

Effectiveness of ProTaper Retreatment System associated with Organic Solvents in the Removal of Root Canal Filling Material

Flávia Angélica Guiotti, Milton Carlos Kuga, Renato de Toledo Leonardo, Gisselle Moraima Chávez-Andrade, Miriam Grazielle Magro, Bruno Cavalini Cavenago, Gisele Faria

ABSTRACT

Aim: To evaluate the effectiveness of ProTaper universal retreatment system in the removal of root canal filling material with thermomechanical compaction, in comparison to manual-mechanical technique, associated with orange oil or eucalyptol.

Materials and methods: Forty extracted lower incisors were filled with thermomechanical compaction technique. After 3 years, the root canal filling was removed by: G1 - manual-mechanical technique with orange oil; G2 - manual-mechanical technique with eucalyptol; G3 - ProTaper universal retreatment system with orange oil and G4 - ProTaper universal retreatment system with eucalyptol. In sequence, all root canals were instrumented to F5 instrument. The teeth were longitudinally grooved, images of buccal half were obtained in stereomicroscope and covered area by root canal filling material was measured using image tool software, in cervical, middle and apical radicular thirds. The results were subjected ANOVA and Tukey test ($p = 0.05$).

Results: In all thirds, the manual-mechanical technique showed lower presence of root canal filling material on root canal dentin in comparison to ProTaper retreatment universal system, regardless of organic solvent used ($p < 0.05$). There is no difference between organic solvents in removal root canal filling material ($p > 0.05$).

Conclusion: The ProTaper universal retreatment system showed lower effectiveness in removal root canal filling material than manual-mechanical technique, regardless of organic solvents (orange oil or eucalyptol oil) used.

Clinical significance: Recently rotary instruments have been proposed to removal of root canal filling material. However, there are no studies evaluating its effectiveness in removal root canal filling material in association with orange oil or eucalyptol oil.

Keywords: Advanced instruments, Endodontic, Root canal treatment.

How to cite this article: Guiotti FA, Kuga MC, de Toledo Leonardo R, Chávez-Andrade GM, Magro MG, Cavenago BC, Faria G. Effectiveness of ProTaper Retreatment System associated with Organic Solvents in the Removal of Root Canal Filling Material. *World J Dent* 2013;4(3):175-179.

Source of support: Nil

Conflict of interest: None declared

INTRODUCTION

The objective of the nonsurgical endodontic retreatment is to remove the intracanal infection persistent and to promote repair of periradicular lesions tissues, keeping the tooth in

function.¹ Although there are no differences in the success rate between the nonsurgical endodontic retreatment and periradicular surgery, procedures that do not compromise the integrity of the mucosa and alveolar bone are always preferable.²

The techniques used in removal of root canal filling material are varied and include the use of manual or rotary instruments, with or without use of organic solvents. There are several NiTi instruments for endodontic instrumentation, some which were adapted for the retreatment of the root canals, such as the ProTaper universal retreatment, MTwo retreatment and the R-Endo.^{3,4} ProTaper universal retreatment system improved the previous ProTaper series by adding retreatment instruments designed specifically to remove root canal filling material.⁵ D1, D2 and D3 instruments of the ProTaper universal retreatment system are recommended for obturation material removal from coronal, middle and apical thirds, respectively.^{5,6} The effectiveness this system to remove totally gutta-percha and/or sealer of root canal is unsatisfactory, always maintaining residues in root canal walls.^{6,7}

The use of organic solvents is recommended to facilitate the access of the instruments until apical radicular third.⁸⁻¹⁰ Orange oil and eucalyptol are essential oils commonly recommended to endodontic retreatment. The orange oil has similar gutta-percha solvent action to xylol, while eucalyptol has similar solvent action to chloroform.¹¹⁻¹³ However, there are no studies assessments the association of organic solvents with NiTi retreatment rotary instruments, in endodontic retreatment.

The studies that assess the effectiveness of several NiTi rotary instruments and/or manual techniques are carried on root canal filled by lateral condensation.^{5,6,14} The thermomechanical compaction technique to root canal filling provide higher amount of gutta-percha in root canal and has showed better effectiveness than lateral condensation technique.^{15,16} However, to this clinical situation is unknown which technique and organic solvent is adequate to remove root canal filling material.

