UNIVERSIDADE DE UBERABA
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GABRIELA TIAGO FERREIRA

AVALIAÇÃO DA EFICIÊNCIA DO SISTEMA RECIPROCANTE COMPLEMENTADO AO USO DO ULTRASSOM NO RETRATAMENTO ENDODÔNTICO FRENTE A DIFERENTES MATERIAIS OBTURADORES

UBERABA – MG

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Dissertação apresentada ao Programa de Pós-graduação em Odontologia – Mestrado Acadêmico da Universidade de Uberaba, como requisito para obtenção do título de Mestre em Clínica Odontológica Integrada.

Orientadora: Profª. Drª. Renata Oliveira Samuel

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BANCA EXAMINADORA:

Profª. Drª. Renata Oliveira Samuel
Orientadora
Universidade de Uberaba

Prof. Dr. Cesar Penazzo Lepri
Universidade de Uberaba

Prof. Dr. Carlos Roberto Emerenciano Bueno
Faculdade de Odontologia de Araçatuba

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RESUMO

O objetivo deste trabalho foi avaliar, comparativamente, a eficiência da limpeza das paredes do canal radicular com uso da lima Reciproc 40.06, com ou sem o uso do ultrassom (US), no retratamento endodôntico com cimento resinoso AH Plus (AH) ou com cimento a base de silicato de cálcio TotalFill (TF). Foram selecionados 80 canais mesiais de molares inferiores extraídos, randomicamente divididos em 8 grupos com 10 canais cada: grupo AH/GP: raiz obturada com cimento AH + guta percha convencional (GP) e desobturada com lima reciprocante (R); grupo AH/GPS: raiz obturada com AH + GP revestida com partículas de silicato de cálcio (GPS) e desobturada com R; grupo AH/GP/US: raiz obturada com AH + GP e desobturada com R e US; grupo AH/GPS/US: raiz obturada com AH + GPS e desobturada com R e US; grupo TF/GP: raiz obturada com cimento TF + GP e desobturada com R; grupo TF/GPS: raiz obturada com TF + GPS: e desobturada com R; grupo TF/GP/US: raiz obturada com TF + GP e desobturada com R e US; grupo TF/GPS/US: raiz obturada com TF + GPS e desobturada com US. Para análise da eficiência dos diferentes protocolos, foram realizadas análises de extravasamento de debris via forame, tomografia computadorizada de feixe cônico (TCFC) e microscopia eletrônica de varredura (MEV). Além disso, visando avaliar se o retratamento endodôntico é capaz de alterar a dureza dentinária, foi feita análise da microdureza dentinária. Os resultados foram submetidos a testes estatísticos específicos para cada análise ($p<0.05$). Não houve diferença na extrusão de debris entre os grupos. O uso do US melhorou a limpeza no terço médio quando comparado aos terços cervical e apical nos grupos AH/GP/US, AH/GPS/US, TF/GP/US, TF/GPS/US ($p<0,05$). O uso da GPS não influenciou sua remoção quando comparado à GP ($p> 0,05$). Além disso, o cimento TF deixou menos resíduos após o retratamento em comparação com o AH ($p <0,10$). Observou-se, também, que nos grupos obturados com cimento TF a microdureza foi maior quando comparado aos grupos obturados com AH ($p<0,05$); e que o US não alterou a microdureza dentinária em nenhum dos grupos ($p>0,05$). Conclui-se que o cimento a base de silicato de cálcio é removido de forma mais eficiente que o cimento resinoso ao utilizar esse protocolo de retratamento endodôntico. Além disso, o cimento a base de silicato de cálcio aumenta a microdureza dentinária, mesmo após a sua remoção.

Palavras-chave: Cimento de silicato. Endodontia. Retratamento. Ultrassom.

ABSTRACT

The objective of this study was evaluate, comparatively, the efficiency of cleaning the root canal walls using the Reciproc 40.06 file, with or without the use of ultrasonic (US), in endodontic retreatment with AH Plus (AH) resin sealer or sealer based on calcium silicate TotalFill (TF). The mesiobuccal root canals of eighty human mandibular molars were selected and randomly divided into 8 groups with 10 canals each: AH/GP group: root filled with AH sealer + conventional gutta percha (GP) and removal with reciprocal file (R); AH/GPS group: root filled with AH + GP coated with calcium silicate particles (GPS) and removal with R; AH/GP/US group: root filled with AH + GP and removal with R and US; AH/GPS/US group: root filled with AH + GPS and removal with R and US; TF/GP group: root filled with TF + GP and removal with R; TF/GPS group: root filled with TF + GPS and removal with R; TF/GP/US group: root filled with TF + GP and removal with R and US; TF/GPS/US group: root filled with TF + GPS and removal with US. For the analysis of the efficiency of the different protocols, debris extrusion analysis, cone beam computed tomography (CBCT) and scanning electron microscopy (SEM) were performed. In addition, to assess whether endodontic retreatment is capable of altering dentinal hardness, an analysis of dentinal microhardness was performed. The results were evaluated with specific statistical tests for each analysis ($p < 0.05$). There was no difference in the extrusion of debris between the groups.The use of US improved cleaning in the middle third when compared to the cervical and apical thirds in groups AH/GP/US, AH/GPS/US, TF/GP/US, TF/GPS/US ($p < 0.05$). The use of GPS did not influence its removal when compared to GP ($p > 0.05$). In addition, TF sealer left less residue after retreatment compared to AH ($p < 0.10$). It was also observed that in groups filled with TF sealer, microhardness was higher when compared to groups filled with AH ($p < 0.05$); and that the US did not alter the dentinal microhardness in any group ($p > 0.05$). It is concluded that calcium silicate sealer is removed more efficiently than resin sealer when using this endodontic retreatment protocol. In addition, calcium silicate sealer increases dentin microhardness, even after removal.

Keywords: Endodontics. Retreatment. Silicate cement. Ultrasonics.

LISTA DE FIGURAS

Capítulo 1:

Capítulo 2:

Apêndice:

LISTA DE TABELAS

Capítulo 2:

LISTA DE ABREVIATURAS, SIGLAS E SÍMBOLOS

TF Cimento a base de silicato de cálcio Totalfill;

AH Cimento resinoso AH plus;

GP Guta percha convencional;

GPS Guta percha com partículas de silicato de cálcio;

US Ultrassom;

R Lima Reciproc;

TCFC tomografia computadorizada de feixe cônico

MEV microscópia eletrônica de varredura

CBCT Cone Beam Computed Tomography **(**Tomografia computadorizada de feixe cônico);

SEM Scanning Electron Microscope **(**Microscopia eletrônica de varredura);

KHN Knoop Hardness Number (Valor de dureza Knoop).

SUMÁRIO

1. INTRODUÇÃO

Atualmente graças aos avanços tecnológicos e novos protocolos de limpeza e modelagem dos canais radiculares, tratamentos endodônticos têm tido cada vez mais previsibilidade clínica e índices de sucesso elevados (FLORATOS & KIM, 2017). No entanto, insucessos ainda são relativamente presentes, e estima-se que em 14-18% dos casos haja indicação de retratamento endodôntico (TORABINEJAD *et al*., 2009), especialmente em tratamentos que envolvem polpa mortificada e infecção (SJOGREN *et al*., 1990).

Assim, a reintervenção é comum e quando indicada, ainda é um desafio para o profissional, uma vez que existe a presença de infecções secundárias com bactérias resistentes (RÔÇAS & SIQUEIRA, 2012). Desta forma, o índice de sucesso do retratamento é de aproximadamente 78%, enquanto o sucesso do tratamento chega a aproximadamente 86% (ELEMAM & PRETTY, 2011). Esse índice reduzido de sucesso no retratamento pode acontecer devido a presença de material obturador remanescente, que pode funcionar como nicho de bactérias resistentes, tais como *Enterococcus faecalis*, dificultando a limpeza efetiva (RÔÇAS & SIQUEIRA, 2012).

Desta forma, há necessidade de protocolos eficientes que visam a remoção da maior quantidade de material obturador possível, e consequentemente, remoção de todo conteúdo séptico-tóxico incorporado nessa massa obturadora (RUDDLE, 2004). Existem hoje diversos protocolos para retratamento, com diferentes limas e solventes com indicação específica para cada caso (JORGENSEN *et al.*, 2017; HE *et al.,* 2017). A diversidade de materiais obturadores utilizados no tratamento endodôntico também ajuda a diversificar o sucesso na remoção de todo material (OLTRA *et al.,* 2017).

Atualmente, cimentos a base de resina como o AH Plus atendem as recomendações da American Dental Association nas suas propriedades físicas e químicas, tais como radiopacidade, biocompatibilidade, fluidez e vedação (BERNARDES *et al.,* 2010). No entanto, cimentos resinosos tem como desvantagem sua citotoxidade frente aos tecidos periapicais, não são reabsorvíveis (MOURA *et al*.,2014), não favorecem o reparo e não tem ação efetiva antimicrobiana por longos períodos (LANGELAND, 1974).

Assim, novas propostas são discutidas a fim de conseguir um material que promova um selamento hermético e promova, simultaneamente, o reparo dos tecidos periapicais e ação contra possíveis bactérias que tenham sobrevivido ao preparo químico-mecânico (UTNEJA *et al.,* 2015).

Dentro deste contexto, a proposta mais promissora de um material obturador próximo ao ideal, seria a utilização de cimentosa base de silicato de cálcio, que até então têm mostrado excelente capacidade de selamento, boa tolerância em ambientes úmidos, induz o reparo e tem efetiva ação antimicrobiana (UTNEJA *et al.,* 2015). Assim, possivelmente, nos próximos anos aumentará o número de dentistas optando pela utilização deste cimento, que atende melhor os pré-requisitos de um cimento ideal no tratamento endodôntico (BEST *et al.*, 2008).

