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UNIVERSIDADE DE SÃO PAULO  
FACULDADE DE ODONTOLOGIA DE BAURU

MARIANA MACIEL BATISTA BORGES

**Analysis in Micro-CT and Scanning Electron Microscopy of new  
instruments in retreatment and cleaning of flattened canals**

**Análise em Micro-ct e Microscopia Eletrônica de Varredura de  
novos instrumentos na desobturação e limpeza de canais  
achatados**

BAURU  
2018

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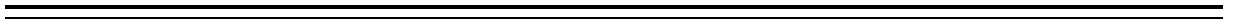
**Análise em Micro-ct e Microscopia Eletrônica de Varredura de novos instrumentos na desobturação e limpeza de canais achatados**

Dissertação constituída por artigo apresentada a Faculdade de Odontologia de Bauru da Universidade de São Paulo para obtenção do título de Mestre em Ciências no Programa de Ciências Odontológicas Aplicadas, na área de concentração Endodontia.

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FOLHA DE APROVAÇÃO

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Dedico este trabalho a todas as pessoas ligadas ao meu coração, sobretudo meus pais, por me darem a oportunidade da vida. Aos meus avós, tios e amigos por estarem sempre ao meu lado ao longo desta jornada.

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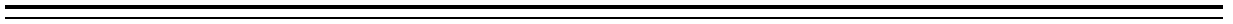
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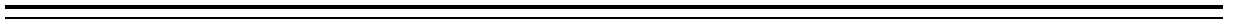
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*“Conheça todas as teorias, domine todas as técnicas, mas ao tocar uma alma humana, seja apenas outra alma humana”.*

*Carl Jung.*

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## ABSTRACT

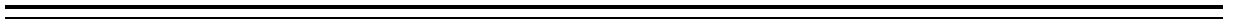
### **Analysis in Micro-CT and Scanning Electron Microscopy of new instruments in retreatment and cleaning of flattened canals**

The aim of this study was to evaluate the efficacy of heat-treated nickel-titanium reciprocating instruments and complementary techniques in retreatment of flattened canals. Material and methods: Twenty-six mandibular incisors were prepared up to size 25/.08 rotary file and filled using the single-cone technique. Subsequently, the teeth were divided into 3 groups (n=12) according to retreatment procedures: Reciproc Blue: R25 and R40; ProDesign R: PDR 25/.06 and PDR 35/.05; WaveOne Gold: WOG Primary and WOG Medium. The apically extruded material was collected in microtubes and the volume (mm<sup>3</sup>) was measured by Micro-CT. After this, the specimens received complementary cleaning with XP-Endo Shaper, PUI and 60° oscillatory instrumentation with #30 Hedström file. Micro-CT scans were performed before and after removing filling material. After quantification of the volume of remaining filling material, the teeth were sectioned and scanning electron microscopy (SEM) images of the cervical, middle and apical thirds were obtained with a 700X magnification, and evaluated by scores based on the amount of filling material in the surface of dentine walls. Results: No reciprocating instrument promoted complete removal of filling material. All systems showed extrusion, however, WOG25 presented the higher extrusion of material (P<.05). XP-Endo Shaper significantly reduced the amount of filling material in the apical and middle thirds (P<.05). In the SEM analysis, there was no statistical difference among the cleaning methods (P> .05). Conclusions: The reciprocating instruments studied did not promote complete removal of root canal filling materials. XP-Endo Shaper, used as a complementary instrument in retreatment, improved removal of filling material.

**Key-words:** Root canal retreatment. Reciprocating systems. Micro-CT. Apical extrusion. XP-Endo Shaper.

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## RESUMO

### **Análise em Micro-CT e Microscopia Eletrônica de Varredura de novos instrumentos na desobturação e limpeza de canais achatados**

O objetivo deste estudo foi avaliar a eficácia de instrumentos reciprocantes em níquel-titânio tratados termicamente e métodos complementares no retratamento de dentes com raízes achatadas. Materiais e métodos: Trinta e seis incisivos inferiores foram preparados com instrumentos rotatórios até o diâmetro 25./08 e obturados pela técnica do cone único. Em seguida, os dentes foram divididos em 3 grupos (n=12) de acordo com os sistemas utilizados para desobturação no retratamento: Reciproc Blue: R25 e R40; ProDesign R: PDR 25./06 e PDR 35./05; WaveOne Gold: WOG Primary e WOG Medium. O material extruído apicalmente foi coletado em microtubos e o volume (mm<sup>3</sup>) foi mensurado com Micro-CT. Na sequência, os espécimes receberam limpeza complementar com XP-Endo Shaper ou com irrigação passiva ultrassônica (PUI) ou com instrumentação com lima #30 Hedström em movimento oscilatório. Escaneamentos em Micro-CT foram realizados antes e após a remoção do material obturador. Após quantificação do volume de remanescente de material obturador, os dentes foram seccionados e imagens com microscópio eletrônico de varredura (MEV), dos terços cervical, médio e apical, foram obtidas com aumento de 700X, e avaliadas através de escores baseados na quantidade de material obturador remanescente nas paredes dentinárias. Resultados: Nenhum instrumento reciprocante promoveu remoção completa do material obturador. Todos os sistemas demonstraram extrusão, no entanto, WOG25 proporcionou maior extrusão (P<.05). XP-Endo Shaper reduziu significativamente a quantidade de material obturador nos terços médio e apical (P<.05). Na análise da limpeza das paredes dentinárias, em MEV, não houve diferença estatística entre os métodos de limpeza (P>.05). Os instrumentos reciprocantes estudados não promoveram a remoção completa do material obturador. XP-Shaper, utilizado como instrumento complementar no retratamento, aumentou a remoção de material obturador.