The aim of this study was to evaluate the efficacy of two endodontic retreatment techniques (ProTaper universal retreatment system or manual- mechanical techniques),

associated with organic solvents (orange oil or eucalyptol), in removal of root canal filling material.

MATERIALS AND METHODS

This study was approved by Ethics Committee of Araraquara Dental School, Univ Estadual Paulista, São Paulo, Brazil, in accordance with the principles of the Helsinki declaration. Forty human extracted mandibular central incisors, extracted for periodontal reasons, with similar anatomy, were selected and maintained in 0.1% thymol solution at 4°C. The crowns were removed with a diamond disk (KG Sorensen, Barueri, São Paulo, Brazil), leaving 16 mm of radicular length. A #15K file (Maillefer, Ballaigues, Switzerland) was introduced in the root canal until it was visible at the radicular apex. The working length was established 1.0 mm shorter than the total radicular length and confirmed radiographically.

The root canals were prepared by crown-down technique using Flexofile hand files, as described by Morgan and Montgomery.¹⁷ The apical diameter was prepared until equivalent to #30K-file (Maillefer, Ballaigues, Switzerland). The root canals were irrigated with 5.0 ml of 2.5% sodium hypochlorite (Asfer, São Caetano do Sul, São Paulo, Brazil) at each instrument change. After chemical-mechanical preparation, an additional irrigation with 17% EDTA was performed for 3 minutes followed by a final flush with 5 ml of 2.5% sodium hypochlorite solution. The root canal was dried using paper points. In sequence, the root canals were filled with gutta-percha (Dentsply, Petropolis, Rio de Janeiro, Brazil) and AH Plus sealer (Dentsply DeTrey GmbH, Konstanz, Germany) by thermomechanical compaction technique.¹⁵ Coronal radicular access were closed with temporary restorative material (Cavit; 3M, St Paul, MN, USA). The roots were immersed in artificial saliva, which was renewed to each 2 weeks, and maintained at 37°C, for 3 years.

After this time, the teeth were randomly divided into 4 groups (n = 10) and submitted to several endodontic retreatment protocol. In G1 (Manual-mechanical technique associated with orange oil), initially a #3 and #2 Gates Glidden drill (Maillefer, Ballaigues, Switzerland) were introduced respectively in coronal and middle radicular third, without use of solvent. In sequence, 0.5 ml of orange oil (Biodinâmica, Ibioporã, Paraná, Brazil) was introduced in root canal and a #15 K-file (Maillefer, Ballaigues, Switzerland) was forced in the apical direction. In sequence, root canal filling material was removed with the sequential use of sizes 15 to 30 hand H-files (Maillefer, Ballaigues, Switzerland) until no more gutta-percha/sealer could be seen on the last file used, as described by Duarte et al.¹⁸ In G2

(Manual-mechanical technique associated with eucalyptol), the sequence was similar to G1, but using eucalyptol oil (Biodinâmica, Ibioporã, Paraná, Brazil) as organic solvent.

In G3(ProTaper universal retreatment system associated with orange oil), the D1, D2 and D3 ProTaper universal retreatment instruments (Dentsply Maillefer, Ballaigues, Switzerland) were used sequentially, in crown-down direction, until the apical working length previously established, as described by Só et al.¹⁹ At each instrument change, 0.1 ml of orange oil (Biodinâmica, Ibioporã, Paraná, Brazil) was introduced in the root canal. In G4 (ProTaper universal retreatment system associated with eucalyptol), the sequence was similar to G3, but using eucalyptol oil (Biodinâmica, Ibioporã, PR, Brazil). To all groups, canal refinement was accomplished with the shaping (S1 and SX in the cervical third and S2 in the middle third) and finishing instruments (F1, F2 and F3 up to WL), at 2 N/cm torque and 250 rpm speed.

In sequence, the root canals were irrigated with 5.0 ml of 2.5% sodium hypochlorite, aspirated and dried with paper point. The roots were split along their long axis, in the mesio-distal direction, and buccal half was chosen to measure the area covered (in mm²) by root canal filling material residues. Microscopic images were acquired with a stereomicroscope (Leica Microsystems, Wetzlar, Germany), at 10× magnification and the area covered by residues was measured using Image Tools for Windows 3.00 software (University of Texas Health Science Center, San Antonio, TX), in each radicular third (coronal, middle and apical). Each radicular third was compared only between different groups. The data was analyzed statistically by the ANOVA and Tukey tests (p = 0.05).