A proposta do fabricante é que os cimentos a base de silicato de cálcio sejam utilizados com uma guta percha própria, revestida com partículas de silicato de cálcio (FKG Dentaire S.A., Suíça). A intenção da utilização da guta percha própria para o cimento é formar um “monobloco”, uma vedação livre de lacunas. O fabricante afirma ainda que a obturação realizada com a guta percha própria possibilita maior resistência do dente a fratura, de forma semelhante a um dente sem tratamento endodôntico realizado (FKG Dentaire S.A., Suíça).

No entanto, estudos mostram que embora este cimento seja promissor do ponto de vista físico-químico, em casos de fracasso do tratamento, a sua remoção parece ser extremamente dificultada quando comparado a cimentos resinosos, como o AH Plus (HESS *et al.,* 2011, DE SIQUEIRA ZUOLO *et al*., 2016, OLTRA *et al.*, 2017). Assim, é necessário estudos comparativos de protocolos que visam melhor remoção da massa obturadora e, consequentemente, melhor limpeza do sistema de canais radiculares, para que se torne ainda mais viável sua utilização clínica.

Classicamente, o retratamento endodôntico pode ser realizado com limas rotatórias próprias para retratamento ou limas atuando com movimento reciprocante, tendo ambas as técnicas, bons resultados (SILVA *et al*.,2015). No entanto, há situações que somente a remoção mecânica não é possível, sendo necessária a utilização de solventes endodônticos para maior eficiência da remoção da obturação (OLTRA *et al*., 2017).

A utilização de solventes como clorofórmio durante o retratamento endodôntico pode ser uma vantagem, uma vez que este pode ajudar promover maior

remoção do material obturador quando comparado com protocolos que não indicam seu uso (OLTRA *et al.*, 2017). Entretanto, nem sempre, é necessária a utilização de solvente (HORVATH *et al*., 2009). Alguns estudos têm demonstrado que sempre que possível o ideal é não utilizá-lo (JAIN *et al*., 2015). Isso porque o solvente faz com que a guta percha mais liquefeita se adira às paredes do canal dificultando sua limpeza (HORVATH *et al*., 2009).

Além disso, a maioria dos solventes utilizados no mercado são citotóxicos e alguns têm potencial carcinogênico. Assim, existem trabalhos que não recomendam a utilização destes materiais durante o retratamento endodôntico, tendo sua indicação restrita a casos em que a remoção puramente mecânica não seja possível (JAIN *et al.,* 2015).

Tendo em vista as desvantagens mostradas com a utilização de solventes, novas abordagens para o retratamento são necessárias para aumentar a eficiência da limpeza, especialmente em cimentosa base de silicato de cálcio, que se aderem mais fortemente às paredes do canal, formando “monobloco” (PAWAR, PUJAR, MAKANDAR, 2014, OLTRA *et al*., 2017). Dentro deste contexto, o ultrassom tem características promissoras que ajudam na remoção mecânica da massa obturadora, sem o prejuízo de acumular resíduos que permaneçam na parede dos canais como acontece com os solventes (JAIN *et al.*, 2015).

A ativação ultrassônica da solução irrigadora (hipoclorito ou clorexidina) melhora consideravelmente a limpeza durante o retratamento endodôntico quando comparado a protocolos que utilizam solventes ou apenas a limpeza mecânica (SILVEIRA *et al.,* 2018). Esta melhoria na limpeza é alcançada graças ao fenômeno conhecido como “cavitação”, que é proporcionado pela ativação ultrassônica. A cavitação age criando novas bolhas, que expande e/ou distorce bolhas preexistentes, os chamados núcleos em um líquido. Dessa forma, o líquido irrigante é ativado pela energia ultrassônica transmitida a partir dos instrumentos energizados, produzindo fluxo acústico e redemoinhos, que atuam diretamente na limpeza (AHMAD *et al.,*1987).

Embora a abordagem com ultrassom seja muito promissora para retratamento, poucos estudos foram realizados avaliando a remoção mecânica diretamente da massa obturadora com insertos ultrassônicos próprios para este fim. A maioria dos estudos buscam a limpeza apenas por meio da agitação da solução

irrigadora (GRISCHKE, MÜLLER-HEINE, HÜLSMANN, 2014; BARRETO *et al.*,2016). Além disso, não há estudos evidenciando se a utilização do ultrassom para remover a massa obturadora em um canal inundado com hipoclorito de sódio pode reduzir a microdureza dentinária ou aumentar a quantidade de debris extravasados apicalmente. Só há, até então, um relato evidenciando que a agitação de ácido etilenodiaminotetracético trissódico (EDTA) pode reduzir a microdureza quando ativado com insertos ultrasônicos (GUO, ZHANG, ZHEN, 2015).

Alguns insertos já foram desenvolvidos com o intuito de atuar diretamente na massa obturadora. Geralmente estes têm formato cônico com a ponta inativa, como por exemplo o SP1 da marca NSK (NSK, Joinville, Santa Catarina, Brasil). Estudos mostram que a utilização deste inserto atuando diretamente na remoção de restos de material obturador foi significativamente melhor quando comparado a técnicas de retratamentos convencionais utilizando somente solventes com brocas de Gattes, brocas de Largo e limas manuais (DE MELLO JUNIOR *et al.,* 2009).

Foi desenvolvido também um inserto com formato de lança conhecido como Clearsonic (Helse, Santa Rosa de Viterbo, São Paulo, Brasil). Segundo o fabricante, este inserto pode alcançar regiões de canais achatados que geralmente as pontas convencionais não chegam. Além disso, seu formato pode ter como vantagem a maior facilidade de avançar com o instrumento no sentido apical, removendo a massa obturadora com mais facilidade (Helse, Santa Rosa de Viterbo, São Paulo, Brasil). Esta característica pode ser promissora especialmente em retratamentos com materiais mais rígidos, como parece ser o caso dos cimentos a base de silicato de cálcio. No entanto, até o momento, ainda não há estudos avaliando este inserto nestes materiais.

A partir do exposto, nota-se que ainda não há um consenso de qual o melhor protocolo para retratamento endodôntico, especialmente quando se utiliza os promissores cimentos a base de silicato de cálcio com seus respectivos cones de guta percha especiais. Assim, o presente estudo visa elucidar: i) se o uso do US aumenta a eficiência da limpeza quando comparado a protocolo que utiliza somente limas; ii) se o material utilizado no tratamento favorece a presença de mais remanescente de obturação após os protocolos de limpeza do retratamento; iii) se o uso do US ou o uso de diferentes cimentos pode alterar a microdureza dentinária; iv) se o retratamento endodôntico é capaz de gerar extrusão de debris em maior quantidade.

2. PROPOSIÇÃO

O objetivo do presente estudo foi avaliar comparativamente:

a) qual o método mais eficiente para limpeza e remoção da massa obturadora, ou seja, com ou sem a utilização do US;
b) Se a presença de diferentes cimentos utilizados no tratamento endodôntico pode interferir na sua remoção;
c) Se nos diferentes terços radiculares há diferença na eficiência de limpeza;
d) Se a utilização de diferentes materiais obturadores ou protocolos de retratameto podem favorecer a extrusão de debris,
e) Se a utilização de diferentes materiais obturadores ou protocolos de retratameto podem levar a diferenças na microdureza dentinária.

3. CAPÍTULO 1

Evaluation of the cleaning efficiency of a new ultrasonic tip for endodontic retreatment against different filling materials

Gabriela Tiago Ferreira – DDS, MSc.
Department of Clinical Dentistry, Universidade de Uberaba, Uberaba, Minas Gerais, Brazil.

Carlos Roberto Emerenciano Bueno – DDS, MSc, PhD
Department of Endodontics, School of Dentistry, São Paulo State University - UNESP, Araçatuba, São Paulo, Brazil

Fabiano Rodrigues da Cunha – DDS
Department of Clinical Dentistry, Universidade de Uberaba, Uberaba, Minas Gerais, Brazil.

Gilberto Antônio Borges – DDS, MSc, PhD
Department of Clinical Dentistry, Universidade de Uberaba, Uberaba, Minas Gerais, Brazil.

Benito André Silveira Miranzi – DDS, MSc, PhD
Department of Endodontics, Universidade de Uberaba, Uberaba, Minas Gerais, Brazil.

Isabela Resende Nunes – DDS
Department of Clinical Dentistry, Universidade de Uberaba, Uberaba, Minas Gerais, Brazil.

Paulo Oliveira Fortunato – DDS
Department of Clinical Dentistry, Universidade de Uberaba, Uberaba, Minas Gerais, Brazil.

Renata Oliveira Samuel – DDS, MSc, PhD
Department of Endodontics, Universidade de Uberaba, Uberaba, Minas Gerais, Brazil.

Address requests for reprints to Drª
Renata Oliveira Samuel,
Department of Endodontics,
University of Uberaba – UNIUBE
Av. Nenê Sabino, 1801
Universitário 38055-500
Uberaba – MG – Brazil
Phone +55 34 3319-8913
Fax +55 34 3319-8800
E-mail address: renata.samuel@uniube.br

ABSTRACT

Introduction: The aim of this study was evaluate the efficiency of root canal cleaning in the endodontic retreatment whether or not using specific ultrasonic tip (Clearsonic, Helse, Santa Rosa de Viterbo, São Paulo, Brazil) to remove endodontic material of roots filled with AH Plus (AH) (resin sealer) or TotalFill (TF) (calcium silicate sealer).

Methods: The mesiobuccal root canals of eighty human mandibular molars were selected and randomly divided into 8 groups (N=10): Group AH/GP: Root filled with AH + conventional gutta percha (GP) and removal only with reciprocal file Reciproc 40.06 (R); Group AH/GPS: root filled with AH + GP coated with calcium silicate particles and removal with R; Group AH/GP/US root filled with AH + GP and removal with ultrasonic tip (US) supplemented with R; Group AH/GPS/US root filled with AH + GPS and removal with US supplemented with R; Group TF/GP root filled with TF + GP and removal with R; Group TF/GPS root filled with TF + GPS and removal with R; Group TF/GP/US root filled with TF + GP and removal with US supplemented with R; Group TF/GPS/US root filled with TF + GPS and removal with US supplemented with R. For the analysis of the efficiency of the different protocols, debris extrusion analysis, cone beam computed tomography (CBCT) and scanning electron microscopy (SEM) were performed and the results were evaluated according to each analysis ($p < 0.05$).

