centralização do preparo. Os resultados demonstraram que Reciproc Blue apresentou maior porcentagem de parede não preparada (35,1%), quando comparada ao Reciproc (15,32%) e XP-endo Shaper (14,5%) ($p<0,05$). O grupo XP-endo Shaper apresentou menor transporte apical, seguido pelo grupo Reciproc e Reciproc Blue. ($p< 0,05$). Entre os terços, a 3mm do ápice houve menor transporte apical, seguido por 7 mm e 5 mm ($p< 0,05$). A centralização dos canais demonstrou diferença significativa entre os grupos Reciproc Blue e XP-endo Shaper ($p<0,05$), sendo o grupo Reciproc Blue o de melhor resultado. Entre os terços, houve diferença significativa entre 3 e 5 mm e 3 e 7 mm do ápice radicular, sendo que a 3 mm do ápice radicular a centralização obteve melhor resultado. Pode-se concluir que Reciproc e XP-endo Shaper apresentaram maiores áreas de paredes preparadas, enquanto XP-endo Shaper apresentou menor transporte apical e Reciproc Blue melhor centralização. O terço apical a 3mm do ápice radicular foi a área de menor transporte apical e, consequentemente, melhor centralização.

Palavras-chave: Microtomografia por Raio-X; Endodontia; Cavidade Pulpar.

ABSTRACT

Anatomical complexity is an obstacle to successful endodontic treatment, as it may allow many areas to remain untouched after root canal system preparation. In an attempt to remedy these problems, new instruments have been developed, such as Reciproc Blue and XP-endo Shaper. The aim of the present study was to compare the performance of three single file systems, Reciproc, Reciproc Blue and XP-endo Shaper in root canal preparation, in relation to the percentage of prepared walls, transportation and centralization of first mandibular molar root canals. For this, 30 mesial roots of mandibular molars were selected, paired according to morphological similarities, divided into 3 groups (n = 10) according to the instrument used and dividided into thirds (3, 5 and 7 mm) for transportation and centralization analysis. The results showed the highest percentage of unprepared walls by Reciproc Blue (35.1%) when compared to Reciproc (15.32%) and XP-endo Shaper (14.5%) (p <0.05). The XP-endo Shaper group had the lowest apical transport, followed by the Reciproc and Reciproc Blue group (p <0.05). Among the thirds, the 3 mm apical third had less apical transportation, followed by 7 mm and 5 mm (p <0.05). Root canal centralization showed significant difference between Reciproc Blue and XP-endo Shaper groups (p <0.05), with Reciproc Blue being the best result. Between the thirds, there was a significant difference between 3 and 5 mm and 3 and 7 mm of the root apex, and 3 mm of the root apex was the best result of centralization. We can conclude that Reciproc and XP-endo Shaper exhibited greater prepared wall areas, while XP-endo Shaper showed the lowest apical transportation and Reciproc Blue better centering. The apical third of 3 mm of root distance was the area with the lowest apical transportation and, consequently, the best centralization.

Key-Words: X-Ray Microtomography; Endodontics; Dental Pulp Cavity.

LISTA DE ILUSTRAÇÕES

LISTA DE ABREVIATURAS E SIGLAS

SCR: Sistema de canais radiculares

PQM: Preparo químico-mecânico

NiTi: Níquel-Titânio

Micro-CT: Microtomografia computadorizada

3D: Tridimensional

CT: Comprimento de trabalho

Mm²: Medida de área de superfície

Mm³: medida de volume

NaOCl: Hipoclorito de sódio

Ml: mililitros

EDTA: Ácido etilenodiaminotetracético

CEP: Comitê de Ética em Pesquisa

UFJF: Universidade Federal de Juiz de Fora

SUMÁRIO

1 INTRODUÇÃO

O tratamento endodôntico tem como objetivo principal eliminar microrganismos, restos de tecido pulpar vital ou necrótico e demais detritos patológicos do sistema de canais radiculares (SCR), e ainda, evitar uma reinfecção pelo selamento tridimensional do SCR (FLEMING et al., 2010; SAINI et al., 2012). Para atingir este objetivo, além do preparo químico-mecânico (PQM), grandes avanços tecnológicos surgiram ao longo das últimas décadas, como microscópios, instrumentos mecanizados de níquel-titânio (NiTi) com movimentação rotatória e reciprocante, localizadores eletrônicos apicais, radiografia digital, novas soluções para irrigação e técnicas de obturação inovadoras (FLEMING et al., 2010).

Porém, mesmo com estes avanços para melhor desempenho do profissional frente aos tratamentos endodônticos, um dos maiores obstáculos encontrados está na complexidade anatômica dos elementos dentários. A compreensão da anatomia e das variações do SCR é indispensável ao sucesso do tratamento endodôntico (MOE et al., 2017). Os primeiros molares inferiores possuem alta complexidade e variação anatômica e são os mais frequentemente tratados na endodontia. Estas complexidades incluem múltiplos canais, istmos, canais laterais e ramificações apicais (HARRIS et al., 2013; KIM et al., 2016; MOE et al., 2017; KELES E KESKIN, 2018).

O istmo é uma complexidade da estrutura anatômica que merece destaque, sendo definido como uma anastomose transversal ou comunicação estreita entre canais radiculares, que contém tecido pulpar e detritos necróticos. Por sua estrutura ser muito fina e apresentar grande dificuldade de preparo mecânico direto e desinfecção química, pode promover o insucesso das terapias endodônticas (KIM et al., 2016; DUQUE et al., 2017; KELES E KESKIN, 2018). Kim et al. (2016) relataram incidência de istmos em aproximadamente 83% das raízes mésio-vestibulares de primeiros molares inferiores.

Diversas técnicas são utilizadas para estudar a morfologia dos canais radiculares, como radiografias, cortes transversais, tomografias computadorizadas e escaneamento eletrônico (MARCELIANO-ALVES et al., 2018). Porém, a micro-tomografia computadorizada (micro-CT) tem sido amplamente utilizada e considerada padrão ouro em estudos com dentes extraídos, por ser uma técnica não destrutiva e de avaliação tridimensional (3D) do sistema de canais radiculares, oferecendo uma resolução superior de qualidade (FITZ-WALTER e PARASHOS, 2009; VERSIANI et al., 2013; JUNAID et al, 2014; PALEKER E VYVER, 2016; MOE et al., 2017; MARCELIANO-ALVES et al., 2018). Alguns estudos avaliam a eficácia de diferentes tipos de instrumentos rotatórios e reciprocantes, quanto ao preparo dos canais radiculares, através da possibilidade de sobreposição de imagens pré e pós-operatórias (MOORE, FITZ-WALTER e PARASHOS, 2009; PAQUÉ, GANAHL e PETERS, 2009; PAQUÉ et al., 2010; LACERDA et al., 2017; SIQUEIRA et al., 2018). A micro-CT também possibilita comparar diversos parâmetros de avaliação antes e após o preparo dos canais, como o volume, área de superfície, transporte apical e áreas não preparadas (PAQUÉ, GANAHL e PETERS, 2009; PAQUÉ et al., 2010; LACERDA et al., 2017; XU et al., 2018).

Amoroso-silva et al. (2017) revelaram que mais da metade das paredes dentinárias permanecem despreparadas, independentemente do sistema de instrumentação utilizado, e que a facilidade de debridamento diminui à medida em que a complexidade anatômica aumenta. No estudo de Siqueira et al. (2018), cerca de 10 a 50% da área de superfície do canal radicular permanece intocada pelos instrumentos. Estas áreas não preparadas abrigam remanescentes de biofilmes bacterianos e tecido pulpar, aumentando a taxa de insucesso do tratamento endodôntico (LACERDA et al., 2017; SIQUEIRA et al., 2018).

Além de minimizar o percentual de áreas não preparadas, e ainda, diminuir a ocorrência de falhas na terapia endodôntica como desvios e fraturas, novos instrumentos têm sido desenvolvidos (ALMEIDA et al., 2014; ZUOLO et al., 2016). Para Saini et al. (2012), a associação entre a instrumentação mecânica e a irrigação do canal é o fator indispensável para o sucesso da terapia endodôntica. Ao que se refere à instrumentação endodôntica, diferentes tipos de instrumentos e técnicas são propostos para o preparo mecânico, tais como: instrumentos manuais e rotatórios, de NiTi ou de aço inoxidável, técnicas com sequência de limas e com lima única, movimentação contínua ou reciprocante, todas visando um melhor índice de sucesso no tratamento endodôntico (YAMAZAKI-ARASAKI et al., 2013; MOURA-NETTO et al., 2015).

O uso do sistema em lima única, com movimento reciprocante, tem sido recomendado para reduzir a fadiga cíclica, contaminação cruzada e melhorar a centralização do preparo no canal radicular (GAVINI et al., 2012; JUNAID et al., 2014 e CROZETA et al., 2016). Dentre os instrumentos encontrados no mercado, destaca-se o Reciproc (VDW, Munique, Alemanha) que é um sistema de lima única acionado em movimento reciprocante, fabricado por liga de NiTi em M-Wire com corte transversal em S, se apresentando em três tamanhos: R25 (25/.08), R40 (40/.06) e R50 (50/.05) (VERSIANI et al., 2013; BANE et al., 2015; AHGMETOGLU et al., 2015).

Novos instrumentos têm sido lançados no mercado, entre eles o Reciproc Blue (VDW, Munique, Alemanha), que de acordo com o fabricante, é um instrumento tratado termicamente com uma camada de óxido de titânio visível de coloração resultante azul, que confere maior flexibilidade ao instrumento, com consequentemente melhor centralização do preparo; resistência à fadiga cíclica; corte eficiente com secção transversal em S, e ponta inativa. Estudos recentes apontam que a Reciproc Blue apresenta resistência à fadiga cíclica aproximadamente duas vezes superior à Reciproc (GUNDOGAR E OZYUREK, 2017; BÜRKLEIN, FLÜCH E SCHÄFER, 2018; KESKIN, SARIYILMAZ E DEMIRAL, 2018; TOPÇUOGLU et al., 2018; BELLADONA, 2018).