RESULTS

Table 1 shows average covered area (in mm²) with root canal filling material residues, in each radicular third to different groups. All groups presented residues persistence on radicular dentin. The total root canal filling material residues presence in G1 and G2 were lower than G3 and

Table 1: Average radicular dentin covered area (in mm²) by root canal filling material to different groups in each radicular third

Groups	G1	G2	G3	G4
Cervical	0.31 ^b	2.89 ^b	9.53 ^a	12.04 ^a
Middle	0.07 ^b	0.77 ^b	5.00 ^a	6.96 ^a
Apical	0.10 ^b	0.56 ^b	2.93 ^a	3.78 ^a

^{a,b}Different letters, in each line, indicate statistical difference (p < 0.05); G1: Manual-mechanical technique associated with orange oil; G2: Manual-mechanical technique associated with eucalyptol oil; G3: ProTaper universal retreatment system associated with orange oil; G4: ProTaper universal retreatment system associated with eucalyptol oil



Figs 1A to D: Representative images of root canal filling material residues on radicular dentin after different endodontic retreatment protocols. (A) G1—manual-mechanical technique associated with orange oil; (B) G2—manual-mechanical technique associated with eucalyptol oil; (C) G3—ProTaper universal retreatment system associated with orange oil; (D) G4—ProTaper universal retreatment system associated with eucalyptol oil

G4 ($p < 0.05$). Regardless of organic solvent used, there was no difference in root canal filling material residues persistence between ProTaper universal retreatment system groups ($p > 0.05$). Similar condition also was observed to manual-mechanical technique groups ($p > 0.05$). When measured in each radicular third, G1 and G2 showed similar amount of residues on radicular dentin, but always lower than G3 and G4 ($p < 0.05$). Representative image of root canal filling material residues on root canal surface to different groups (Figs 1A to D).

DISCUSSION

The manual-mechanical technique showed lower dentin area covered by root canal filling material residues than provided by ProTaper universal retreatment system, regardless of organic solvent (orange oil or eucalyptol) used, in all radicular thirds.

To evaluate the efficacy of several organic solvents and/or techniques in removal of root canal filling material several methodologies were used.^{12,14,19} In present study, the images of root canal filling material residues on root canal dentin was obtained using a stereomicroscopy.²⁰ In digitalized images the residues persistence were quantified through a specific software.⁵ This methodology allows a larger visualization of the root canal wall than images obtained through scanning electron microscopy, allowing the quantification of residues (in mm^2).¹²

Persistence of thermomechanically compacted root canal filling material residues were found in all samples, regardless of removal technique and/or organic solvents

used. Similar results were observed in endodontic retreatment of root canal filled by lateral condensation.^{5,14,20} In this study, ProTaper universal retreatment system provided higher residues persistence on dentin root canal than manual-mechanical technique, in all radicular thirds, regardless of organic solvent.

Bramante et al²¹ showed that retreatment rotary systems (Mtwo R and ProTaper universal retreatment) left lower root canal dentin area covered by debris than manual-mechanical technique, but these authors not completed the endodontic reinstrumentation, as performed in present study. On the other hand, Aguiar et al²² observed that combination of K-file and H-file to obturation removal was more effective than ProTaper universal retreatment system, regardless of the solvent used. To evaluate the effectiveness of a system or method to endodontic retreatment, chemical-mechanical preparation should be finished.^{18,22}

The cleanliness of the cervical and middle radicular thirds of canals by manual-mechanical technique was likely caused by previous use of Gates Glidden drills which their kinematics pushes the root canal filling material out of root canal.^{19,21,23} As in thermomechanical compaction technique there is a greater amount of gutta-percha than in lateral condensation technique and ProTaper universal retreatment increase the local temperature during its use, is possible that the plasticization of gutta-percha has provided greater persistence of residues on root canal dentin.²¹

Despite the specific design of cross-section of ProTaper universal retreatment, this system acts with rotation, penetration and removal movements, and while to manual-

mechanical technique the circumferential movement with K-file and H-file was utilized, being a kinematics more effective to removal root canal debris.²⁴ Therefore, in function these factors, the manual-mechanical technique provided lower root canal dentin area covered by root canal filling material residues than NiTi rotary instruments, in accordance to previous studies.^{22,24,25}