Results: There was no significant statistical difference in debris extrusion ($p > 0.05$). Specific US tip to remove endodontic material improved cleanliness in the middle third when compared with cervical and apical third ($p<0.05$). GPS did not influence its removal when compared to GP ($p>0.05$). In addition, TF left less residue after retreatment compared to AH ($p<0.10$).

Conclusions: AH is more difficult to be completely removed from the root canal walls in endodontic retreatment than TF sealer with the studied protocol. Specific US tip to remove endodontic material is effective to assist in cleaning of the root canal system, especially in the middle third.

KEY WORDS: Endodontics. Retreatment. Silicate cement. Ultrasonics.

4. INTRODUCTION

Faced with an endodontic failure, there is a need to perform root canal retreatment. However, this procedure is challenging due to the difficulty of completely removing the filling materials (1). Studies show that no method currently can remove all this material from the root canal (2,3).

In order to improve cleaning, there are several techniques being proposed (4,5). Recently, the use of ultrasonic (US) has shown promising results in agitation of the irrigating solution in both treatment (6) and retreatment (7) . However, the use of these tips has a greater focus on agitation of the solution rather than directly on the plug mass. A new ultrasonic tip design has been proposed aiming to act directly on the obturator mass (Clearsonic, Helse, Santa Rosa de Viterbo, São Paulo, Brazil). Thus, it is possible that with this new approach, removal of the filling material will be more efficient (8).

Studies show that calcium silicate based-sealer have very promising biological, physical and chemical characteristics (9). With this material, it is idealized to create a more hermetically sealed filling, with more uniform adhesion. To this end, the manufacturers recommend that in addition to the use of sealer, also use a gutta percha coated with calcium silicate particles (GPS), so that there is adhesion of sealer in both root canal walls and gutta percha (GP), avoiding gaps (FKG Dentaire - La-Cheaux-de Fonds – Switzerland). However, it is still not completely known how this material behaves when it is necessary to remove it from the root canals in case of endodontic retreatment: there are investigations that show the greater difficulty of removing them (10,11,12) as studies that show that they are removed more easily when compared to resin based (13,14). Thus, there may be a need for more efficient and more secure protocols to remove this material.

Within this context, and with the favorable results presented with the use of US in endodontic retreatment, it may be that this newly ultrasonic tip that acts directly on the obturator mass is ideal in more complex cases or in regions where are materials harder to remove from the canal. In the literature, the Clearsonic was used as a supplementary approach in the retreatment of mandibular incisors and showed a significant reduction of filling material of the roots (15). Although done, incisors has less

difficulty in removing filling material when compared to molars. Thus, more detailed studies should be done to assess the effect of using clearsonic on other dental groups.

Besides the analysis of cleaning effectiveness, it is necessary to evaluate if the use of US directly in the obturator mass can influence the extrusion of debris. Extruded fragments are a major disadvantage, especially in retreatment, as they can carry bacteria and irritating material remains to periapical tissues, causing postoperative pain and further causing inflammation in periapical tissues (16).

Therefore, the objective of this study was to evaluate comparatively whether the removal of TotalFill (TF) sealer when compared to AH Plus sealer associating US or not with the cleaning protocol and analyzing whether there is a different of debris extrusion via apical foramen than expected. The null hypothesis is that based-silicate sealer does not able to left less residues in the root canal.

5. MATERIALS AND METHODS

This study was approved by the Research Ethics Committee (CAAE: 86728218.8.0000.5145). Eighty mesiobuccal roots of mandibular molars were included. The teeth were submitted to an initial cone-beam computed tomography (CBCT) to be selected.

5.1 Cone Beam Computed Tomography scans (CBCT)

CBCT were scanned in a tomography device (Eagle 3D, Dabi Atlante, Brazil). Each sample was scanned with a pixel size of 0,02mm, 40s exposure time and Field of view (FOV) of 6 centimeters. The scans were made in three times: 1. Before the instrumentation; 2. After the obturation and 3. After the endodontic retreatment.

5.2 Specimen Preparation

Roots less than 10˚ and more than 25˚ curvature or with marked convexity in the distal root wall (furcation area) were excluded. Canals with incomplete rhizogenesis, root

fractures or perforations were excluded too. All teeth were standardized at 19mm of length. A coronal access preparation was performed, and the working length was established by subtracting 1 mm from the tip of a size 10 K-file (Dentsply Maillefer, Ballaigues, Switzerland) when visualized at the apical foramen.

5.3 Root canal instrumentation

This procedure was performed with the Logic System (Easy Dental Equipment, Belo Horizonte, MG, Brazil) according to the manufacturer's recommendation (size 25, 0.01 taper and size 25, 0.06 taper) and the final file used was size 30, 0.06 taper (Hero, Micromega, Besançon, France). The canals were irrigated with 3 mL of 2.5% NaOCl after each file.

After root canal instrumentation, the root canals were randomly divided into 8 groups with 8 teeth each using Random Allocation software (Microsoft, Seattle, WA, USA): Group AH/GP/R: Root filled with AH (Dentsply, DeTrey, Konstanz, Germany) + GP (MK Life Medical and Dental Products Brazil, Porto Alegre, RS, Brazil) and removal with R size 40, 0.06 taper (Reciproc, VDW, Munich, Germany) Group AH/GPS root filled with AH + GPS (FKG Dentaire - La-Cheaux-de Fonds - Switzerland) and removal with R; Group AH/GP/US root filled with AH + GP and removal with US tip specific to retreatment (Clearsonic, Helse, Santa Rosa de Viterbo, São Paulo, Brazil). ; Group AH/GPS/US root filled with AH + GPS and removal with US; Group TF/GP root filled with TF + GP and removal with R; Group TF/GPS/R) root filled with TF + GPS and removal with R; Group TF/GP/US root filled with TF+GP and removal with US; Group TF/GPS/US root filled with TF+GPS and removal with US.

All root canals have been final irrigated with 17% EDTA and left for 3 min, were dried with absorbent paper points and filled using the sealer and the type of GP with size 30/.06 (MicroMega, Besançon, France) and type according with each group. Vertical compaction was performed with a Paiva condensor compatible with the canal diameter. The canals were sealed with Coltosol (Coltène/Whaledent AG, Altstätten, Switzerland) and were stored in an oven at 37°C for 2 weeks.

5.4 Filling Removal

The removal of filling material was performed according to the experimental group: a) Groups AH/GP; AH/GPS; TF/GP; TF/GPS: the mechanical removal of the filling material was performed by thirds. Initially Reciproc (VDW, Munich, Germany) size 40, 0.06 taper entered the cervical third in the first 6mm; later in the middle third until 12mm and at last the file entered the 18mm. The canals were irrigated with 3 mL of 2.5% NaOCl after each file.

B) Groups AH/GP/US; AH/GPS/US; TF/GP/US; TF/GPS/US: In the cervical and middle third the Clearsonic ultrasonic insert (Helse, Santa Rosa de Viterbo, São Paulo, Brazil) was used at 35KHz, which was activated by Olsen (Olsen, Palhoça, Santa Catarina, Brazil) (17). For the apical third, R file 40, 0.06 taper file was used to remove the filling material from the apical third. The canals were irrigated with 3 mL of 2.5% NaOCl after each file.

5.5 Debris Collection

The method used was adapted from previous studies[17,18]. Prior to retreatment, the teeth were placed in empty Eppendorf tubes were pre-weighted by using a 10-5g precision analytic microbalance (SP Labor, São Paulo, SP, Brazil). Three consecutive weights were obtained for each tube, and the mean value was considered to be its initial weight. Each tube was weighted three consecutive times and the mean value was its initial weight. To equalize the air pressure inside and outside the tubes, a 27-G needle was inserted alongside in a barrier constructed with addition silicone (DFL, Rio de Janeiro, RJ, Brazil). Then each set composed of silicone, tooth and needle was attached to its Eppendorf tube and the tubes were placed in vials.

The root apex was not seen during the endodontic retreatment procedure by a laminated paper that wrapped the Eppendorf tube. Immediately after the reinstrumentation, the laminated paper was removed from the vial. Each tooth was gently removed from the Eppendorf tube and the debris adhered to the root surface were collected by washing off the apex with 1 mL of distilled water into the Eppendorf tube. The tubes were stored in an incubator at 68°C for 5 days to evaporate the

moisture before weighing the dried debris. Weighing was carried out again and three consecutive weights were obtained for each tube, and the mean was calculated. The dried weight of the extruded debris was calculated by subtracting the weight of the empty tube from that of the tube containing debris.

5.6 Root canal evaluation by CBCT

For each specimen, two calibrated researchers attributed scores relating to the amount of remaining obturator material found: score 1 (presence of up to 5% of remaining obturator material); score 2 (presence of approximately 6 - 30% of remaining obturator material), score 3 (presence of more than 30% of obturator material) (18).

5.7 Root canal evaluation by SEM

For the SEM analysis, five samples of each group were selected and a groove was made in each tooth with a diamond saw to split it longitudinally. Both root halves were dehydrated at 37 °C for 7 days and sputter coated with gold (Desk IV Denton Vacuum, Moorestown, NJ, USA). Images of the cervical, middle and apical thirds of the buccal and lingual extensions of all roots were taken by SEM (JEOL, JSMTLLOA, Tokyo, Japan) at 25 kV and at a standard magnification of 1000X. The SEM images were scored: score 1 (presence of up to 5% of remaining material); score 2 (presence of approximately 6 - 30% of remaining material), score 3 (presence of more than 30% of obturator material.

5.8 Statistical analysis

Statistical analysis was performed using the SigmaPlot 12.0 ™ program (Chicago, IL, USA). For the analyzes that were assigned scores, the Kruskal-Wallis test was applied, and when any significant difference was observed, the cross-grouping was performed by Dunn's multiple comparisons test[19]. We also used the Mann Whitney test[20] for comparison between two groups alone. The results were considered statistically significant when the probability was less than 5% ($p \leq 0.05$).