A lima XP-endo Shaper (FKG Dentaire, La Chaux-de-Fonds, Suíça) é um instrumento único de movimento rotatório que traz como característica diferencial a liga MaxWire®, que promove superelasticidade e memória de forma, além da capacidade de reagir a variações da temperatura e assumir uma forma pré-determinada dentro de canais radiculares complexos, devido à sua possibilidade de expansão e contração. À temperatura ambiente, o instrumento se encontra na fase martensística e se converte para a fase autenística à temperatura corporal, sendo citado em alguns estudos por possuir formato de cobra (BAYRAM et al., 2017; USLU et al., 2018). O instrumento tem diâmetro 30/.01, que o torna mais flexível e resistente à fadiga cíclica. A XP-endo Shaper pode atingir um preparo final do canal com 30/.04 e se adapta facilmente às irregularidades do canal, gerando um mínimo de estresse às paredes dentinárias (LACERDA et al., 2017; AZIM et al., 2017; ELNAGHY e ELSAKA, 2017; BAYRAM et al., 2017; VERSIANI et al., 2018; ALVES et al., 2018; KESKIN, SARIYILMAZ e DEMIRAL, 2018; SILVA et al., 2018; USLU et al., 2018).

Diante do exposto, o objetivo deste estudo foi comparar a eficácia de três sistemas de lima única, Reciproc, Reciproc Blue e a XP-endo Shaper no preparo dos canais radiculares, no que tange à porcentagem de paredes preparadas, transporte e centralização do preparo.

2 PROPOSIÇÃO

A proposta do presente estudo visou comparar o desempenho de três sistemas de lima única – Reciproc, Reciproc Blue e a XP-endo Shaper – no preparo dos canais radiculares, em relação ao volume, área de superfície e a porcentagem de paredes preparadas de canais mesiais de primeiros molares inferiores. Foram ainda avaliados o transporte apical e centralização do preparo.

3 MATERIAL E MÉTODOS

3.1 Tipo de Estudo

O presente trabalho trata-se de um estudo experimental *ex vivo,* laboratorial, realizado em 30 molares inferiores, extraído de humanos, provenientes do Banco de Dentes Humanos da Faculdade de Odontologia da Universidade Federal de Juiz de Fora/MG.

3.2 Aspectos Éticos

Para o desenvolvimento desta pesquisa, o projeto foi submetido ao Comitê de Ética em Pesquisa com Seres Humanos da Universidade Federal de Juiz de Fora (CEP/UFJF) e aprovado sob o Parecer de número 1.840.821 (Anexo A).

3.3 Seleção e preparo da amostra

Para o presente estudo, foram selecionados 30 molares inferiores, extraídos de humanos, provenientes do Banco de Dentes Humanos da Faculdade de Odontologia da UFJF.

Para serem incluídos no estudo, os dentes deveriam apresentar raízes mesiais com ápice completamente formado, sem tratamento endodôntico, calcificações ou reabsorções e ser classe I de Schneider (SCHNEIDER, 1971). A seleção dos dentes foi confirmada usando imagens de micro-CT.

Após a digitalização da amostra, os dentes foram pareados de acordo com a anatomia, volume e curvatura radicular. Um dente de cada trio pareado foi distribuído aleatoriamente (www.random.org) em três grupos experimentais (n=10): Reciproc (VDW, Munique, Alemanha), Reciproc Blue (VDW, Munique, Alemanha) e XP-endo Shaper (FKG Dentaire, La Chaux-de-Fonds, Suíça) (Figura 1). Após a seleção, os dentes foram cortados e acessados com broca diamantada esférica 1012 (FG KG Sorensen, São Paulo, Brasil), acoplada a motor de alta rotação e acionada sob refrigeração com água. Objetivando retificar a base coronária com a finalidade de obter uma imagem de maior qualidade e padronizada durante o escaneamento, com o auxílio de um disco de aço dupla face número 7020 (Discoflex, KG Sorensen, São

Paulo, Brasil), os dentes foram seccionados 2 mm acima da face vestibular da junção amelocementária e fixados, nessa região, a um anel com resina epóxi (Figura 2).

Figura 1: Ilustração dos instrumentos utilizados no trabalho. A – Reciproc; B- XP-endo Shaper e C- Reciproc Blue.

Figura 2: Fixação do dente a um anel com resina epóxi na região amelocementária.

A patência foraminal foi determinada com auxílio de uma lima tipo Kerr #10 (Dentsply, Petrópolis, RJ, Brasil) introduzida no interior do canal até que sua ponta atingisse o forame apical, de modo a ser visualizado a olho nu, com o cursor de borracha do instrumento ajustado na superfície do corte. O instrumento foi retirado da amostra, medido em régua milimetrada (Maquira, Maringá, PR, Brasil) e o comprimento de trabalho (CT) foi estabelecido subtraindo 1 mm desta medida (Figura 3). Foi realizado o *glide path* com limas manuais tipo K flexofile, até que a lima #15 alcançasse o CT estabelecido. Durante o PQM, a cada troca de instrumento, uma lima Kerr #10 foi utilizada para manter a patência foraminal.

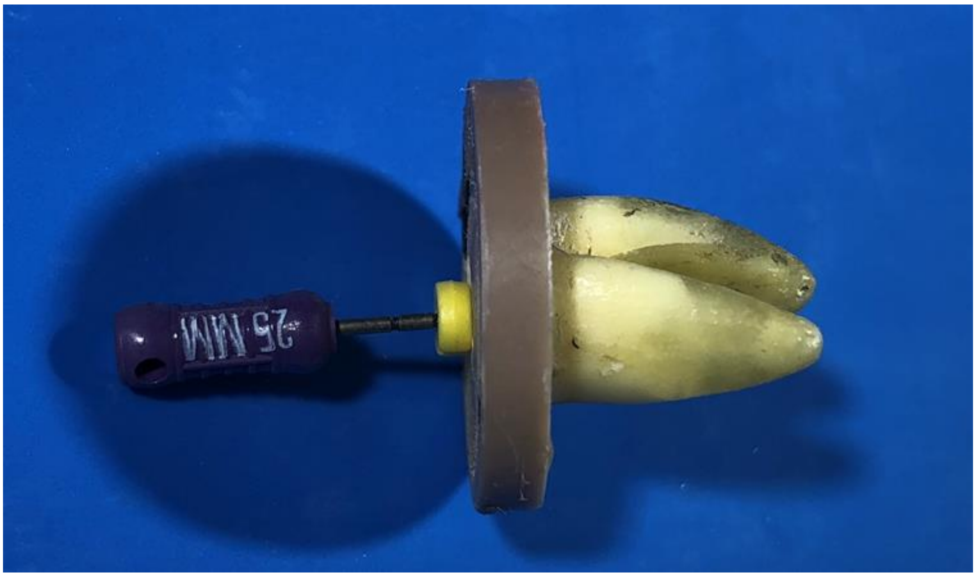

Figura 3: Determinação do comprimento de trabalho.

O forame apical foi vedado com Top Dam (FGM, Joinville, SC, Brasil) para permitir o fluxo e refluxo da substância irrigadora, simulando a condição clínica. A instrumentação foi realizada por um especialista em endodontia e foi utilizado um instrumento para cada dente da amostra, com descarte após o uso.

3.4 Escaneamento inicial por micro-CT e divisão da amostra em grupos

As amostras foram escaneadas no microtomógrafo SkyScan (1173, Bruker, Kontich, Bélgica) com o seguinte parâmetro de aquisição: 114 Kv e 70 mA, filtro de alumínio a 1 mm de espessura, tempo de exposição de 320 milissegundos com rotação de 0,5º e tamanho de pixel de 9,97 µm, totalizando 1 h e 20 minutos de escaneamento para cada espécime.

Após os escaneamentos, as imagens foram reconstruídas tridimensionalmente pelo software Nrecon (v1.6.1.0; Bruker) usando parâmetros padronizados de redução de artefatos: 1 *smoothing,* 5 *ring artefacts reduction*, 50% *beam hardening correction*. Com as imagens obtidas por micro-CT, no programa Image J (Fiji 1.49b; Java 1.6.0 24 [64bit]), foram determinados o raio e o ângulo de curvatura dos canais (SCHNEIDER, 1971) e a confirmação da classe I de Schneider, para o pareamento das amostras. Neste mesmo programa, foi mensurada a área de superfície (mm^2) e volume (mm^3) inicial dos canais. Os espécimes foram então pareados em triplicata, tendo como base as características morfológicas do canal: volume, ângulo de curvatura da raiz e anatomia tridimensional.

3.5 Cuba térmica para instrumentação dos canais

Para a instrumentação dos canais radiculares foi necessária a idealização de um aparato que permitisse que o processo se desenvolvesse de forma similar às condições humanas de temperatura e hidratação do dente. Assim, foi construída uma cuba térmica para instrumentação. Ela consiste de uma morsa de bancada montada sobre uma mini-bancada de granito, cujo conjunto foi posicionado de forma submersa em água a 37°C (LACERDA et al., 2017), dentro de uma cuba de vidro (tipo aquário). Integra-se também o aparato, uma resistência elétrica (500W/110V) controlada por um termostato eletrônico ajustado para 37°C (+/- 0,2°C) e uma moto-bomba submersa – 90 L/h – (Sarlobetter, São Caetano do Sul, SP, Brasil) para circulação contínua da água e uniformização da temperatura em toda área do volume do recipiente. Foram ainda adicionados à cuba um frasco para armazenamento de hipoclorito de sódio e um tubo de ensaio para servir como apoio para a seringa de irrigação. Ambos ficavam quase totalmente submersos, apenas com a abertura dos frascos acima da linha d’água (Figura 4).