The organic solvents (orange oil and eucalyptol) are frequently used in endodontic retreatment.²⁶ Despite the gutta-percha solvent action of the orange oil is similar to xylol and superior to eucalyptol, in present study, there are no increase in cleaning provided by organic solvents.^{27,28} The residues persistence on root canal dentin and consequently the similar results each other can be due to low AH Plus solubility to organic solvents used.²⁹

Another fact that can have contributed to different results was the teeth group used in endodontic retreatment. In present study was used human extracted lower incisor in accordance to Barletta et al.³⁰ This tooth present radicular mesiodistal narrow, is possible that ProTaper universal retreatment instruments have displaced to palatal half, maintained obturation greater covered area by obturation residues in buccal half.

CONCLUSION

Based on the results obtained in the present study, in removal root canal filling material compacted by thermomechanical technique, ProTaper universal retreatment system showed lower effectiveness than manual-mechanical technique, regardless of essential oil used (orange oil or eucalyptol oil).

CLINICAL SIGNIFICANCE

Recently rotary instruments have been proposed to removal of root canal filling material. However, there are no studies evaluating its effectiveness in removal root canal filling material in association with orange oil or eucalyptol oil.

REFERENCES

1. Torabinejad M, Corr R, Handsydes R, Shabahang S. Outcomes of nonsurgical retreatment and endodontic surgery: a systematic review. *J Endod* 2009;35:930-937.
2. Kvist T, Reit C. Results of endodontic retreatment: a randomized clinical study comparing surgical and nonsurgical procedures. *J Endod* 1999;25:814-817.
3. Somma F, Cammarota G, Plotino G, Grande NM, Parmejier CH. The effectiveness of manual and mechanical instrumentation for the retreatment of three different root canal filling materials. *J Endod* 2008;34:466-469.
4. Tasdemir T, Er K, Yildirim T, Celik D. Efficacy of three Rotary NiTi instruments in removing gutta-percha from root canals. *Int Endod J* 2008;41:191-196.
5. Takahashi CM, Cunha RS, de Martin AS, Fontana CE, Silveira CF, da Silveira Bueno CE. In vitro evaluation of effectiveness of ProTaper universal rotary retreatment system for gutta-percha removal with or without a solvent. *J Endod* 2009;35:1580-1583.
6. Giuliani V, Cocchetti R, Pagavino G. Efficacy of ProTaper universal retreatment files in removing filling materials during root canal retreatment. *J Endod* 2008;34:1381-1384.
7. Gu LS, Ling JQ, Wei X, Huang XY. Efficacy of ProTaper universal rotary retreatment system for gutta-percha removal from root canals. *Int Endod J* 2008;41:288-295.
8. Mushtaq M, Farooq R, Ibrahim M, Khan FY. Dissolving efficacy of different organic solvents on gutta-percha and resilon root canal obturating materials at different immersion time intervals. *J Conserv Dent* 2012;15:141-145.
9. Kaplowitz GJ. Evaluation of the ability of essential oils to dissolve gutta-percha. *J Endod* 1991;17:448-449.
10. Uemura M, Hata G, Toda T, Weine FS. Effectiveness of eucalyptol and d-limonene as gutta-percha solvents. *J Endod* 1997;23:739-741.
11. Pécora JD, Spanó JCE, Barbin EL. In vitro study on the softening of gutta-percha in endodontic retreatment. *Braz Dent J* 1993;4:43-47.
12. Scelza MF, Coil JM, Maciel AC, Oliveira LR, Scelza P. Comparative SEM evaluation of three solvents used in endodontic retreatment: an ex vivo study. *J Appl Oral Sci* 2008;16:24-29.
13. Hunter KR, Doblecki W, Pelleu GB Jr. Halothane and eucalyptol as alternatives to chloroform for softening gutta-percha. *J Endod* 1991;17:310-312.
14. Só MV, de Figueiredo JA, Freitas-Fachin EV, et al. Clinical microscopic analysis of ProTaper retreatment system efficacy considering root canal thirds using three endodontic sealers. *Microsc Res Tech* 2012; 75:1233-1236.
15. Tagger M, Tamse A, Katz A, Korzen BH. Evaluation of the apical seal produced by a hybrid root canal filling method, combining lateral condensation and thermatic compaction. *J Endod* 1984;10:299-303.
16. Marciano MA, Bramante CM, Duarte MA, Delgado RJ, Ordinola-Zapata R, Garcia RB. Evaluation of single root canal filled using lateral compaction, Tagger's hybrid, Microseal, and Guttaflow techniques. *Braz Dent J* 2010;21:411-415.
17. Morgan LF, Montgomery S. An evaluation of the crown-down pressureless technique. *J Endod* 1984;10:491-498.
18. Duarte MA, Só MV, Cimadon VB, Zucatto C, Vier-Pelisser FV, Kuga MC. Effectiveness of rotary or manual techniques for removing a 6-year-old filling material. *Braz Dent J* 2010;21:148-152.
19. Só MV, Saran C, Magro ML, Vier-Pelisser FV, Munhoz M. Efficacy of ProTaper retreatment system in root canals filled with gutta-percha and two endodontic sealers. *J Endod* 2008;34:1223-1225.
20. Imura N, Kato AS, Hata GI, Uemura M, Toda T, Weine F. A comparison of the relative efficacies of four hand and Rotary instrumentation techniques during endodontic retreatment. *Int Endod J* 2000;33:361-366.
21. Bramante CM, Fidelis NS, Assumpção TS, et al. Heat release, time required, and cleaning ability of MTwo R and ProTaper universal retreatment systems in the removal of filling material. *J Endod* 2010;36:1870-1873.
22. Aguiar CM, Lima GAC, Bernart FD, Câmara AC. Effectiveness of the ProTaper universal retreatment™ system and the manual