6. RESULTS

6.1. Debris collection analysis

Debris extrusion was observed in all groups, regardless of the technique of remove or type of filling material used. Thus, no significant differences were observed in debris extravasation between obturator removal protocols (p=0,741).

6.2. The computed tomography scans

After the endodontic retreatment, the efficiency of the removal of the material was not statistically different between the groups that used R or US in the cervical and apical thirds (p> 0.05). In the middle third, the groups that used US obtained a greater cleaning when compared to the groups that didn't have this resource during the retreatment of the root canals (p <0.05) (Fig.1 – A).

The use of resin sealer AH left more residues in the root canal than the TF sealer (p = 0.07) (Fig.1 – A). The type of GP used, being conventional or GPS, did not indicate statistical difference in cleaning efficiency between the groups presented in the study (p >0.05).

6.3. Scanning electron microscope analysis (SEM)

Within a qualitative analysis, SEM confirmed the results obtained by CBCT. A common cleaning pattern was observed between the groups that used or not the US when analyzing the cervical and apical thirds (figure 1 - A). In addition, in the groups that used US (figure 1 – C,E,G and I), was a greater effectiveness of cleaning in the middle third when comparing with groups that used only R (figure 1 – B,D,F and H) When comparing the types of sealers used, a greater presence of residues within the root canal was observed in the groups that used AH (figure 1 – B,C,D and E). However, when comparing the different GP, the cleaning efficiency remained the same.

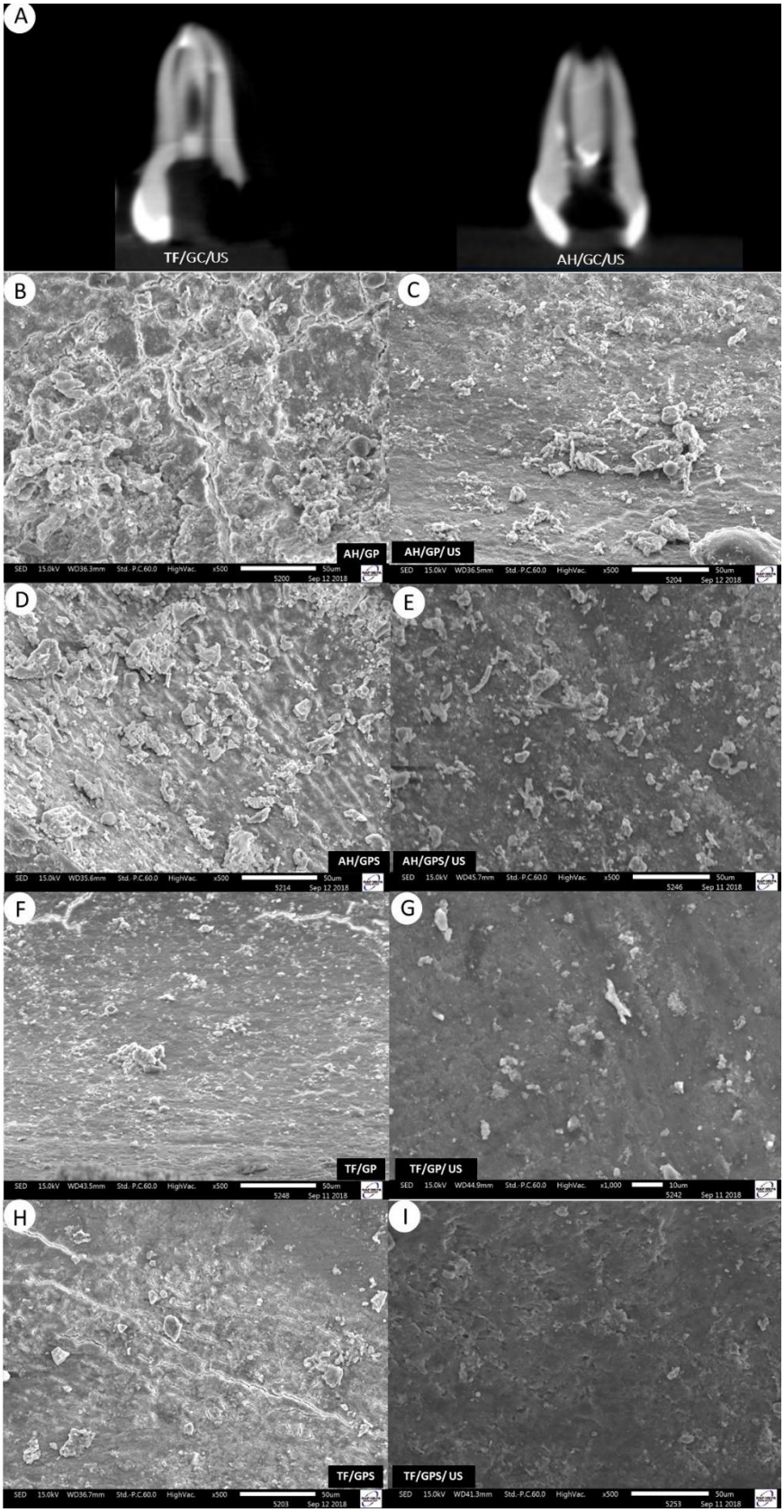

Figure 1 - Representative images of (A) CBCT and (B, C, D, E, F, G, H and I) SEM at the middle third. A greater cleaning in the middle third of the groups that used US (C, E, G, I). The

use of TF sealer left less filling material than AH resin sealer (comparing F, G, H and I with B,C,D and E).

7. DISCUSSION

This study was carried out to evaluate the efficiency of cleansing of endodontic retreatment in the different thirds of the root canal with protocols that used or not the US associated with different obturator materials. It was observed that in the medium third, independent of the obturator material used, the cleaning efficiency was higher in the groups that used the US when compared to those that used only R. This result was already expected and demonstrated in previous studies that used inserts to activate the irrigation solution in the canal (7,8,23,24).

Although the cleaning efficiency was similar to the inserts that only agitate the irrigating solution (7,8,23,24), this new proposal allows for easier material removal, especially due to the heat generated by the US, which initiates GP thermoplasticization (15). Unlike the other inserts on the market, it does not only act on the agitation of the irrigation solution inside the canal: it has a direct action on the obturator material through its spear-shaped tip. Thus, it is possible, with this new insert, for the material to be "hooked" by the operator, as it has the ideal strength and shape for removal of these fragments. In addition, due to its longer stem, the insert may reach, in some cases - in the absence of curvature - up to the apical third. However, this apparatus is still new in the market and does not have many studies analyzing the real cleaning action compared to other inserts, mainly inserts to agitate the irrigation solution in front of different materials.

In addition, our results demonstrated that in the cervical third there was no statistically significant difference between the study groups. Possibly this result was obtained due to the greater facility of cleaning, better visualization by the operator and an easier access to the root canal. Thus, the anatomy of the cervical third allows effective instrumentation in this region independent of the cleaning protocol used (24).

In relation to the apical third, a greater presence of waste of obturator material was found when compared to the other thirds of the same tooth. However, when comparing the apical third in all groups, it was noticed that there was no difference between them, regardless of the cleaning technique and the obturator material used. This fact occurs due to the tip of the ultrasonic insert being able to access only up to

the middle third of the root canal. Thus, it prevents the direct contact and action of the ultrasonic insert in the apical third on the obturator material. This result was already expected and had already been demonstrated in other reports when the ultrasonic inserts were used to activate the irrigation solution in the canal (7, 23,24,25,26).

Regarding the type of sealer used, there was a slight higher presence of residues in the groups with AH sealer when compared to TF groups ($p = 0.07$). There is a report showing removal of resinous AH was better when associated with the use of chloroform solvent in relation to BC Sealer (calcium silicate based-sealer) (12). However, this result may have been contrary to that presented by the present study due to the absence of solvent use and the difference of commercial brands of the materials used. In addition, the present study in the literature is not conclusive in the analysis of which type of material was better removed, only being described that it is not possible to remove it completely (27). It has also been proven in reports (28) that whenever possible, the ideal is not to use solvents, as the liquefied GP can adhere to the root canal walls making it even more difficult to clean (29).

There are not many reports on the cleaning efficiency of calcium silicate based-sealers after endodontic retreatment. There are results showing both more difficult removal and reports showing more efficient retreatment removal compared to resin sealer (10-14). The question is whether this easier removal may be the result of poor prey reaction. Studies show that although calcium silacated based-sealers has promising characteristics, in some cases, due to the difficulty of standardizing how much moisture needed in the root canal, it can directly affect the polymerization process (30). In the present study, the teeth were conditioned in ambience with humidity and standardized temperature, at 37 ° C for 15 days to approximate the clinical situation. However, as there is still no standardization of the amount of moisture required for these sealer have set, further studies are needed to evaluate if the ease of removal of calcium silicate based sealer is related to the absence of total polymerization of the material.

The CBCT analysis was chosen for its non - destructive character of the samples, for its easy visualization of the quantity of residual sealing material in three dimensions within the root canal and for the ease of quantitative analysis. Studies have reported that using image analysis such as tomography and micro-tomography (an analysis similar to tomography but on a smaller scale), there is a superior evaluation

in the quantification of residues in three-dimensional images in the quantitative aspect (31,32).

In the present study, with the objective of detailing the residues quality in the walls of the root canal, as well as the condition of cleaning of the dentin tubules and removal of the smear layer, SEM was also performed (33,34). It was observed that the teeth had microscopic remains of obturator material added to the root canal and infiltrating the dentinal tubules, which proves that the absolute cleaning is not yet possible in the case of an endodontic retreatment (8). In addition, through SEM, it was possible to observe that in the middle third in the groups that used ultrasound, there was more exposure and cleanliness of the canal walls and dentinal tubules. Thus, SEM results were crucial to confirm the results obtained with the CT scans.