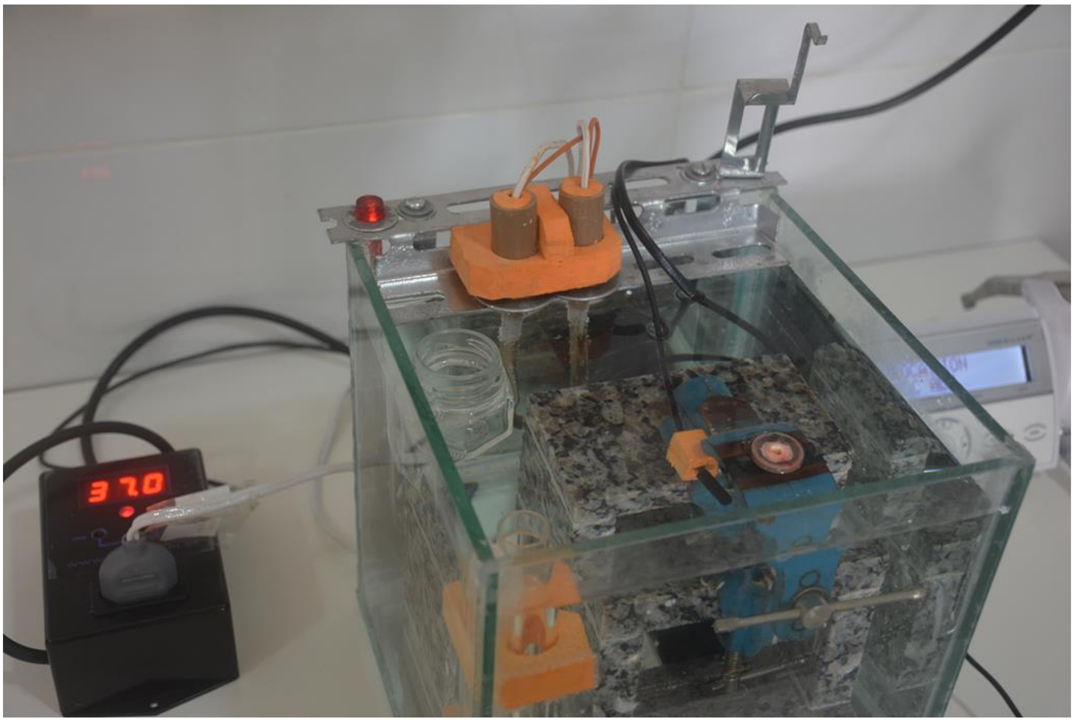

Figura 4: Aparato confeccionado para realização da instrumentação.

3.6 Preparo do canal radicular

Previamente à instrumentação, cada dente foi fixado na morsa de bancada da cuba térmica de instrumentação de modo que o anel de resina epóxi, sustentada pela base da junção amelocementária, ficasse posicionada na linha da superfície da água.

3.6.1 Reciproc: O instrumento Reciproc R25 (ponta 25, conicidade .08; VDW, Munique, Alemanha) foi usado no motor Reciproc Silver (VDW, Munique, Alemanha), em modo “Reciproc All” de acordo com as recomendações do fabricante. A instrumentação foi conduzida em três estágios (cervical, médio e apical) utilizando 1 movimento de entra-e-sai, com pequena amplitude para cada terço. Após a instrumentação de cada terço, o instrumento foi removido do canal e limpo com gaze.

3.6.2 Reciproc Blue: O instrumento Reciproc Blue R25 (ponta 25, conicidade .08; VDW, Munique, Alemanha) foi usado no motor Reciproc Silver (VDW, Munique, Alemanha), em modo “Reciproc All” de acordo com as recomendações do fabricante. A instrumentação foi conduzida em três estágios (cervical, médio e apical) utilizando 1 movimento de entra-e-sai, com pequena amplitude para cada terço. Após a instrumentação de cada terço, o instrumento foi removido do canal e limpo com gaze (Figura 5).

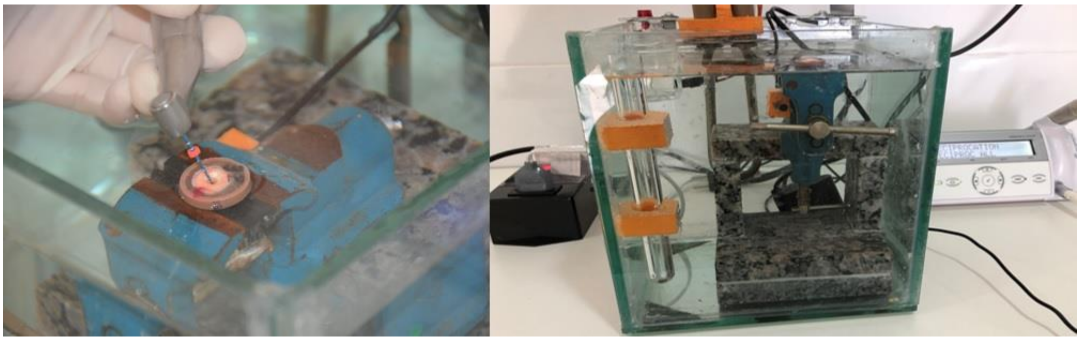

Figura 5: Instrumentação do grupo Reciproc Blue.

3.6.3 XP-endo Shaper: A instrumentação do grupo XP-endo Shaper (ponta 30, conicidade .01; FKG Dentaire, La Chaux-de-Fonds, Suíça) foi realizada no motor VDW

Silver (VDW, Munique, Alemanha) em movimento rotatório, com 800 rpm de torque e a 1 N/cm² e instrumentado de acordo com as recomendações do fabricante. A instrumentação foi conduzida em movimentos suaves de entrada e saída até atingir o CT. Se não atingisse o CT após 3 a 5 movimentos, o movimento seria reiniciado. Após atingir o CT, o instrumento foi utilizado em movimento de entrada e saída por 10 vezes e removido do canal, finalizando a instrumentação.

Nos três sistemas apresentados anteriormente, a irrigação dos canais foi realizada a cada remoção do instrumento, por terços, e após a finalização do preparo, como descrito a seguir.

3.7 Irrigação dos canais radiculares

Os canais foram irrigados com 5 ml de hipoclorito de sódio (NaOCl) a 5,25%, aquecido a 37°C por meio da cuba térmica, com auxílio de uma seringa tipo Luer de 5 ml equipada com agulhas *Navytip* de calibre 30 gauge (Ultradent Products Inc., Indaiatuba, SP, Brasil). A agulha foi inserida no canal até 2 mm do CT. A substância irrigadora foi injetada com a seringa e aspirada com cânula de sucção, em um tempo de aproximadamente 30 segundos. A irrigação final foi realizada com 5 ml de ácido etilenodiaminotetracético a 17% (EDTA) (Biodinâmica, Ibiporã, Brasil), para remover a *smear layer*, seguida de 5 ml de NaOCl a 5,25%. Os dentes instrumentados foram armazenados em ambiente seco e limpo para o segundo escaneamento por micro-CT.

3.8 Avaliação por micro-CT após a instrumentação

Após o preparo do canal radicular nos três grupos, os dentes foram re-escaneados por micro-CT com os mesmos parâmetros de aquisição e reconstrução descritos anteriormente, para avaliação da morfologia dos canais quanto ao volume, à área de superfície e às áreas não preparadas. O *software* 3D Slicer 4.4.0 (www.slicer.org, Artificial Intelligence Laboratory of Massachusetts Institute of Technology and Surgical Planning Laboratory at Brighamand Women’s Hospital and Harvard Medical School) foi usado para registrar os modelos 3D pré e pós-operatórios sobrepondo-se as imagens antes e após o PQM a uma precisão maior que 1 voxel, após conversão dos modelos inicial e final dos canais no formato BMP para o formato NRRD no *software* Image J1.50d (Institutos Nacionais de Saúde, Bethesda, MD).

3.8.1 Volume e Área de superfície

O volume (mm³) e a área de superfície (mm²) do canal preparado no segmento apical (5 mm) e no comprimento total do canal foram calculados no *software* Image J 1.50d (Institutos Nacionais de Saúde, Bethesda, MD). O mesmo *software* foi utilizado para avaliar as áreas não preparadas por meio da sobreposição de imagens antes e após o PQM. Esse parâmetro foi contabilizado através do cálculo da porcentagem do número de voxels estáticos, que são aqueles que permaneceram imóveis após o preparo do canal radicular, e da porcentagem do número de voxels da superfície inicial do canal. O *software* CTVol v.2.3.1 (Bruker-microCT) foi usado para definir um padrão codificado por cores para os modelos de canais (verde para pré-instrumentação e vermelho para canais após a instrumentação) (Figura 6). Isso permitiu a comparação de modelos de canais radiculares sobrepostos dos escaneamentos pré-operatórios e pós-operatórios.