**Palavras-chaves:** Retratamento. Sistemas reciprocantes. Micro-CT. Extrusão apical. XP-Endo Shaper.

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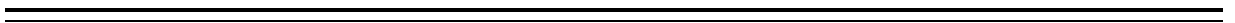
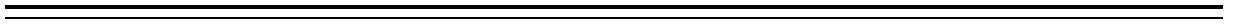
## TABLE OF CONTENTS

<b>1</b>	<b>INTRODUCTION .....</b>	<b>07</b>
<b>2</b>	<b>ARTICLE .....</b>	<b>11</b>
2.1	ARTICLE 1 – Removal of filling material and apically extruded debris from flattened canals and complementary cleaning methods in retreatment .....	13
<b>3</b>	<b>DISCUSSION.....</b>	<b>33</b>
<b>4</b>	<b>CONCLUSIONS .....</b>	<b>39</b>
	<b>REFERENCES .....</b>	<b>43</b>
	<b>APPENDIX.....</b>	<b>55</b>

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# *1 - Introduction*

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# 1 INTRODUCTION

When endodontic retreatment is necessary due to primary treatment failure, the removal of all filling materials is fundamental to promote better disinfection, cleaning and shaping to obtain a favorable long term outcome<sup>1,2,3</sup>.

With the introduction of mechanical instrumentation, different techniques have been proposed for removing filling material by means of nickel-titanium rotary and/or reciprocating systems that have shown favorable results for this purpose<sup>4,5,6,7,8</sup>. The reciprocating motion with new nickel-titanium (NiTi) instruments, proposed by Yared<sup>9</sup>, is comparable with balanced forces, because their clockwise movement angle of the instruments is smaller than their counterclockwise angle, and favors continuous movement to reach the apex safely and with lower risk of fractures<sup>10</sup>.

Moreover, the new generation of reciprocating instruments, such as Reciproc Blue, WaveOne Gold and ProDesign R, have undergone improvement resulting from metallurgical changes to NiTi alloys through heat treatment. This has adjusted the transition temperatures of NiTi alloys to increase their mechanical properties<sup>11</sup>. Thus, more knowledge is required about the efficiency of these new heat-treated instruments for endodontic retreatment, taking into account their high flexibility.

During endodontic retreatment, filling material extrusion beyond the apical foramen may occur. This may negatively influence prognosis of the treatment, and can be directly related to postoperative pain and delay in peri-radicular repair<sup>12,13,14,15</sup>. Therefore, in addition to being efficient in removing the filling material, these new instruments need to be safe for the apical tissues.

Another challenge in retreatment is related to the root canal anatomy. Removing filling material from an oval cross-section, such as in flattened canals, may require complementary removal procedures<sup>16</sup>, because of the non-adaptive core of the standard NiTi files<sup>17,18</sup>. Thus supplementary methods for cleaning after retreatment procedures, such as passive ultrasonic irrigation (PUI), have been suggested.

A novel NiTi rotary system, called XP-Endo Shaper (FKG Dentaire), was recently introduced. According to the manufacturer, it is made with MaxWire alloy, which gives the instrument the capacity to expand from its original size when exposed to body temperature, and prepare the canal at size 30/.04. Its Booster tip enables the file to enlarge the apical area, from a size #15 to #30<sup>19,20,21</sup>. Although it has been recommended for shaping the root canal,

because of its ability to expand and touch complex areas, and has a larger taper compared with other XP-Endo instruments<sup>22,23</sup>, it may also contribute to complementing cleaning in retreatment.

Thus, the purpose of this study was to compare the amount of remaining filling material and apically extruded material, by means of micro-CT, when using the following reciprocating systems: Reciproc Blue, WaveOne Gold and ProDesign R. In addition, we evaluated complementary cleaning with XP-Endo Shaper, passive ultrasonic irrigation (PUI), and 60°-oscillatory instrumentation with a #30 Hedström file, by comparing micro-CT images and quantifying the residual filling material by means of using Scanning Electron Microscopy (SEM). The null hypotheses tested were: a) There would be no differences among the reciprocating systems in removing the filling material from the root canals; b) There would be no differences among the complementary cleaning methods used, for both the analyses.

# *4-Conclusions*

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## **4 CONCLUSIONS**

Under the experimental condition, no technique was able to completely remove the root filling from teeth with flattened root canals. The use of additional methods of cleaning, with XP-Shaper promoted a better removal in the apical and middle thirds.





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