8. CONCLUSION

The use of US significantly improves root canal cleansing in endodontic retreatment, especially in the middle third. The calcium silicate-based sealer left less residues in the root canal when compared to the resin sealer AH plus, regardless of the retreatment technique evaluated. The protocol used does not change the volume of debris extrusion during endodontic retreatment.

9. ACKNOWLEDGMENTS

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The authors deny any conflicts of interest related to this study.

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11. CAPÍTULO 2

Evaluation of Dental Microhardness After Endodontic Retreatment of Teeth Filled with a Calcium Silicate-Based Sealer

Gabriela Tiago Ferreira – DDS, MSc
Department of Clinical Dentistry, Universidade de Uberaba, Uberaba, Minas Gerais, Brazil.

Carlos Roberto Emerenciano Bueno – DDS, MSc, PhD
Department of Endodontics, School of Dentistry, São Paulo State University - UNESP, Araçatuba, São Paulo, Brazil

César Penazzo Lepri – DDS, MSc, PhD
Department of Clinical Dentistry, Universidade de Uberaba, Uberaba, Minas Gerais, Brazil.

Benito André Silveira Miranzi – DDS, MSc, PhD
Department of Endodontics, Universidade de Uberaba, Uberaba, Minas Gerais, Brazil.

Stephanea Monteiro – DDS
Department of Clinical Dentistry, Universidade de Uberaba, Uberaba, Minas Gerais, Brazil.

Renata Oliveira Samuel – DDS, MSc, PhD
Department of Endodontics, Universidade de Uberaba, Uberaba, Minas Gerais, Brazil.

Address requests for reprints to Drª
Renata Oliveira Samuel,
Department of Endodontics,
University of Uberaba – UNIUBE
Av. Nenê Sabino, 1801
Universitário 38055-500
Uberaba – MG – Brazil
Phone +55 34 3319-8913
Fax +55 34 3319-8800
E-mail address: renata.samuel@uniube.br

ABSTRACT

Introduction: The aim of this study was evaluate the dentin microhardness alteration in the endodontic retreatment of teeth filled with AH Plus sealer (Dentsply, DeTrey, Konstanz, Germany) or TotalFill sealer (FKG Dentaire, La-Cheaux-de Fonds, Switzerland).

Methods: Mesial root canals of sixteen human mandibular molars extracted were selected and randomly divided into 2 groups (N=8): Group AH: Root sealed with AH Plus sealer (AH) and removal with Reciproc 40.06 file (VDW, Munich, Germany) (R). Group TF: root filled with TotalFill sealer (TF) and removal with R. Dentin microhardness was evaluated by comparing the different groups ($p<0.05$).

Results: In the group TF, the microhardness was higher when compared to the group AH at cervical and middle thirds ($p<0.05$). In the apical third no significant differences were observed ($p>0.05$).

Conclusions: TF sealer is able to considerably increase the dentin microhardness of the cervical and middle thirds compared to AH plus sealer.

Keywords: Retreatment. Microhardness. Calcium silicate-based bioceramic sealer.

12. INTRODUCTION

Unlike resin sealers, considered the gold standard in endodontic treatment, calcium silicate based-sealers have gained prominence due to their relative biological importance and their chemical and physical properties (1). This type of sealer is also known as bioceramic, which refers to ceramic materials designed for use in Medicine and Dentistry and include in your composition zirconia, bioactive glass, glass ceramic, alumina, hydroxyapatite and or calcium phosphates (2). In endodontics, bioceramic sealers have been shown to be an excellent option in biocompatibility, sealing ability, good tolerance in humid environments, with repair induction, effective antimicrobial action (3) and antifungal action (4). Thus, this sealer better meets the prerequisites of a sealer considered ideal for endodontic treatment (5).

In addition, because it contains calcium phosphate in its composition, it results in a chemical property that makes it similar to dental apatite and found in bone (6). Fact that promotes a potential for bone regeneration in cases of involuntary extrusion of sealer beyond the apical foramen or even when repairing perforations (7,8).The antimicrobial property of calcium-based sealer is guaranteed due to its alkalinity and release of calcium ions (9) and when chemically bonded to the root canal, it promotes a mechanical lock that increases the sealing capacity (10,11).

During endodontic treatment, the structural properties of dentin can change after contact with irrigating solutions, such as sodium hypochlorite (NaOCl) and ethylenediaminetetraacetic acid (EDTA) (12). It is common for some studies to report that irrigation with sodium hypochlorite can alter dentinal microhardness (13-15). However, if materials that act on the dental chemical structure in relation to calcium and phosphorus, tend to produce damage to dental microhardness. Thus, if sealer based on calcium silicate has a positive interaction with dentin, it is possible that dentin microhardness will be altered when using this type of material.

In addition, it is not known if the effects of the materials used inside the roots perpetuate even after their removal whether the efficiency of calcium silicate-based sealer remains after its removal from inside the root canal in an endodontic retreatment. Therefore, the objective of this study was to comparatively evaluate if the TotallFill sealer or Ah Plus sealer can change the dentinal microhardness in teeth

submitted to endodontic retreatment. The null hypothesis is that based-silicate sealer does not able to modify the dentinal microhardness.

13. MATERIALS AND METHODS

This study was approved by the Research Ethics Committee (CAAE: 86728218.8.0000.5145). Sixteen mesiobuccal roots of mandibular molars were included.

13.1 Cone Beam Computed Tomography scans (CBCT)

CBCT were scanned in a tomography device (Eagle 3D, Dabi Atlante, Brazil). Each sample was scanned with a pixel size of 0,02mm, 40s exposure time and Field of view (FOV) of 6 centimeters. The scans were made in three times: 1. Before the instrumentation; 2. After the obturation and 3. After the endodontic retreatment.

13.2 Specimen Selection

Roots less than 10˚ and more than 25˚ curvature or with marked convexity in the distal root wall (furcation area) were excluded. Canals with incomplete rhizogenesis, root fractures or perforations were excluded too. All teeth were standardized at 19mm of length. A coronal access preparation was performed, and the working length was established by subtracting 1 mm from the tip of a size 10 K-file (Dentsply Maillefer, Ballaigues, Switzerland) when visualized at the apical foramen.

13.3 Root canal instrumentation

This procedure was performed with the Logic System (Easy Dental Equipment, Belo Horizonte, MG, Brazil) according to the manufacturer's recommendation (size 25, 0.01 taper and size 25, 0.06 taper) and the final file used was size 30, 0.06 taper (Hero, Micromega, Besançon, France). The canals were irrigated with 3 mL of 2.5% NaOCl after each file.

After root canal instrumentation, the root canals were randomly divided into 2 groups with 8 canals each using Random Allocation software (Microsoft, Seattle, WA, USA): Group AH: Root filled with AH (Dentsply, DeTrey, Konstanz, Germany) + GP (MK Life Medical and Dental Products Brazil, Porto Alegre, RS, Brazil) and removal

with R size 40, 0.06 taper (Reciproc, VDW, Munich, Germany); Group TF root filled with TF + GP and removal with R;

All root canals have been final irrigated with 17% EDTA for 3 min, were dried with absorbent paper points and filled using the sealer and the type of GP with size 30/.06 (MicroMega, Besançon, France) and type according with each group. Vertical compaction was performed with a Paiva condensor compatible with the canal diameter. The canals were sealed with Coltosol (Coltène/Whaledent AG, Altstätten, Switzerland) and were stored in an oven at 37°C for 2 weeks.

13.4 Filling Removal

The mechanical removal of the filling material was performed by thirds. Initially Reciproc (VDW, Munich, Germany) size 40, 0.06 taper entered the cervical third in the first 6mm; later in the middle third until 12mm and at last the file entered the 18mm. The canals were irrigated with 3 mL of 2.5% NaOCl after each file.

13.5 Specimen Preparation

Each root was sectioned longitudinally to the axis in the buccolingual direction. One root section was mounted in a PVC device, 20 mm diameter and 15 mm high. The samples were placed with the root canal dentin facing the interior of the PVC device, filled with epoxi resin (Redelease, São Paulo, Brazil).

After the polymerization period, the blocks were removed from the PVC device and the cross section of the sample was performed according to the cervical, middle and apical thirds, generating forty-eight surfaces to be analyzed (Isomet 1000 - Buehler, Lake Bluff, Il). Each surface was first polished using sandpapers leaf (3M, Sumaré, São Paulo,Brazil) granulation (#600 and #1200) and then with an aluminum oxide suspension (Profill, S.S. White, Rio de Janeiro, RJ, Brazil) at Politriz (Arotec® APL-4, Brasil) . All samples were washed with distilled water for 10 minutes.

13.6 Microhardness Measurement

A microhardness meter (Shimadzu Micro Hardness Tester HMV-2000, Japan) and a Knoop (KHN) diamond hardness surface (HMV2; Shimadzu, Tokyo, Japan) were used

in penetrations at the region of dentin closest to the root canal lumen with 25gf for 30 seconds. Penetrations were performed in the region of dentin closest to the root canal lumen. The first measurement was located 20µm below the channel light and the next measurement was made at 50µm. An average of microhardness values was obtained for each surface analyzed.

13.7 Statistical analysis

Statistical analysis was performed using the SigmaPlot 12.0 ™ program (Chicago, IL, USA). The normal distribution of quantitative continuous variables was verified by the Shapiro-Wilk test. Variables with normal distribution were expressed as means for each depth of the indentation microhardness (20 µm and 50 µm) and each third of the root canal. The quantitative values of the analyzes followed a normal distribution and the t test was applied. Results were considered statistically significant when the probability was less than 5% ($p \leq 0.05$).

14 RESULTS

14.1 CBCT scans

After filling removal, the efficiency of cleaning was proven through the CBTC to analysis of dentinal microhardness be performed (figure 1).