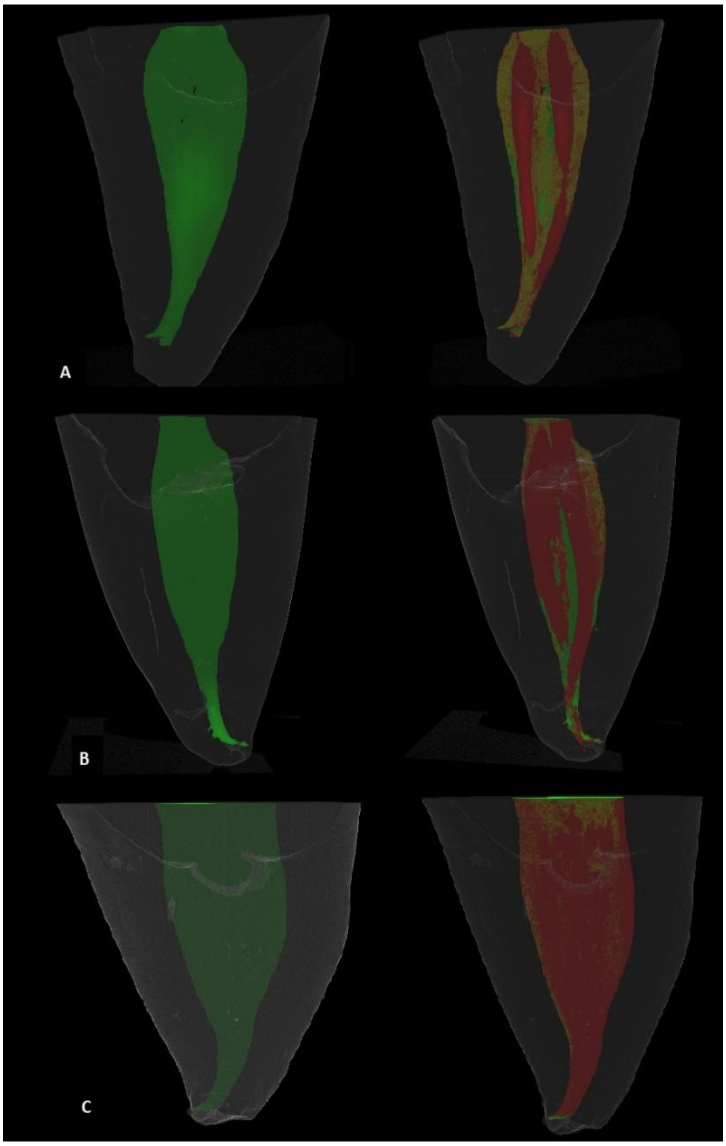

Figura 6: Sobreposição das imagens antes (verde) e após (vermelho) instrumentação. (A) Reciproc (B) Reciproc Blue (C) XP-endo Shaper.

3.9.2 Transporte e centralização

O transporte do canal e a centralização do preparo foram calculados em 3 níveis (3, 5 e 7 mm do forame apical) utilizando as equações a seguir (GAMBILL; ALDER; DEL RIO, 1996):

Transporte do canal = (m1-m2) - (d1-d2)

Centralização do preparo = (m1-m2)/(d1-d2) ou (d1-d2)/(m1-m2)

Onde: m1 é a distância mais curta da margem mesial da raiz para a margem mesial da região não instrumentada do canal; m2 é a menor distância da margem mesial da raiz para a margem mesial do canal instrumentado; d1 é a menor distância da margem distal da raiz para a margem distal do canal não instrumentado; e d2 é a menor distância da margem distal da raiz a margem distal do canal instrumentado (Figura 7).

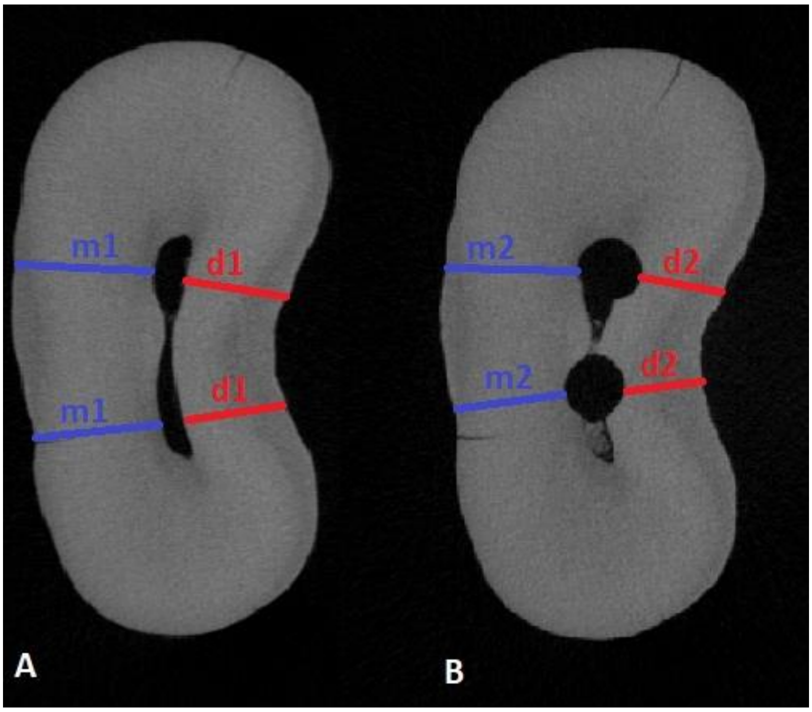

Figura 7: Ilustração da mensuração das paredes dentinárias no canal hígido (A) e instrumentado (B).

Transporte do canal igual a 0 significa que não houve transporte; valor negativo significa que ocorreu transporte na direção distal; e valor positivo indica transporte na região mesial. A equação utilizada para determinar a capacidade de centralização do preparo depende do valor obtido pelo numerador, que deve sempre ser menor do que o denominador. Valores iguais a 1 indicam perfeita centralização, e valores próximos a 0 indicam uma reduzida capacidade do instrumento de manter o eixo central do canal radicular.

3.10 Análise Estatística

A análise estatística foi realizada utilizando o *software* R (R Core Team, 2018). O teste de *Shapiro-Wilk* foi utilizado para verificar a normalidade das variáveis da amostra (Volume, Área e Paredes Tocadas). Devido à rejeição da normalidade, testes não-paramétricos foram utilizados. Para verificação de significância da diferença das variáveis entre os grupos (volume, área de superfície e paredes não preparadas) considerando o terço apical e o canal em toda a sua extensão foi utilizado o teste de *Mann-Whitney*. Já para comparação entre o terço apical e o canal em toda a sua extensão (intragrupos) foi utilizado o teste de *Wilcoxon*.

Para a avaliação de centralização e transporte, foram ajustados modelos de regressão linear utilizando "grupo" (1, 2 e 3) e "terço" (3, 5 e 7 mm) como covariáveis. Para a variável dependente "transporte" foi considerada uma distribuição normal estendida, e para a variável "centralização" foi utilizado um modelo de regressão Beta 0-1 Inflado. O teste de *Shapiro-Wilk* para ambos os modelos não rejeitou a hipótese nula de normalidade dos resíduos, indicando que estão bem ajustados.

Em todos os testes aplicados foi considerado o nível de significância de 5% ($p<0{,}05$).

4 ARTIGO

O artigo abaixo está apresentado nas normas do periódico Journal of Endodontics, classificado no Qualis da CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior), na Área de Avaliação de Odontologia, como A1.

MICRO–COMPUTED TOMOGRAPHIC EVALUATION OF THE SHAPING ABILITY OF RECIPROC, RECIPROC BLUE AND XP-ENDO SHAPER IN MESIAL ROOTS OF MANDIBULAR MOLARS.

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Abstract

Introduction The aim of this study was to compare the shaping ability of 3 different nickel-titanium systems, used to prepare canals using micro–computed tomographic analysis.

Methods Thirty mesial roots of mandibular molars were matched based on similar morphologic dimensions and assigned to 3 experimental groups (n = 10) according to the canal preparation: Reciproc, Reciproc Blue, and XP-endo Shaper systems. Changes in 3-dimensional morphologic parameters as well as canal transportation were compared among groups using the analysis of variance Mann-Whitney and Wilcoxon tests with the significance level set at 5%.

Results The results showed the highest percentage of unprepared walls by Reciproc Blue (35.1%) when compared to Reciproc (15.32%) and XP-endo Shaper (14.5%) ($p < 0.05$). The XP-endo Shaper group had the lowest apical transport ($p < 0.05$). Among the thirds, the 3 mm apical third had less apical transportation, followed by 7 mm and 5 mm ($p < 0.05$). Root canal centralization showed significant difference between Reciproc Blue and XP-endo Shaper groups ($p < 0.05$), with Reciproc Blue being the best result. Between the thirds, there was a significant difference between 3 and 5 mm and 3 and 7 mm of the root apex, and 3 mm of the root apex was the best result of centralization.

Conclusion Reciproc and XP-endo Shaper exhibited greater prepared wall areas, while XP-endo Shaper exhibited the lowest apical transportation and Reciproc Blue better centering.

Key Words Transportation; Root canal; Reciproc Blue; XP-endo Shaper; Reciproc.

INTRODUCTION

The main objective of endodontic treatment is to eliminate microorganisms, pulp tissue remains and other pathological debris from the root canal system (RCS)[1,2]. However, anatomical complexity is a considerable obstacle, and the understanding of this system and its variations is indispensable, especially concerning molars, which often present multiple canals, isthms, lateral canals and apical branches, which makes preparation of the entire RCS difficult[3-5].

Previous studies have shown that approximately 10% to 50% of the main root canal area remains uninstructed after preparation[6,7]. These unprepared areas harbor bacterial biofilm and pulp tissue remnants, increasing endodontic treatment failure rates[8]. To remedy this problem and reduce the occurrence of endodontic treatment failures, such as apical transport, deviations and fractures, new instruments have been constantly developed[9].

The Reciproc instrument (VDW, Munich, Germany) is a reciprocating motion system made of an M-Wire NiTi alloy that provides cutting efficiency, fatigue resistance and centering capability[10]. Reciproc Blue (VDW, Munich, Germany) was developed by controlled heat treatment (cooling and heating) resulting in a blue color, leading to greater instrument flexibility[11].

The XP-endo Shaper (FKG Dentaire, La Chaux-de-Fonds, Switzerland) file is a unique rotary movement instrument featuring the differential feature of the MaxWire® alloy, which promotes superelasticity and shape memory, as well as the ability to react to temperature variations and assume a predetermined shape within complex root canals, due to their possibility of expansion and contraction. The instrument presents a 30/.01 diameter, which makes it more flexible and resistant to cyclic fatigue, achieving a final root canal preparation with a minimum of 30/.04 easily and easily adapting to root canal irregularities by generating minimum stress to dentin walls[8].

