Int. J. Odontostomat.,
18(4):510-513, 2024.

Effectiveness of ProTaper Retreatment, WaveOne Gold and Reciproc Blue Systems in Removing Obturation Material

Eficacia de los Sistemas ProTaper, WaveOne Gold y Reciproc Blue en la Eliminación del Material de Obturación

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VIEIRA, M. S.; COAGUILA-LLERENA, H.; CAMILLI, C. A.; PAVANELLI, R. A. L. & OLIVEIRA, P. L. Effectiveness of ProTaper Retreatment, WaveOne Gold and Reciproc Blue Systems in removing obturation material. *Int. J. Odontostomat., 18(4)*:510-513, 2024.

ABSTRACT. Complete removal of filling material is essential for proper endodontic retreatment. The aim of this study was to compare, through digital radiography, the effectiveness of the ProTaper Retreatment (PRO), WaveOne Gold (WOG), and Reciproc Blue (REC) systems in removing filling material. Sixty extracted human mandibular premolars were treated and subsequently retreated. Initial endodontic treatment was performed with ProTaper Next system. After obturation, the specimens were retreated using the following systems (n=20): WOG, REC, and PRO. Then, the specimens were analyzed in the mesio-distal (MD) and bucco-lingual (BL) directions using the ImageJ software, considering the residual material as a percentage of the total area of initial obturation. Statistical analysis was performed using ANOVA and Tukey's tests. Although the percentage of residual material in the BL direction was higher than in the MD direction in all groups, there was no differences among groups ($p>0.05$). So, none of the systems completely removed the filling material, showing similar effectiveness among them.

KEYWORDS: endodontics, retreatment, root canal obturation, root canal therapy

INTRODUCTION

Endodontic treatment is based in a complete debridement of the root canal system and a subsequent three-dimensional obturation (Alberdi *et al*., 2023). However, many treatments are conducted incorrectly, causing endodontic therapy to be unsuccessful, requiring retreatment to reverse the initial situation (Stueland *et al*., 2023). During retreatment, proper removal of filling materials demands great efforts, and is time-consuming and challenging (Abboud *et al*., 2024). For this reason, it is essential that the clinician uses effective instruments in order to reduce clinical time, avoiding operator fatigue and establishing better patient comfort (Zuolo *et al*., 2013).

Different techniques were proposed, using rotary or reciprocating kinematics. The basic difference between the both kinematics is that rotary and reciprocating motion use continuous and alternating rotation with asymmetric angulation, respectively (Abboud *et al*., 2024). Two reciprocating systems are WaveOne Gold – WOG (Dentsply Sirona Endodontics, Ballaigues, Switzerland) and Reciproc Blue – REC (VDW, Munich, Germany) (Ye & Gao, 2012), which are also used for retreatment (Borges *et al*., 2019; Romeiro *et al*., 2020). Regarding rotary motion, ProTaper Retreatment system (Dentsply Sirona Endodontics) has been used specifically for retreatment (Giuliani *et al*., 2008; Rios *et al*., 2014). Although the available bibliography of the three systems separately is abundant, the comparison among them is still scarce. Thus, the aim of the present study was to compare the effectiveness of ProTaper D, WaveOne Gold and

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Received: 2022-08-08 Accepted: 2024-11-23

Reciproc Blue systems in removing filling material. The null hypothesis is that there would be no differences among systems.

MATERIAL AND METHOD

The sample size calculation was performed according to a previous study (Rios *et al*., 2014). After approval by the Ethics Committee of the School of Dentistry (86263118.4.0000.5211), 60 human extracted mandibular premolars were used. The teeth were selected using digital radiographic following the inclusion criteria: complete root formation, Schneider angle less than 5°, without calcifications or previous endodontic treatment, sound root structure and no cracks. Additionally, a single oval canal that allows the insertion of a file no larger than a #15 K-file into the apical foramen was confirmed. The oval canal configuration was also confirmed radiographically [bucco-lingual (BL) diameter greater than the mesio-distal (MD) diameter]. Subsequently, the selected teeth were stored in a 0.1% thymol until the use.