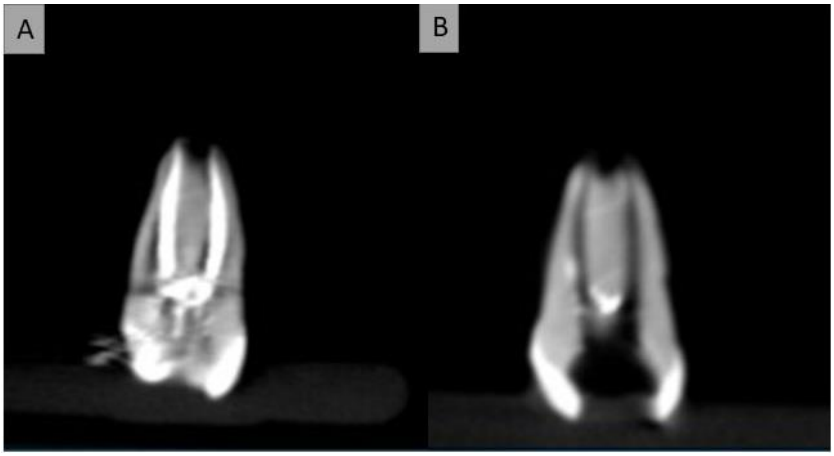

Figura 1- Representative images of CBCT after the obturation (A) and after the retreatment (B).

14.2 Knoop Microhardness

Within the analysis performed, a significant increase in dentin microhardness was observed in the group filled with TF sealer when compared to the group filled with AH (Table 1). This result was present in both the cervical and middle third at both depths ($p < 0.05$). Unlike these thirds, there was no statistically significant difference in the apical third ($p > 0.05$).

Table 1. Microhardness Measurement

	THIRDS					
	Cervical		Middle		Apical	
Groups	Mean ±SD		Mean ±SD		Mean ±SD	
	20 um	50um	20 um	50um	20 um	50um
AH/GP	13,310 ± 3,546	12,161 ± 2,905	14,733 ± 5,786	13,729 ± 4,849	15,050 ± 12,900	14,368 ± 4,327
TF/GP	20,370 ± 7,477	19,044 ± 7,950	22,858 ± 8,139	22,766 ± 9,027	16,025 ± 15,262	18,464 ± 3,125
P value	p = 0,0434	p = 0,0525	p = 0,0373	p = 0,0257	p = 0,955	p = 0,0733

Table 1 – Microhardness measurement with all groups, thirds and depths.

15. DISCUSSION

This study was carried out with the objective of comparatively evaluating the possible alteration in dentinal microhardness in thirds of the root canal against protocols using calcium silicate-based sealer or resin sealer. It was observed when assessing the type of sealer used, a significant increase in dentin microhardness was observed in the middle and cervical thirds in the groups filled with TF. So, the null hypothesis was rejected.

Calcium silicate-based sealers can be indicated both for filling root canals and for inducing the repair process. Until then, the best known are used to induce the repair process in cases of perforation, apicification, among other situations in which periodontium is exposed in endodontic treatment (16-18). These sealers that induce the repair process have the same active principle as the TF sealer used to obturation in the present study and are known as mineral trioxide aggregate (MTA) or bioceramic sealer. There are studies that indicate that the MTA, can induce chemical formation of

a calcium phosphate / apatite coating when immersed in biological fluids, in addition to nuclear capability apatite, remineralizing and inducing the formation of new mineralized tissues (3,19).

In calcium silicate-based sealers indicated for filling the canals, such as the TF used in the present study, the setting reaction occurs in two-phase reaction. At the first phase, monobasic calcium phosphate reacts with calcium hydroxide in the presence of water to produce water and hydroxyapatite. In the second phase, the water derived from the dentin humidity, as well as that produced by the phase I reaction, contributes to the hydration of calcium silicate particles to trigger a calcium silicate hydrate phase (20) thus increasing the power of mineralization (8). So, studies also claim that calcium silicate-based sealers in addition to stimulating dental mineralization can encourage apatite crystal deposits mainly in the apical and middle thirds of the root canal walls (21,22). In the present study, the cervical and middle third also presented alteration of dentin microhardness due to the use of these endodontic sealers. It may be that the alteration in microhardness found in the present study is a result of this stimulation to the mineralization shown in previous findings (23).

Another factor that can further stimulate the bioactivity of calcium silicate-based sealers indicated for filling is the fact that smaller particles with 1 – 10 μm (24,25). The use of nanoparticles allowed the manufacture of calcium silicate-based sealers with the root canal filling function, which until then was not possible. The nanoparticle can even have the great advantage of increasing the interaction of the product with the dentinal walls, which may also explain this increase in microhardness presented in the present study. Further studies need to be carried out in order to assess whether there is a difference in the bioactivity of conventional calcium silicate-based sealers and the nanoparticulate calcium silicate-based sealers recommended for filling root canals.

The increase in dentinal microhardness can be a great advantage in a product used in endodontic treatment. This is because teeth with this indication usually have a great loss of structure. Thus, it is extremely advantageous that a sealer has, in addition to adequate chemical and biological properties (26,27), it also has as an advantage in its physical properties, the increase of dentin microhardness. It may be that this increase clinically reduces the chances of root fracture, especially in teeth with great

destruction. More studies need to be carried out in the long-term with the use of this sealer clinically to evaluate its effects compared to traditional sealers.

In the present study, the apical third showed no statistically significant difference, this may have occurred because the apical region had a more irregular distribution of the dentinal tubules. In addition, in this region, because there are smaller dentinal tubules in number and diameter, the penetration and chemical reaction of the sealer may have been impaired (28). Moreover, the smear layer present within the root canal is not completely removed by substances such as EDTA in the apical region and how much smaller tubules, less moisture is found, thus hindering the penetration of endodontic sealer, possibly causing losses in TF bioactivity in the present study, justifying the difference in results in the different thirds (29).

In view of the results of this study, it is noted that calcium silicate-based sealers can be used with a new perspective, hitherto not discussed in conventional sealers: these sealers can increase dentinal microhardness. Thus, teeth with few dental structure, currently indicated for endodontic treatment, can be clinically reinforced with the use of these materials. Further clinical studies are needed to confirm this hypothesis.

16. CONCLUSION

TF Calcium silicate-based sealer is able to increase dentin microhardness at the cervical and middle thirds of the root canal compared to AH plus.

17. ACKNOWLEDGMENTS

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The authors deny any conflicts of interest related to this study.

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19. CONCLUSÃO

O uso do ultrassom melhora significativamente a limpeza do canal radicular no retratamento endodôntico, principalmente no terço médio. O cimento a base de silicato de cálcio deixou menos resíduos no canal radicular quando comparado ao cimento AH. Além disso, TF aumentou a microdureza dentinária dos terços médio e apical quando comparado com o cimento AH.

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21. APÊNDICE

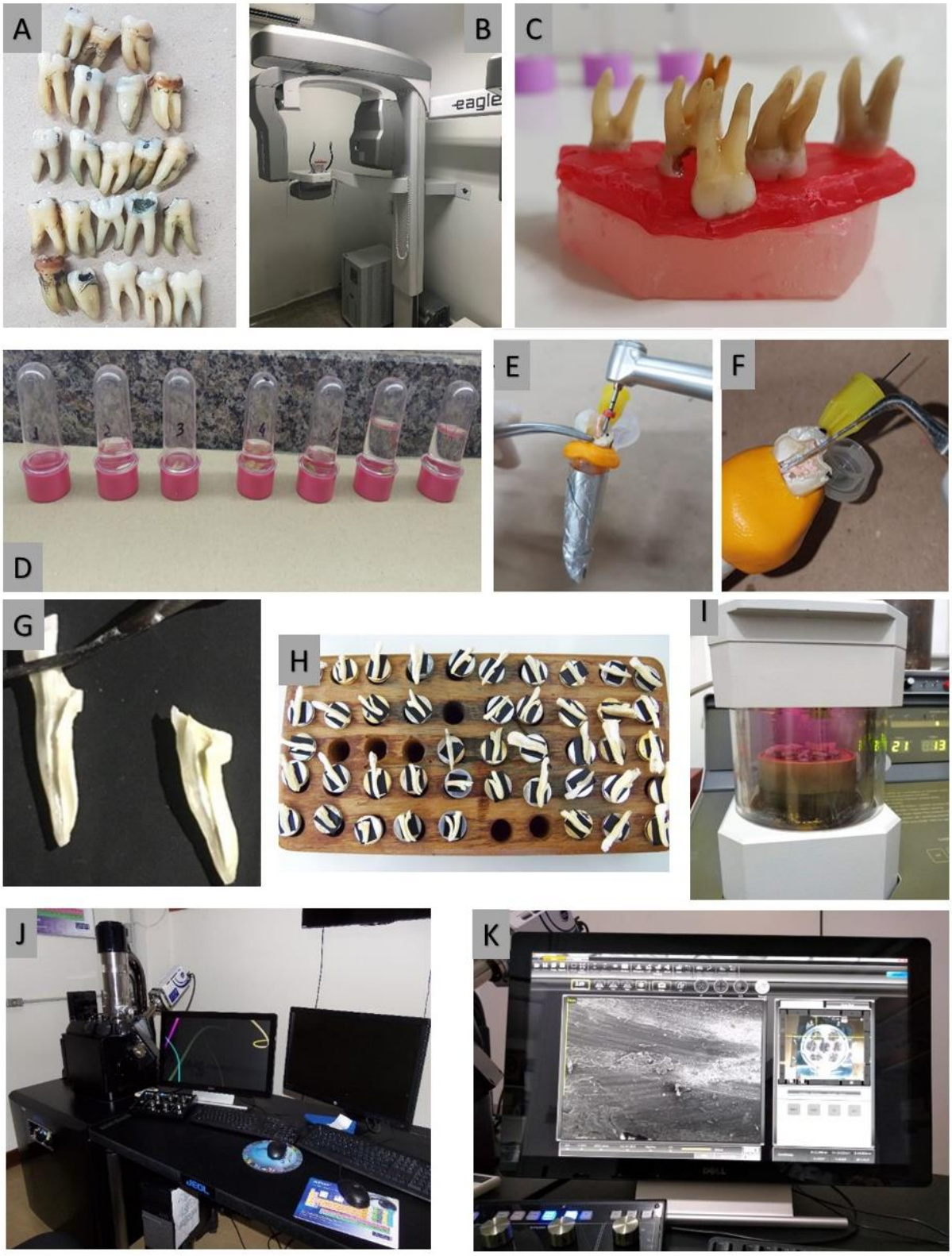

Figura 1 – **A**: Molares inferiores no processo de seleção dos dentes; **B**: Tomógrafo Eagle 3D (Dabi Atlante, Brazil) da Policlínica Getúlio Vargas (UNIUBE); **C:** Molde de cera utilidade com os dentes em suas respectivas marcações para padrão de escaneamento tomográfico; **D:** Amostras representativas de um grupo do presente estudo; **E:** Momento do retratamento com

o dispositivo para análisa de extrusão de debris com lima Reciproc; **F:** Dispositivo para análise de extrusão de debris via forame nos grupos com Ultrassom; **G:** Corte longitudinal dos canais radiculares para preparação para Microscopia Eletrônica de Varredura; **H:** Amostras fixadas em stubs com fita adesiva própria na mesa de apoio; **I:** Processo de metalização das amostras com partículas de ouro; **J:** Microscópio eletrônico de varredura (JEOL, JSMTLLOA, Tokyo, Japan) da Escola Superior de Agricultura Luiz de Queiroz (USP- ESALQ); **K:** Análise quantitativa realizada nos três terços dos canais radiculares.