For better RCS preparation analysis, microcomputerized tomography (micro-CT) has been widely used and considered the gold standard in studies on extracted teeth, as it is a non-destructive technique and three-dimensional (3D) structure evaluation, offering superior quality resolution[4,10,12]. Some studies have evaluated the effectiveness of different types of instruments in preparing root canals, through the possibility of overlapping pre- and postoperative images, as well as comparing root canal preparation evaluation parameters, such as volume, surface area, apical transport, centralization and unprepared walls[6,8].

Thus, the aim of this study was to compare the shaping ability of 3 different nickel-titanium systems, used to prepare canals using micro–computed tomographic analysis.

MATERIAL AND METHODS

Sample selection

This project was approved by the local ethics committee (no. 1.840.821). Thirty lower molars with formed apices, no endodontic treatment, no calcifications, no resorption, and presenting Schneider class I[13] were selected after the micro-CT pairing. Teeth were divided in three experimental groups (n = 10) with similar root anatomy, volume and curvature: Reciproc (VDW, Munich, Germany), Reciproc Blue (VDW, Munich, Germany) and XP-endo Shaper (FKG Dentaire, La Chaux-de-Fonds, Switzerland).

Initial micro-CT scan and sample classification into groups

Samples were scanned on a microtomograph at acquisition parameters of 114 Kv and 70 mA, using a 1 mm thick aluminum filter, with exposure time of 320 milliseconds at 0.5º rotation and an isotropic resolution of 9.97 µm, totaling 1h and 20min of scanning for each specimen.

After scanning, the images were three-dimensionally reconstructed by the Nrecon software (v1.6.1.0; Bruker) using standardized artifact reduction parameters, as follows: 1 smoothing, 5 ring artefact reduction, 50% beam hardening correction. The micro-CT images were then assessed using the Image J software (Fiji 1.49b; Java 1.6.0 24 -64bit-). The radius and curvature angle of the canals[13] (Schneider class I confirmation), as well as the surface area (mm^2) and initial volume (mm^3) of the canals were measured. The specimens were pairing based on morphological canal characteristics concerning volume, root curvature angle and three-dimensional anatomy.

Sample preparation

After pairing, the teeth were sectioned 2 mm above the cementoenamel junction and accessed with a 1012 spherical diamond burs (FG KG Sorensen, São Paulo, Brazil), coupled to a high-speed motor and driven under water cooling. The teeth were fixed to an epoxy resin ring in the cementoenamel junction region of the to form a grounded support base.

The foraminal patency was determined with a Kerr #10 file (Dentsply, Petrópolis, RJ, Brazil) introduced into the canal until the tip reached the apical foramen, and the working length (WL) was established by subtracting 1 mm from this measurement. The glide path was performed with a flexofile #15 K-type until file reached the established

WL. During chemical-mechanical preparation (CMP), a Kerr #10 file was used to maintain foraminal patency at each instrument change.

The apical foramen was sealed with Top Dam (FGM, Joinville, SC, Brazil) to allow the flow of irrigating substance, simulating clinical conditions. Instrumentation was performed by an endodontist and one instrument was used for each tooth, discarded after use.

Canal instrumentation

For root canal instrumentation, it was necessary to design an apparatus in order to allow similar way regarding human temperature and tooth hydration conditions. Thus, an instrumentation thermal vat was constructed, consisting of a bench vise mounted on a granite mini-bench, submerged in water at 37°C, inside a glass vat (aquarium type). An electrical resistance (500 W/110 V) controlled by an electronic thermostat set to 37°C (+/- 0.2°C) was coupled to the system, as well as a submerged motor pump – 90 L/h - (Sarlobetter, São Caetano do Sul, SP) used for continuous water circulation and uniform temperature maintenance throughout the container volume area. One vial for sodium hypochlorite storage and one vial to support the irrigation syringe were added to the vat. Both were almost completely submerged, with only the mouth of the vials above the water line, thus ensuring a fixed irrigant temperature of at 37°C[8]. Tooth was fixed to the bench vise of the instrumentation thermal vat so that the epoxy resin ring, supported by the cementoenamel junction base, was positioned at the water surface line.

The teeth were instrumented according to the manufactor's instruction of the different systems:

<u>*Reciproc Group:*</u> The Reciproc R25 instrument (size 25, taper 08; VDW, Munich, Germany) was used coupled to the Reciproc Silver (VDW, Munich, Germany) engine in the "Reciproc All" mode according to the manufacturer's recommendations. Instrumentation was conducted in three stages (cervical, mid and apical) using in-and-out movements with a small range of motion. After instrumentation of each third, the instrument was removed from the canal and cleaned with gauze.

<u>*Reciproc Blue Group:*</u> The Reciproc Blue R25 instrument (size 25, taper 08; VDW, Munich, Germany) was used coupled to the Reciproc Silver (VDW, Munich, Germany)

engine in the “Reciproc All” mode according to the manufacturer's recommendations. Instrumentation was conducted in three stages (cervical, mid and apical) using in-and-out movements with a small range of motion. After instrumentation of each third, the instrument was removed from the canal and cleaned with gauze.

XP-endo Shaper Group: The XP-endo Shaper (FKG Dentaire, La Chaux-de-Fonds, Switzerland) 30/.01 instrumentation was performed using a rotary motion VDW Silver (VDW, Munich, Germany) engine at 800 rpm torque and 1 N/cm² according to the manufacturer's recommendations. Instrumentation was conducted using smooth in-and-out movements until reaching the WL. If the WL was not reached after 3 to 5 movements, movement was resumed. After reaching the WL, in-and-out movements were performed 10 times and the instrument was then removed from the canal, ending instrumentation.

Canal irrigation was performed at each instrument removal by thirds and after preparation completion. They were irrigated with 5 ml of 5.25% sodium hypochlorite (NaOCl), with the aid of a 5 ml Luer-type syringe equipped with 30-gauge Navytip needles (Ultradent Products Inc., Indaiatuba, SP, Brazil). The needles were inserted into the canal up to 2 mm from the WL. The irrigant was injected with the syringe and aspirated with a suction cannula within approximately 30 seconds. Final irrigation was performed with 5 ml of 17% ethylenediaminetetraacetic acid (EDTA) (Biodynamics, Ibiporã, Brazil) to remove the smear layer and 5 mL of 5.25% NaOCl were used as the final irrigant.

Micro-CT evaluation after instrumentation

After root canal preparation of the three groups, all teeth were rescanned by micro-CT with the same acquisition and reconstruction parameters described previously, to evaluate canal morphology concerning volume, surface area, transport, centering and non-prepared areas. The 3D Slicer 4.4.0 software (www.slicer.org, Artificial Intelligence Laboratory of Massachusetts Institute of Technology and Surgical Planning Laboratory at Brighamand Women’s Hospital and Harvard Medical School) was used to record pre- and postoperative 3D models by superimposing the images before and after root canal instrumentation to a precision greater than 1 voxel, after conversion of the initial and final canal models to the BMP format to the NRRD format using the Image J 1.50d software (National Institutes of Health, Bethesda, MD).

Volume and superficie area

The volume (mm^3) and surface area (mm^2) of the prepared canals in the apical segment (5 mm) and total canal lengths were calculated using the Image J 1.50d software (National Institutes of Health, Bethesda, MD). The same software was used to evaluate unprepared areas by overlapping images before and after PQM. This parameter was accounted for by calculating the percentage of the number of static voxels, which are those that remained immobile after root canal preparation, and the percentage of the number of voxels of the initial canal surface. The CTVol v.2.3.1 (Bruker-microCT) software was used to define a color-coded standard for canal models (green for pre-instrumentation and red for after instrumentation), allowing for comparisons of overlapping preoperative and postoperative root canal scan models.

Canal transport and centering

Canal transport and preparation centralization were calculated at three levels (3, 5 and 7 mm from the apical foramen) using the following equations[14]:

Canal transport = (m1-m2) - (d1-d2)
Preparation centralization = (m1-m2)/(d1-d2) or (d1-d2)/(m1-m2)

Where m1 is the shortest distance from the mesial margin of the root to the mesial margin of the uninstrumented canal region, m2 is the shortest distance from the mesial margin of the root to the mesial margin of the instrumented canal; d1 is the shortest distance from the distal root margin to the distal margin of the uninstrumented canal, and d2 is the shortest distal margin from the root to the distal margin of the instrumented canal (Figure 1).

A canal transport equal to 0 indicates no transport, a negative value indicates distal transport, and positive value indicates mesial region transport. The equation used to determine the centering capacity of the staging depends on the value obtained by the numerator, which must always be smaller than the denominator. Values equal to 1 indicate perfect centering, while values close to 0 indicate reduced instrument ability to maintain the central axis of the root canal.

Statistical analysis

Statistical analyses were performed using the R software (R Core Team, 2018). The Shapiro-Wilk test was used to verify variable normality (volume, area and non-prepared areas). Due to rejection of normality, nonparametric tests were used. To verify the significance of the difference of variables between the groups (volume, surface area and non-prepared areas), considering the apical third and the canal in all extension, the Mann-Whitney test was used. For comparison between the apical third and the canal in all extension (intragroups), the Wilcoxon test was used.

To evaluate centering and transport, linear regression models were defined using “group” (1, 2 and 3) and “third” (3, 5 and 7 mm) as covariates. For regression, the dependent variable “transport” was considered as an extended normal distribution, and for the “centering” variable a Zero One Inflated Beta regression model was used. The Shapiro-Wilk test for both models did not reject the hypothesis of residual normality, indicating that they are well adjusted.

A significance level of 5% ($p < 0.05$) was considered for all applied tests.

RESULTS

The pre- and postoperative 2D and 3D root canal preparation analysis results are detailed in Table 1, where an increase in volume and surface area after instrumentation was observed in all groups for the full length of the canal and the apical third of the canal, with no statistical difference between areas ($p > 0.05$).

Reciproc Blue displayed a higher percentage of unprepared walls (35.1%) throughout the root canal when compared to Reciproc (15.32%) and XP-endo Shaper (14.5%) ($p < 0.05$). However, Reciproc and XP-endo Shaper demonstrated similar percentages of unprepared walls ($p > 0.05$) (Figure 2).