After access, the working length was determined using a #10 K-file until its tip was visible in the apical foramen, and subtracting 1 mm. Then, the canals were instrumented using ProTaper Next system (Dentsply Sirona Endodontics) up to X3 file (30.07) under irrigation with 2.5% sodium hypochlorite (NaOCl) between each file. The total volume of NaOCl in each specimen was 25 mL. Final irrigation was performed with 5 mL of NaOCl, which was activated using an ultrasonic tip (E1 Irrisonic, Helse, Santa Rosa de Viterbo, SP, Brazil) 3 times for 20 seconds. The same protocol was performed with 5 mL of 17% ethylenediaminetetraacetic acid (EDTA). Finally, the canals were irrigated with 5 mL of distilled water. After drying, the canals were filled with gutta-percha cones equivalent to the final file and AH Plus sealer (Dentsply DeTrey GmbH, Konstanz, Germany) using the continuous wave technique. The teeth were restored with glass ionomer cement – Maxxion R (FGM, Joinville, SC, Brazil) and stored at 37°C and 95% humidity for 30 days. In the sequence, digital radiographs were taken, in order to observe the absence of obturation failures.

The teeth were randomly distributed into 3 groups (n=20 per group) with the aid of a computerized algorithm (http://www.random.org), as follows: WOG (WaveOne Gold), REC (Reciproc Blue) and PRO (ProTaper Retreatment). For WOG Group, the canals were opened and retreated using a 25.07 file (Primary). For REC Group, the canals were retreated using a 25.08 file. For PRO group, the canals were retreated sequentially using D1 (30.07), D2 (25.08) and D3 (20.07) files, in the cervical, middle and apical thirds, respectively. Irrigation during retreatment was performed using a total of 25 mL of 2.5% NaOCl per tooth. Irrigation with 5 mL of 17% EDTA was performed for 3 minutes to remove the smear layer, followed by a final irrigation with 5 mL of NaOCl in each specimen. The filling material removal was considered complete when there were no residual gutta-percha and/or sealer visible on the canal walls or adhered to the files, and the final visualization was performed using an operating microscope (Alliance, São Carlos, SP, Brazil) at 12.5x magnification. After retreatment, the teeth were radiographed again. The radiographical images of the retreated teeth were evaluated using the Image J software (National Institutes of Health, NIH), measuring the areas of residual material, which were delimited, calculated and expressed in pixels. Then, the data were tabulated in Microsoft Excel (Microsoft Corp., Redmond, WA, USA). The residual material area in the MD and BL directions was expressed as a percentage (%) from total volume of initial obturation, which was considered as 100%.

Statistical analysis was performed using the GraphPad Prism 6.0 software (GraphPad Software, La Jolla, CA, USA) by the parametric one-way ANOVA and Tukey tests, at a significance level of 5%.

RESULTS

In PRO group, the mean residual material was 29.89% in the BL direction, and 24.14% in the MD direction. In the WOG group, the mean residual material was 46.93% in the BL direction, and 39.04% in the MD direction. In the REC group, the mean residual material was 30.78% in the BL direction, and 24.53% in the MD direction (Figure 1). This indicates that residual material was observed in all systems, showing similar effectiveness among them ($p>0.05$). Although the percentage of residual material in the BL direction was slightly higher than MD direction for all systems, no statistical significance was observed among them ($p>0.05$) (Fig. 1).

DISCUSSION

The present study compared the effectiveness of PRO, WOG and REC systems in removing filling material. The null hypothesis was accepted due no differences among systems.

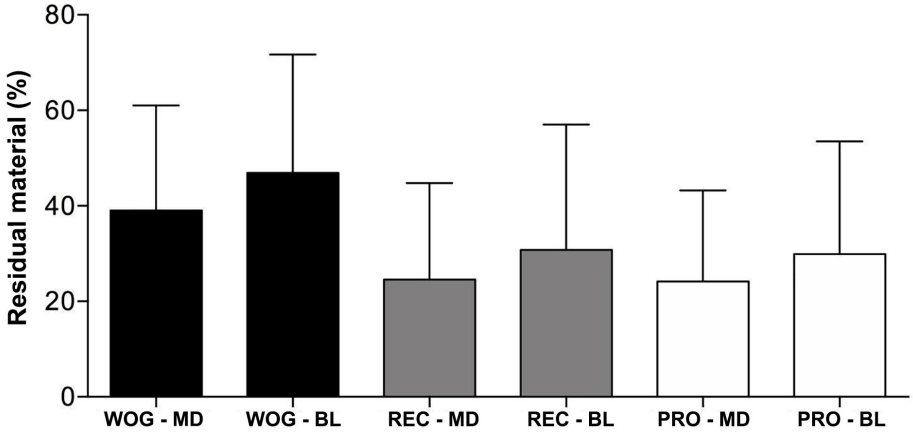

Fig. 1. Mean and standard deviation of the percentage of residual material after retreatment with WOG (WaveOne Gold), REC (Reciproc Blue), and PRO (ProTaper Retreatment) in the mesio-distal (MD) and bucco-lingual (BL) directions.