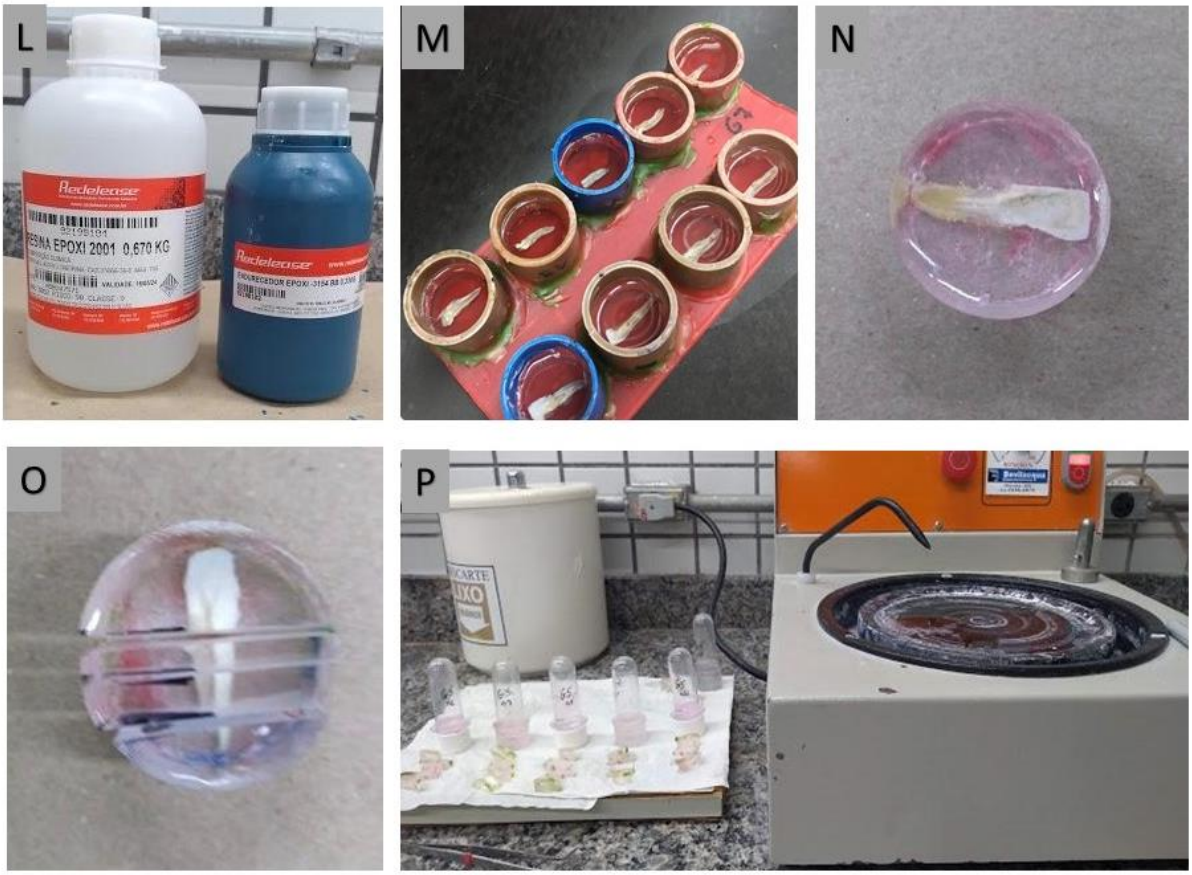

Figura 2 – Preparação dos espécimes para análise da microdureza. **L:** Resina Epóxi usada para inclusão dos espécimes; **M:** Inclusão dos espécimes com resina epóxi em dispositivo de PVC; **N:** Espécimes após desinclusão dos dispositivos de PVC; **O:** Seção dos terços cervical, médio e apical para posterior polimento das superfícies a serem analisadas. **P:** Amostras divididas em grupos e Politriz utilizada para polimento das superfícies amostrais.

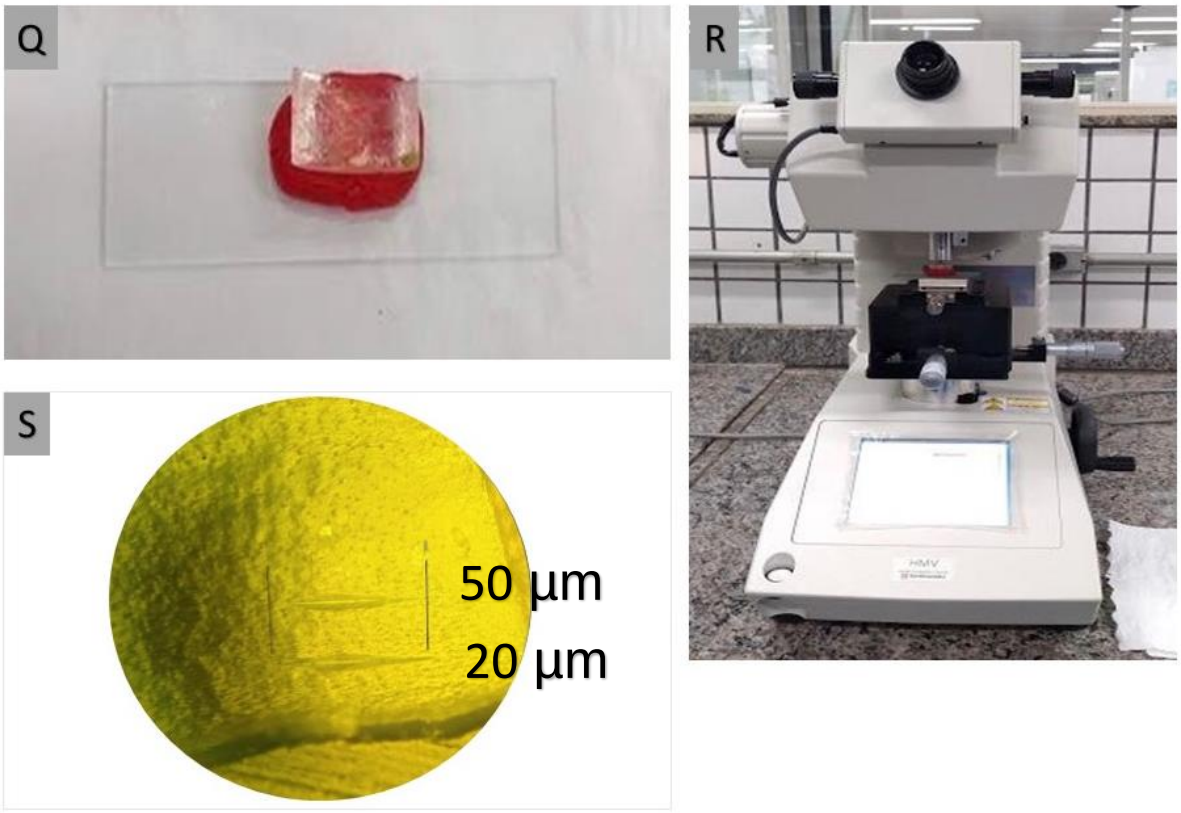

Figura 3 – Análise da microdureza. **Q:** Colocação da amostra paralela a uma placa de vidro para análise no microdurômetro. **R:** Microdurômetro utilizado para análise da microdureza dentinária. **S:** Análise da microdureza dentinária após identação na amostra nas profundidades de 20 µm e 50 µm.

22. ANEXO:

22.1 Anexo 1: Normas para publicação na revista “Journal of Endodontics”

Instructions 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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Author contributions

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Preparation

General Points on Composition

Authors are strongly encouraged to analyze their final draft with both software (eg, spelling and grammar programs) and colleagues who have expertise in English grammar. References listed at the end of this section provide a more extensive review of rules of English grammar and guidelines for writing a scientific article. Always remember that clarity is the most important feature of scientific writing. Scientific articles must be clear and precise in their content and concise in their delivery because their purpose is to inform the reader. The Editor reserves the right to edit all manuscripts or to reject those manuscripts that lack clarity or precision or that have unacceptable grammar or syntax. 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.

h. Authors should be aware that the JOE uses iThenticate, plagiarism detection software, to ensure originality and integrity of material published in the journal. The use of copied sentences, even when present within quotation marks, is highly discouraged. Instead, the information of the original research should be expressed by

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To avoid unnecessary errors you are strongly advised to use the 'spell-check' and 'grammar-check' functions of your word processor.

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Structured abstract

A structured abstract, by means of appropriate headings, should provide the context or background for the research and should state its purpose, basic procedures (selection of study subjects or laboratory animals, observational and analytical methods), main findings (giving specific effect sizes and their statistical significance, if possible), and principal conclusions. It should emphasize new and important aspects of the study or observations.