The unprepared area percentage was lower in the Reciproc group (24.62%) in the apical third, followed by the XP-endo Shaper group (30.19%) and Reciproc Blue (41.64%), with no statistical difference between groups ($p > 0.05$).

No statistically significant difference was observed between the apical third and the entire canal regarding volume, surface area and unprepared areas ($p < 0.05$ - Wilcoxon). No instruments were fractured during root canal instrumentation.

The results for apical transport and centralization are presented in Table 2. Regarding apical transport, all groups displayed significant inter-group differences and between thirds ($p<0.05$ - Shapiro Wilk), with the XP-endo Shaper group presenting lower apical transport, followed by the Reciproc and Reciproc Blue groups ($p <0.05$). Among the thirds, less apical transport was noted at 3mm from the apex, followed by 7 mm and 5 mm ($p <0.05$).

Root canal centralization was significantly different between the Reciproc Blue and XP-endo Shaper groups ($p <0.05$), with the Reciproc Blue group presenting the best centralization result, unlike the XP-endo Shaper group, which presented the lowest value, close to 0. Between thirds, a significant difference was noted between 3 and 5 mm and 3 and 7 mm from the root apex, while centralization was better at 3 mm from the root apex than at 5 and 7 mm from the apex.

DISCUSSION

Improvements in the development of instrumentation systems in recent decades have led to instruments presenting new heat treatments, kinematics, geometry and differentiated designs, which may directly impact biomechanical preparation and anatomical complexities, particularly in lower molar mesial roots, due to anatomical complexity with the presence of isthms and intercommunications that hinder RCS cleaning and disinfection by instruments[15].The present study evaluated the efficacy of the preparation of lower first molar mesial canals through micro-CT after using the Reciproc, Reciproc Blue and XP-Endo Shaper endodontic instruments.

In the present study, Reciproc Blue led to a higher percentage of unprepared area compared to the Reciproc and XP-endo shaper instruments ($p <0.05$). Although Reciproc and Reciproc Blue have similar designs with the same cross section and same diameter and taper (25/.08), this difference can be explained by the fact that Reciproc Blue has a different heat treatment, resulting in greater flexibility and lower material hardness[16]. This result is in contrast with an earlier study demonstrating no statistical difference between Reciproc and Reciproc Blue in relation to the percentage of unprepared areas[17] in isthms.

Regarding the XP-endo Shaper, the lower percentage of unprepared area in the root canal compared to Reciproc Blue can be explained due the XP-endo Shaper larger diameter (30/.00 - 30/.04), and its expansion and contraction properties at 37ºC, which may lead to better root canal wall preparation compared to Reciproc Blue (25 /.08). However, Zhao et al.[18] observed no difference between Reciproc Blue and XP-endo Shaper ($p > 0.05$) in C-shaped canal, justified by the fact that the assessed canals are C-shaped, making preparation difficult, which may have led to similar results.

No difference was found between the Reciproc (15.32%) and XP-endo Shaper (14.5%) instruments regarding unprepared area throughout canals. This similarity may exist, although the XP-endo Shaper does not present the same dentin cutting and removal efficiency as Reciproc, due to the contraction and expansion action within the root canal, by a phase change at 37°C. The XP-endo Shaper group presented 14.5% of unprepared area, similar to the results reported by Lacerda et al.[8], where the authors found similar percentages (17%) in oval root canal instrumentation when using the XP-endo shaper. Among the three assessed groups, the amount of unprepared wall (from lowest to highest value) ranged between 14.5% and 35.1%, matching literature reports ranging from 10 to 50%[19,20].

In the present study, variables along the entire canal were assessed, as well in the apical portion, as this area has the ability to maintain biofilm colonization and become a potential cause of persistent infection, which may compromise the success of the endodontic biofilm treatment. No statistical difference between groups regarding the percentage of unprepared walls and surface area was observed in the apical third.

A variation between the Reciproc and XP-endo Shaper groups ($p < 0.05$), was observed concerning volume, where the Reciproc group displayed the highest volume and the XP-endo Shaper, the lowest, respectively, in the apical third. This can be explained due to the fact that the the Reciproc instrument presentd excellent cutting and effectiveness in root canal preparation. Moreover, the action movement of the XP-endo Shaper and its final dimension during instrumentation (30.04) may also account for this difference when compared to the size of the Reciproc instrument (25.08), which lead to twice the taper of the XP-endo shaper file.

The development of a preparation that maintains the original canal shape, tapering from the cervical to the apical direction, is one of the goals of endodontic therapy[21]. Excessive apical transport may result in thinned inner walls, which may lead to perforations or vertical fractures[22]. According to Poly et al.[25], the risk of apical transport depends on the degree of root curvature and the types of instruments used to prepare the canals. Schneider class I samples, with maximum curvature of 20°, tested in different NiTi alloys, with conventional (Reciproc) and heat treated (Reciproc Blue) and MaxWire (XP-endo Shaper) alloys were used here in.

All groups displayed significant inter-group differences and between the thirds analyzed for apical transport (3, 5 and 7 mm). The XP-endo Shaper presented lower cervical third transport (7 mm), corroborating other studies that indicate a higher degree of transport in canals prepared with reciprocating systems[24,25], which can be explained by the use of the MaxWire alloy, which confers greater instrument flexibility compared to M-Wire alloys and can lead to lower canal transport. It is noteworthy that the Reciproc Blue and XP-endo Shaper instruments displayed the same transport behavior compared to the Reciproc instrument in the apical and middle thirds, which may be due to properties leading to greater instrument flexibility. Some studies have reported that, in order to not cause damage and/or negative impacts on the clinical prognosis of endodontic treatment, a 0.3 mm apical transport is considered the parameter limit[26,27]. All systems were below this limit in the present study.

The centering ability is one of the endodontic instrument properties used to maintain the original root canal direction and, according to some studies[28,29], better preparation centralization can be achieved with adequate cervical preparation, as well as thermally treated instruments, which tend to present greater preparation centralization[30]. This justifies the results of the present study, where a significant difference between the Reciproc Blue and XP-endo Shaper groups was observed, with better results for the Reciproc Blue group concerning centralization preparation. This contrasts with the study carried out by Pacheco-Yanes et al.[31], which compared the centralization of these same instruments and reported that the XP-endo Shaper presented better centralization preparation. This difference can be explained due to methodological differences, as lower molars extracted from humans were used in the present study, while Pacheco-Yanes et al.[31] used artificial resin canals.

No statistical difference was observed regarding centralization preparation between the Reciproc and Reciproc Blue, or between the Reciproc and XP-endo Shaper groups. The first comparison (Reciproc and Reciproc Blue) results are justified by the similarity of the metallic instrument body, while the absence of any significance for the second comparison (Reciproc and XP-endo Shaper) may be due to the absence of instrument heat treatment. A significant difference between the analyzed thirds was observed when the apical third and the middle third and the apical third and the cervical third were compared.

The Reciproc Blue instrument displayed higher unprepared area percentages when compared to the XP-endo Shaper and Reciproc instruments. XP-endo Shaper showed lower apical transport and better Reciproc Blue centering.

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FIGURES

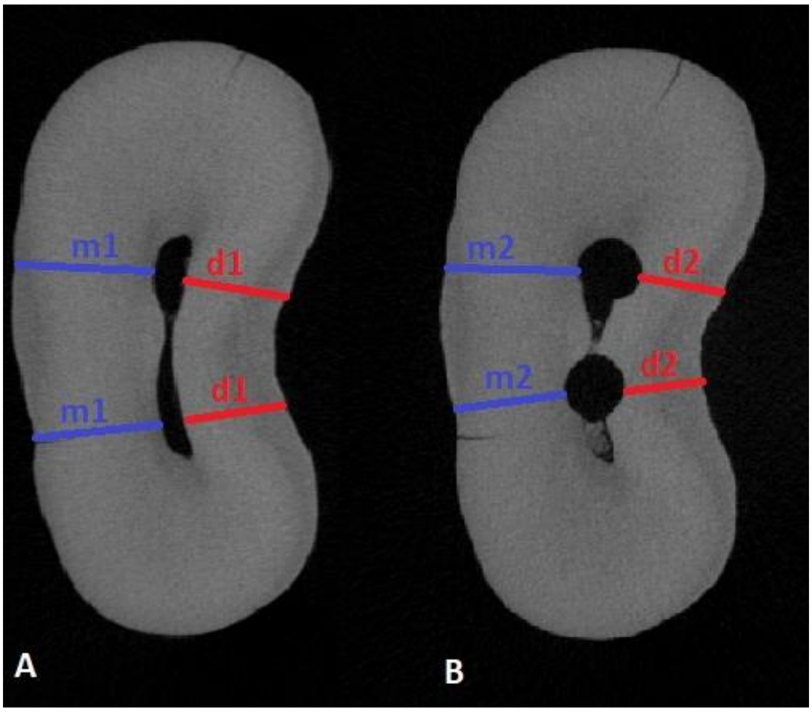

Figure 1 Illustration of dental wall measurement in the uninstrumented (A) and instrumented canal (B).