In endodontic retreatment, the removal of filling material through files and irrigating solutions makes it possible to act on the debris and microorganisms responsible for apical periodontitis (Marques da Silva *et al*., 2012). In the present study, the analysis of residual material was performed using a software on digital radiographs. Furthermore, the percentages, calculated from the total area of the canal, were used to deal with anatomical variations that could be present (Giuliani *et al*., 2008; Gu *et al*., 2008; Çelik Ünal *et al*., 2009). Although the material radiopacity allows an appropriate measurement of residues through radiographs, the micro-computed tomography (micro-CT) would have allowed a three-dimensional and morphometric assessment of the pre- and post-treatment specimens condition (Rödig *et al*., 2014; Romeiro *et al*., 2020). This constitutes the main limitation of the present study. However, to evaluate the removal of filling material, an analysis was performed in the MD and BL directions, aiming to minimize the methodological bias inherent to two-dimensional analyses.

Among the systems used, three systems used only the PRO system is specific for retreatment (Marques da Silva *et al*., 2012; Shaheen *et al*., 2021). WOG and REC systems, although not originally developed for endodontic retreatment, effectiveness of these systems in endodontic retreatment (Canali *et al*., 2019; Romeiro *et al*., 2020). The REC system is effective in root canal preparation (Caviedes-Bucheli *et al*., 2018; Keskin *et al*., 2018). The WOG system has similar instrumentation effectiveness compared to REC (Pérez Morales *et al*., 2021). Reciprocating/rotary systems have different taper in relation to tip size; however, in order to standardize the retreatment preparation, files 25.07, 25.08 and 20.07 were used for WOG, REC and PRO, respectively.

All systems, rotary or reciprocating, showed similar effectiveness in removing residual material, which is in line with a previous study that revealed that reciprocating/rotary systems (Reciproc, WaveOne and PRO) showed no significant differences among them (Rios *et al*., 2014). Regarding reciprocating instruments, a study revealed that there was no difference between Reciproc and REC in oval canals gutta-percha removal, by micro-CT analysis (De-Deus *et al*., 2019). The authors of this study concluded that regardless technique or system used, there were remnants of filling material on all canal walls. In fact, a study that assessed the complementary retreatment of oval canals with PRO using cone beam computed tomography (CBCT) revealed that although supplementary WOG, TruNatomy, and XP-endo Finisher files were used all canals showed residual material (Shaheen *et al*., 2021). Regarding assessment in BL and ML directions, the present study results showed above 20 % residual material for allsystems analized. A study in maxillary anterior transparent teeth showed that PRO promoted the removal of 10.12 % in the BL direction and 10.25 % in the MD direction (Gu *et al*., 2008). Although those values are lower than those shown in the present study, the authors reported no difference in removal percentages between both directions. The contrasting results can be explained by methodological differences since the analysis of that study was performed with sectioned teeth.

CONCLUSION

None of the systems completely removed the filling material, showing similar effectiveness among them.

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RESUMEN: La remoción completa del material de relleno es esencial para un retratamiento endodóntico adecuado. El objetivo de este estudio fue comparar, a través de radiografía digital, la efectividad de los sistemas ProTaper Retreatment (PRO), WaveOne Gold (WOG) y Reciproc Blue (REC) en la remoción de material de relleno. Se trataron y retrataron sesenta premolares mandibulares humanos extraídos. El tratamiento endodóntico inicial se realizó con el sistema ProTaper Next. Después de la obturación, las muestras fueron retratadas utilizando los siguientes sistemas (n = 20): WOG, REC y PRO. Luego, las muestras fueron analizadas en las direcciones mesio-distal (MD) y buco-lingual (BL) utilizando el software ImageJ, considerando el material residual como un porcentaje del área total de la obturación inicial. El análisis estadístico se realizó mediante ANOVA y pruebas de Tukey. Aunque el porcentaje de material residual en la dirección BL fue mayor que en la dirección MD en todos los grupos, no hubo diferencias entre los grupos (p>0,05). Se puede concluir que ninguno de los sistemas eliminó completamente el material de relleno, mostrando una efectividad similar entre ellos.

PALABRAS CLAVE: endodoncia, retratamiento, obturación de conductos, terapia de conductos.

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