Abstract Headings

Introduction, Methods, Results, Conclusions

Keywords

Immediately after the abstract, provide a maximum of 6 keywords, using American spelling and avoiding general and plural terms and multiple concepts (avoid, for example, 'and', 'of'). Be sparing with abbreviations: only abbreviations firmly established in the field may be eligible. These keywords will be used for indexing purposes.

Acknowledgements

Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

The authors deny any conflicts of interest related to this study.

Original Research Article Guidelines

Title Page

The title describes the major emphasis of the paper. It must be as short as possible without loss of clarity. Avoid abbreviations in the title because this may lead to imprecise coding by electronic citation programs such as PubMed (eg, use sodium hypochlorite rather than NaOCl). The author list must conform to published standards on authorship (see authorship criteria in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals at www.icmje.org). Include the manuscript title; the names and affiliations of all authors; and the name, affiliation, and full mailing address (including e-mail) of the corresponding author. This author will be responsible for proofreading page proofs and ordering reprints when applicable. Also highlight the contribution of each author in the cover letter.

Abstract

The Abstract concisely describes the purpose of the study in 250 or fewer words. It must be organized into sections: Introduction, Methods, Results, and Conclusions. The hypothesis is described in the Abstract Introduction. The Abstract describes the new contributions made by this study. The Abstract word limitation and its wide distribution (eg, PubMed) make it challenging to write clearly. This section is written last by many authors. Write the abstract in past tense because the study has been completed. Provide 3-5 keywords.

Introduction

The introduction briefly reviews the pertinent literature in order to identify the gap in knowledge that the study is intended to address and the limitations of previous studies in the area. Clearly describe the purpose of the study, the tested hypothesis, and its scope. Many successful manuscripts require no more than a few paragraphs to accomplish these goals; therefore, do not perform extensive literature review or discuss the results of the study in this section.

Materials and Methods

The Materials and Methods section is intended to permit other investigators to repeat your experiments. There are 4 components to this section: (1) detailed description of the materials used and their components, (2) experimental design, (3) procedures employed, and (4) statistical tests used to analyze the results. Most manuscripts should cite prior studies that used similar methods and succinctly describe the essential aspects used in the present study. A "methods figure" will be rejected unless the procedure is novel and requires an illustration for comprehension. If the method is novel, then you must carefully describe the method and include validation experiments. If the study used a commercial product, the manuscript must either state that you followed manufacturer’s protocol or specify any changes made to the protocol. If the study used an *in vitro* model to simulate a clinical outcome, describe either experiments made to validate the model or previous literature that proved the clinical relevance of the model. The statistical analysis section must describe which tests were used to analyze which dependent measures; *P* values must be specified. Additional details may include randomization scheme, stratification (if any), power analysis as a basis for sample size computation, dropouts from clinical trials, the effects of important confounding variables, and bivariate versus multivariate analysis.

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be published online. Supplemental material often is used to provide additional information or control experiments that support the results section (eg, microarray data).

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There are 2 general types of figures: type 1 includes photographs, radiographs, or micrographs; type 2 includes graphs. *Type 1:* Include only essential figures and use composite figures containing several panels of photographs, if possible. Each panel must be clearly identified with a letter (eg, A, B, C), and the parts must be defined in the figure legend. A figure that contains many panels counts as 1 figure. *Type 2:* Graphs (ie, line drawings including bar graphs) that plot a dependent measure (on the Y axis) as a function of an independent measure (usually plotted on the X axis). One example is a graph depicting pain scores over time. Use graphs when the overall trend of the results is more important than the exact numeric values of the results. A graph is a convenient way to report that an ibuprofen-treated group reported less pain than a placebo-treated group over the first 24 hours, but pain reported was the same for both groups over the next 96 hours. In this case, the trend of the results is the primary finding; the actual pain scores are not as critical as the relative differences between the NSAID and placebo groups.

Tables

Tables are appropriate when it is critical to present exact numeric values; however, not all results need be placed in either a table or figure. Instead of a simple table, the results could state that there was no inhibition of growth from 0.001%-0.03% NaOCl, and a 100% inhibition of growth from 0.03%-3% NaOCl (N=5/group). If the results are not significant, then it is probably not necessary to include the results in either a table or as a figure.

Acknowledgments

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22.2 Anexo 2: Comitê de Ética em Pesquisa

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DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Avaliação da eficiência do ultrassom e do sistema reciprocante no retratamento endodôntico com materiais biocerâmicos

Pesquisador: RENATA OLIVEIRA SAMUEL

Área Temática:

Versão: 2

CAAE: 86728218.8.0000.5145

Instituição Proponente: Sociedade Educacional Uberabense

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 2.697.923

Apresentação do Projeto:

O projeto em tela traz como título "Avaliação da eficiência do ultrassom e do sistema reciprocante no retratamento endodôntico com materiais biocerâmicos", e trabalha com a hipótese de que cimentos biocerâmicos deixam mais resíduos de material obturador remanescente após a realização do retratamento endodôntico, e que a utilização do ultrassom potencializa a limpeza e deixa menos resíduo de material obturador após a desobturação. Nesse sentido, a proposta será de avaliar comparativamente a eficiência da limpeza, extrusão de debrs e alteração da microdureza dentinária na utilização do ultrassom e da lima reciprocante Wave One Gold no retratamento endodôntico utilizando cimento endodôntico resinoso AH Plus e cimento biocerâmico TotalFill. Para isso, serão utilizados dentes humanos oriundos do banco de dentes da Universidade de Uberaba. Serão incluídos na pesquisa raízes mesiais de molares inferiores humanos completamente formados com terminação distinta dos canais, e que possuam entre 10° e 25° de curvatura; raízes mesiais fissionadas com angulo de curvatura menor que 10° e maior que 25° não serão excluídos. A proposta pretende selecionar 56 raízes mesio vestibulares de molares inferiores. As raízes serão randomicamente divididas em 8 grupos com 7 dentes cada: Grupo 1 (AH/GP/R): Raiz obturada com cimento AH Plus (AH) + guta percha convencional (GP) e desobturados com lima reciprocante (R) Wave One Gold 45.05; Grupo 2 (AH/GP BIO/R) raiz obturada com AH + GP revestida com partículas biocerâmicas (GP BIO) e desobturados com R; grupo 3 (AH/GP/US) raiz obturada com AH+GP e desobturados com ultrassom (US); grupo 4

Endereço: Av.Nene Sabino, 1801
Bairro: Universitário **CEP:** 38.055-500
UF: MG **Município:** UBERABA
Telefone: (34)3319-8950 **Fax:** (34)3314-8910 **E-mail:** cep@uniube.br

(AH/GP BIO/US) raiz obturada com AH + GP BIO e desobturadas com ultrassom; grupo 5 (TF/GP/R) raiz obturada com cimento TotalFill (TF) + GP e desobturado com R; grupo 6 (TF/GP BIO/R) raiz obturada com TF+GP BIO e desobturadas com R; grupo 7 (TF/GP/US) raiz obturada com TF+GP e desobturadas com ultrassom; grupo 8 (TF/GP BIO/US) raiz obturada com TF+GP BIO e desobturadas com US. Para análise da eficiência da limpeza dos diferentes protocolos será realizada a tomografia computadorizada de feixe cônico e microscopia eletrônica de varredura. Além disso, será realizada a avaliação da quantidade de debris que sairá via forame apical e será avaliada a microdureza dentinária comparando os diferentes grupos. Os dados obtidos serão analisados através de testes estatísticos adequados. A proposta traz como desfecho primário a possibilidade de translação clínica de um protocolo ideal para retratamento endodôntico quando se utiliza biomateriais; e de modo secundário pretende avaliar se o ultrassom reduz a microdureza e/ou promove o aumento do extravasamento de debris via forame apical

Objetivo da Pesquisa:

Identificar as vantagens e desvantagens de diferentes protocolos de retratamento endodôntico frente a diferentes materiais obturadores.

Avaliação dos Riscos e Benefícios:

Os benefícios superam os riscos

Comentários e Considerações sobre a Pesquisa:

O presente projeto é pertinente, apresenta uma fundamentação coerente e é relevante do ponto de vista científico. A pesquisadora atendeu a recomendação do relator que fora apontada na versão 1 da submissão (proteção dos dados que pudessem identificar os sujeitos da pesquisa).

Considerações sobre os Termos de apresentação obrigatória:

Foram apresentados os seguintes documentos:

-Folha de rosto indica a Instituição proponente (Universidade de Uberaba), assinada pelo pró-reitor de Pesquisa, Pós-graduação e Extensão o prof. Dr. André Luis Teixeira Fernandes

Declaração assinada pelo responsável do Banco de Dentes da UNIUBE, que se compromete a contribuir com o material (56 dentes) para a pesquisa após aprovação pelo CEP-UNIUBE

- Projeto de pesquisa

Recomendações:

Não há.

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Conclusões ou Pendências e Lista de Inadequações:

O relator vota pela aprovação do projeto, salvo melhor juízo deste comitê.

Considerações Finais a critério do CEP:

Em 06/06/2018 a plenária votou de acordo com o relator, pela aprovação da proposta, lembrando o proponente do compromisso com o que trata a Resolução 466/12, especialmente no que diz respeito a entrega dos Relatórios Parcial e Final da pesquisa ao CEP.

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_1084890.pdf	08/05/2018 10:27:14		Aceito
Declaração de Instituição e Infraestrutura	comite_etica.pdf	02/04/2018 11:20:59	RENATA OLIVEIRA SAMUEL	Aceito
Projeto Detalhado / Brochura Investigador	Projeto_retratamento.pdf	26/03/2018 09:21:54	RENATA OLIVEIRA SAMUEL	Aceito
Folha de Rosto	comite.pdf	21/03/2018 15:51:01	RENATA OLIVEIRA SAMUEL	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

UBERABA, 07 de Junho de 2018

Assinado por:
Geraldo Thedei Junior
(Coordenador)