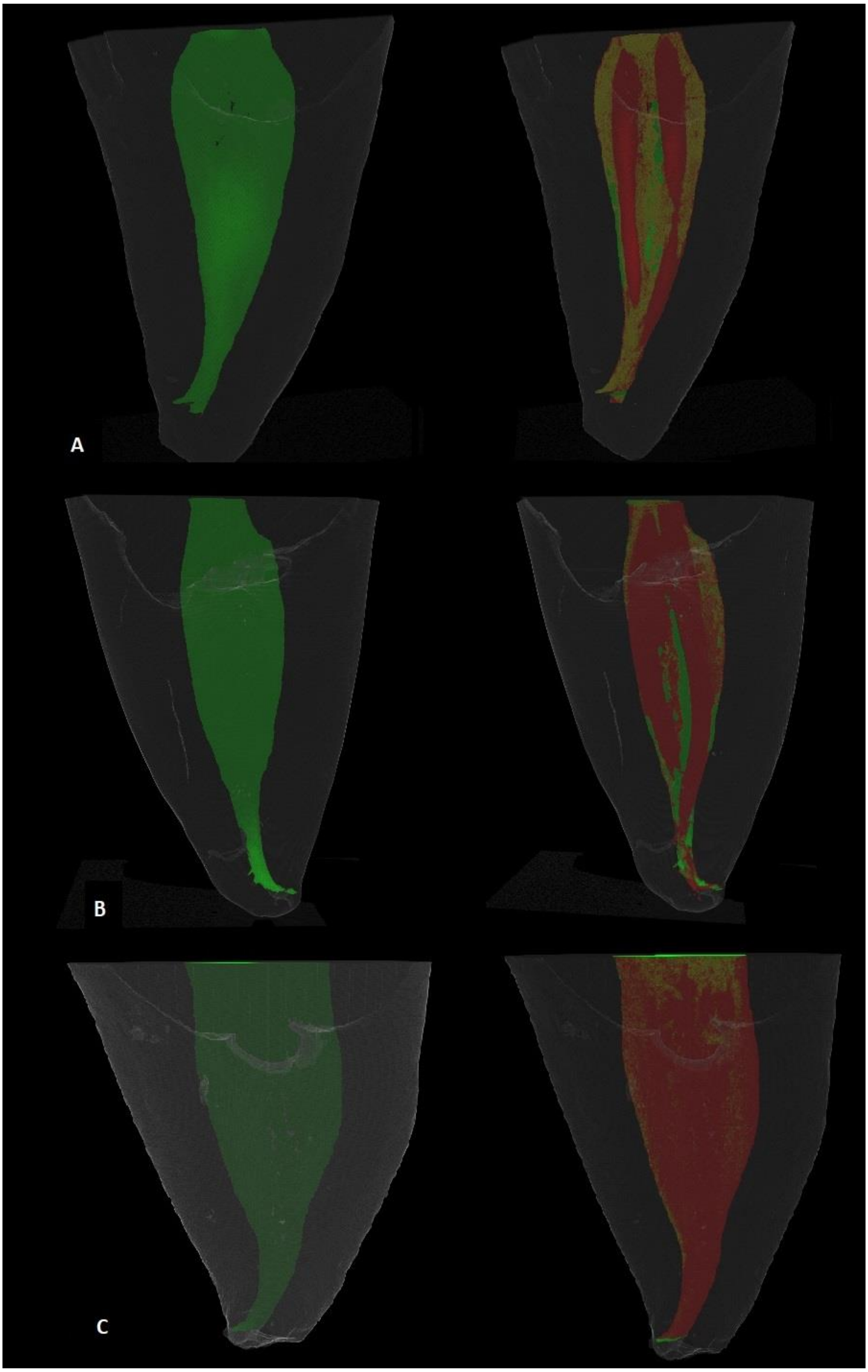

Figure 2 Image overlay before (green) and after (red) instrumentation. (A) Reciproc (B) Reciproc Blue (C) XP-endo Shaper.

TABLE

Table 1: Micro-CT parameters before and after instrumentation of root canals.

Micro-CT parameters	**Reciproc mean (SD)**	**Reciproc Blue mean (SD)**	**XP-endo Shaper mean (SD)**
FULL LENGTH OF THE CANAL			
Unprepared area (%)	15,32 (±17,57)	35,10 (±20,72)	14,50 (±14,29)
Volume (mm³)			
Before	6,84 (±3,74)	7,19 (±8,02)	6,61 (±3,92)
After	9,49(±3,44)	10,36 (±9,97)	8,78 (±4,60)
Surface area (mm²)			
Before	77,49 (±33,48)	71,19 (±42,03)	72,01 (±24,47)
After	83,23 (±25,38)	87,54 (±49,09)	75,96 (±21,70)
TERÇO APICAL			
Unprepared area (%)	24,62 (±28,05)	41,64 (±26,82)	30,19 (±31,72)
Volume (mm³)			
Before	0,62 (±0,30)	0,95 (±1,38)	0,80 (±0,35)
After	0,89 (±0,33)	1,17 (±1,55)	0,92 (±0,39)
Surface area (mm²)			
Before	12,24 (±5,92)	16,17 (±14,66)	13,79 (±5,08)
After	13,97 (±6,34)	16,15 (±12,29)	14,33 (±5,37)

Table 2: Outcomes of transport and centering according to distance from the apex root (3, 5 and 7 mm).

	Transport – mean (SD)		
	Reciproc	**Reciproc Blue**	**XP-endo Shaper**
3mm	0,01 (±0,04)	0,01 (±0,04)	-0,01 (±0,04)
5mm	0,02 (±0,09)	-0,01 (±0,09)	-0,01 (±0,07)
7mm	0,06 (±0,12)	0,05 (±0,06)	0,02 (±0,05)
	Centering – mean (SD)		
	Reciproc	**Reciproc Blue**	**XP-endo Shaper**
3mm	0,7(±0,26)	0,5 (±0,31)	0,4 (±0,35)
5mm	0,6 (±0,20)	0,6 (±0,30)	0,3 (±0,30)
7mm	0,5 (±0,23)	0,5 (±0,20)	0,3 (±0,25)

5. CONSIDERAÇÕES FINAIS

Pode-se concluir que os sistemas Reciproc e XP-endo Shaper apresentaram maiores áreas de paredes preparadas. O sistema XP-endo Shaper apresentou menor transporte apical e Reciproc Blue melhor centralização. Na avaliação do terço apical, para todos os sistemas, a área a 3mm do ápice radicular foi a de menor ocorrência de transporte apical e, consequentemente, de melhor centralização do preparo. Assim, considerando os sistemas de lima única avaliados e de acordo com a metodologia aplicada neste estudo, ainda não foi possível estabelecer um sistema ideal para o preparo dos canais radiculares, visto que, quando comparados entre si, os sistemas apresentaram divergências em relação aos quesitos avaliados individualmente, fazendo-se indispensável um plano de tratamento para a região do canal a ser tratada e se necessário for, correlacionar sistemas para alcanças melhores índices de sucesso.

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ANEXOS

ANEXO A – Parecer Consubstanciado do Comitê de Ética em Pesquisa

COMITÊ DE ÉTICA EM PESQUISA COM SERES HUMANOS | ufjf UNIVERSIDADE FEDERAL DE JUIZ DE FORA/MG Plataforma Brasil

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Análise de diferentes sistemas de lima única no preparo dos canais radiculares: estudo por microtomogradia computadorizada

Pesquisador: Celso Neiva Campos

Área Temática:

Versão: 1

CAAE: 61915416.6.0000.5147

Instituição Proponente: FACULDADE DE ODONTOLOGIA

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 1.840.821

Apresentação do Projeto:

Apresentação do projeto esta clara, detalhada de forma objetiva, descreve as bases científicas que justificam o estudo, de acordo com as atribuições definidas na Resolução CNS 466/12 de 2012, item III.

Objetivo da Pesquisa:

O Objetivo da pesquisa está bem delineado, apresenta clareza e compatibilidade com a proposta, tendo adequação da metodologia aos objetivos pretendido, de acordo com as atribuições definidas na Norma Operacional CNS 001 de 2013, item 3.4.1 - 4.

Avaliação dos Riscos e Benefícios:

O risco que o projeto apresenta é caracterizado como risco mínimo e estão adequadamente descritos, considerando que os indivíduos não sofrerão qualquer dano ou sofrerão prejuízo pela participação ou pela negação de participação na pesquisa e benefícios esperados. A avaliação dos Riscos e Benefícios estão de acordo com as atribuições definidas na Resolução CNS 466/12 de 2012, itens III; III.2 e V.

Comentários e Considerações sobre a Pesquisa:

O projeto está bem estruturado, apresenta o tipo de estudo, número de participantes, critério de inclusão e exclusão, forma de recrutamento. As referencias bibliográficas são atuais, sustentam os

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objetivos do estudo e seguem uma normatização. O cronograma mostra as diversas etapas da pesquisa,além de mostra que a coleta de dados ocorrerá após aprovação do projeto pelo CEP. O orçamento lista a relação detalhada dos custos da pesquisa que serão financiados com recursos próprios conforme consta no campo apoio financeiro. A pesquisa proposta está de acordo com as atribuições definidas na Resolução CNS 466 de 2012, itens IV.6, II.11 e XI.2; com a Norma Operacional CNS 001 de 2013. Itens: 3.4.1-6, 8, 9, 10 e 11; 3.3 - f; com o Manual Operacional para CEPS Item: VI - c; e com o Manual para submissão de pesquisa "Desenho".

Considerações sobre os Termos de apresentação obrigatória:

O protocolo de pesquisa está em configuração adequada, apresenta FOLHA DE ROSTO devidamente preenchida,com o título em português, identifica o patrocinador pela pesquisa, estando de acordo com as atribuições definidas na Norma Operacional CNS 001 de 2013 item 3.3 letra a; e 3.4.1 item 16. Apresenta o TERMO DE DISPENSA DO TCLE de acordo com a Resolução CNS 466 de 2012, item: IV.8. O Pesquisador apresenta titulação e experiência compatível com o projeto de pesquisa, estando de acordo com as atribuições definidas no Manual Operacional para CPEs. Apresenta DECLARAÇÃO de infraestrutura e de concordância com a realização da pesquisa de acordo com as atribuições definidas na Norma Operacional CNS 001 de 2013 item 3.3 letra h.

Conclusões ou Pendências e Lista de Inadequações:

Diante do exposto, o projeto está aprovado, pois está de acordo com os princípios éticos norteadores da ética em pesquisa estabelecido na Res. 466/12 CNS e com a Norma Operacional Nº 001/2013 CNS. Data prevista para o término da pesquisa:Junho de 2017.

Considerações Finais a critério do CEP:

Diante do exposto, o Comitê de Ética em Pesquisa CEP/UFJF, de acordo com as atribuições definidas na Res. CNS 466/12 e com a Norma Operacional Nº001/2013 CNS, manifesta-se pela APROVAÇÃO do protocolo de pesquisa proposto. Vale lembrar ao pesquisador responsável pelo projeto, o compromisso de envio ao CEP de relatórios parciais e/ou total de sua pesquisa informando o andamento da mesma, comunicando também eventos adversos e eventuais modificações no protocolo.

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_810674.pdf	27/10/2016 18:53:29		Aceito
Outros	declaracao_banco_de_dentes.jpg	27/10/2016 18:53:07	Carolina Oliveira de Lima	Aceito
Folha de Rosto	folha_de_rosto.pdf	23/10/2016 21:29:17	Carolina Oliveira de Lima	Aceito
Declaração de Instituição e Infraestrutura	declaracao_coparticipante.jpg	23/10/2016 21:27:47	Carolina Oliveira de Lima	Aceito
Projeto Detalhado / Brochura Investigador	Projeto.docx	23/10/2016 21:19:31	Carolina Oliveira de Lima	Aceito
Declaração de Pesquisadores	confidencialdade_sigilo.pdf	23/10/2016 21:17:17	Carolina Oliveira de Lima	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	dispensa_tcle.pdf	23/10/2016 21:16:49	Carolina Oliveira de Lima	Aceito
Declaração de Instituição e Infraestrutura	declaracao_instituicao.jpg	23/10/2016 21:16:34	Carolina Oliveira de Lima	Aceito

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

JUIZ DE FORA, 28 de Novembro de 2016

Assinado por:
Vânia Lúcia Silva
(Coordenador)

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ANEXO B – Normas do periódico ‘’JORNAL OF ENDODONTICS’’

GUIDE FOR AUTHORS

INTRODUCTION

The Journal of Endodontics is owned by the American Association of Endodontists. Submitted manuscripts must pertain to endodontics and may be original research (eg, clinical trails, basic science related to the biological aspects of endodontics, basic science related to endodontic techniques, case reports, or review articles related to the scientific or applied aspects of endodontics). Clinical studies using CONSORT methods (http://www.consort-statement.org/consort-statement/) or systematic reviews using meta-analyses are particularly encouraged. Authors of potential review articles are encouraged to first contact the Editor during their preliminary development via e-mail at JEndodontics@UTHSCSA.edu. Manuscripts submitted for publication must be submitted solely to JOE. They must not be submitted for consideration elsewhere or be published elsewhere.

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• E-mail address

• Full postal address

All necessary files have been uploaded:

Manuscript:

• Include keywords

• All figures (include relevant captions)

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• Ensure all figure and table citations in the text match the files provided

• Indicate clearly if color should be used for any figures in print

Graphical Abstracts / Highlights files (where applicable)

Supplemental files (where applicable)

Further considerations

• Manuscript has been 'spell checked' and 'grammar checked'

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• Permission has been obtained for use of copyrighted material from other sources (including the Internet)

• A competing interests statement is provided, even if the authors have no competing interests to declare

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• Referee suggestions and contact details provided, based on journal requirements

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PREPARATION

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The following list represents common errors in manuscripts submitted to the Journal of Endodontics:

a. The paragraph is the ideal unit of organization. Paragraphs typically start with an introductory sentence that is followed by sentences that describe additional detail or examples. The last sentence of the paragraph provides conclusions and forms a transition to the next paragraph. Common problems include one-sentence paragraphs, sentences that do not develop the theme of the paragraph (see also section "c," below), or sentences with little to no transition within a paragraph.

b. Keep to the point. The subject of the sentence should support the subject of the paragraph For example, the introduction of authors' names in a sentence changes the subject and lengthens the text. In a paragraph on sodium hypochlorite, the sentence, "In 1983, Langeland et al, reported that sodium hypochlorite acts as a lubricating factor during instrumentation and helps to flush debris from the root canals" can be edited to: "Sodium hypochlorite acts as a lubricant during instrumentation and as a vehicle for flushing the generated debris (Langeland et al, 1983)." In this example, the paragraph's subject is sodium hypochlorite and sentences should focus on this subject.

c. Sentences are stronger when written in the active voice, that is, the subject performs the action. Passive sentences are identified by the use of passive verbs such as "was," "were," "could," etc. For example: "Dexamethasone was found in this study to be a factor that was associated with reduced inflammation," can be edited to: "Our results demonstrated that dexamethasone reduced inflammation." Sentences written in a direct and active voice are generally more powerful and shorter than sentences written in the passive voice.

d. Reduce verbiage. Short sentences are easier to understand. The inclusion of unnecessary words is often associated with the use of a passive voice, a lack of focus, or run-on sentences. This is not to imply that all sentences need be short or even the same length. Indeed, variation in sentence structure and length often helps to maintain reader interest. However, make all words count. A more formal way of stating this point is that the use of subordinate clauses adds variety and information when constructing a paragraph. (This section was written deliberately with sentences of varying length to illustrate this point.)

e. Use parallel construction to express related ideas. For example, the sentence, "Formerly, endodontics was taught by hand instrumentation, while now rotary instrumentation is the common method," can be edited to "Formerly, endodontics was taught using hand instrumentation; now it is commonly taught using rotary instrumentation." The use of parallel construction in sentences simply means that similar ideas are expressed in similar ways, and this helps the reader recognize that the ideas are related.

f. Keep modifying phrases close to the word that they modify. This is a common problem in complex sentences that may confuse the reader. For example, the statement, "Accordingly, when conclusions are drawn from the results of this study, caution must be used," can be edited to "Caution must be used when conclusions are drawn from the results of this study."

g. To summarize these points, effective sentences are clear and precise, and often are short, simple and focused on one key point that supports the paragraph's theme.

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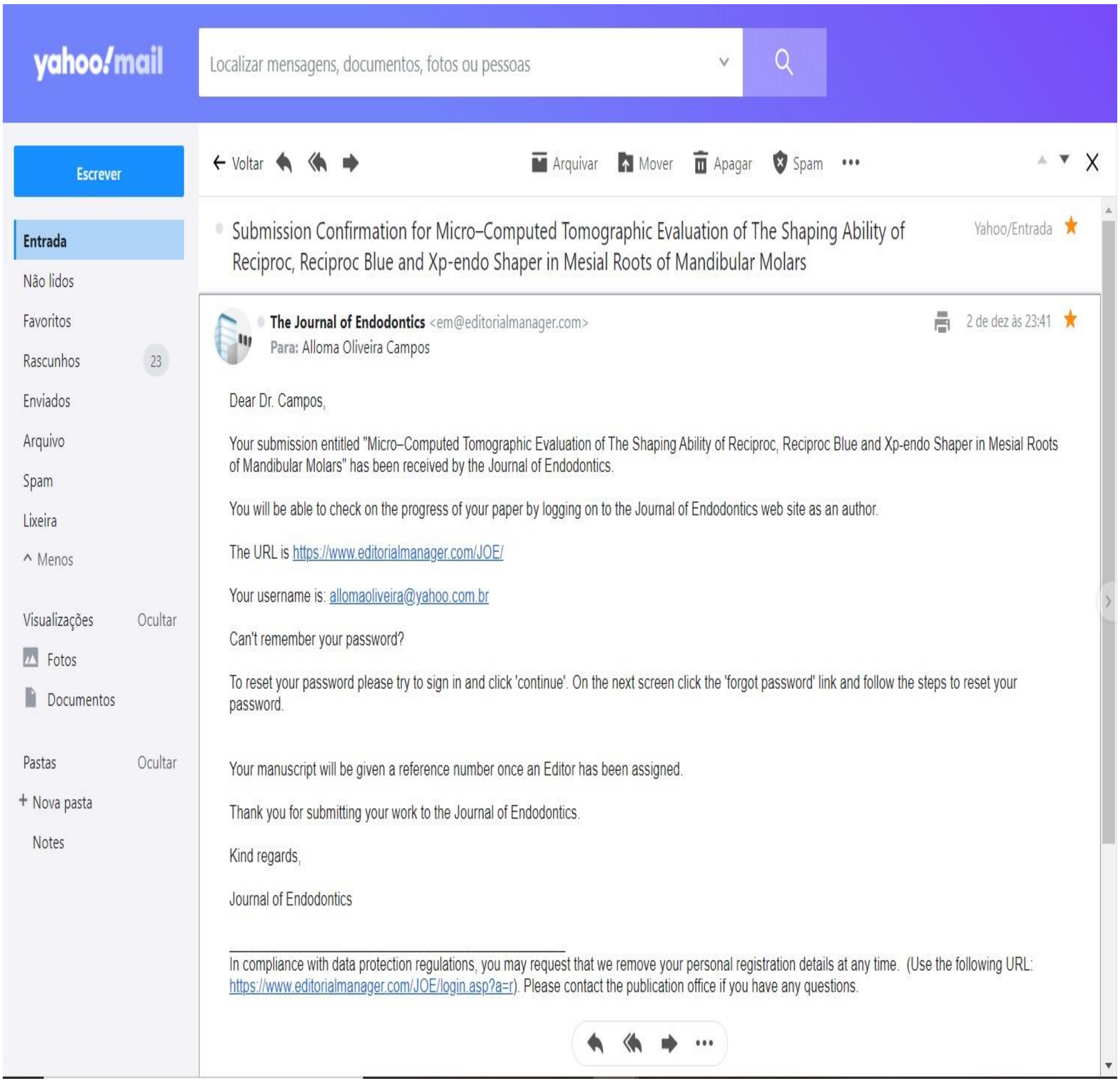

Submission Confirmation for Micro–Computed Tomographic Evaluation of The Shaping Ability of Reciproc, Reciproc Blue and Xp-endo Shaper in Mesial Roots of Mandibular Molars

The Journal of Endodontics <em@editorialmanager.com>
Para: Alloma Oliveira Campos
2 de dez às 23:41

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