- technique in endodontic retreatment. *Acta Stomatol Croat* 2011;45:239-246.
23. Zmener O, Pameijer CH, Banegas G. Retreatment efficacy of hand versus automated instrumentation in oval-shaped root canals: an ex vivo study. *Int Endod J* 2006;39:521-526.
 24. Hammad M, Qualtrough A, Silikas N. Three-dimensional evaluation of effectiveness of hand and rotary instrumentation for retreatment of canals filled with different materials. *J Endod* 2008;34:1370-1373.
 25. Unal GC, Kaya BU, Taç AG, Keçeci AD. A comparison of the efficacy of conventional and new retreatment instruments to remove gutta-percha in curved root canals: an ex vivo study. *Int Endod J* 2009;42:344-350.
 26. Mushtaq M, Masoodi A, Farooq R, Yagoob-Khan F. The dissolving ability of different organic solvents on three different root canal sealers: in vitro study. *Iran Endod J* 2012;7:198-202.
 27. Oyama KON, Siqueira EL, Santos M. In vitro study of effect of solvent on root canal retreatment. *Braz Dent J* 2002;13:208-211.
 28. Bodrumlu E, Er O, Kayaoglu G. Solubility of root canal sealers with different organic solvents. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008;106:e67-69.
 29. Hansen MG. Relative efficiency of solvents used in endodontics. *J Endod* 1998;24:38-40.
 30. Barletta FB, de Souza Reis M, Wagner M, Borges JC, Dall'Agnol C. Computed tomography assessment of three techniques for removal of filling materials. *Aust Endod J* 2008;34:101-105.

ABOUT THE AUTHORS

Flávia Angélica Guiotti

Postgraduate Student, Department of Restorative Dentistry, Araraquara Dental School, UNESP—Univ Estadual Paulista, Araraquara, São Paulo, Brazil

Milton Carlos Kuga

Assistant Professor, Department of Restorative Dentistry, Araraquara Dental School, UNESP—Univ Estadual Paulista, Araraquara, São Paulo, Brazil

Correspondence Address: Faculdade de Odontologia de Araraquara, FOAr—UNESP, Departamento de Odontologia Restauradora—3º andar. Rua Humaitá 1680 Centro CEP 14801-903, Araraquara, São Paulo, Brazil, e-mail: kuga@foar.unesp.br

Renato de Toledo Leonardo

Associate Professor, Department of Restorative Dentistry, Araraquara Dental School, UNESP—Univ Estadual Paulista, Araraquara, São Paulo, Brazil

Gisselle Moraima Chávez-Andrade

Postgraduate Student, Department of Restorative Dentistry, Araraquara Dental School, UNESP—Univ Estadual Paulista, Araraquara, São Paulo, Brazil

Miriam Grazielle Magro

Postgraduate Student, Department of Restorative Dentistry, Araraquara Dental School, UNESP—Univ Estadual Paulista, Araraquara, São Paulo, Brazil

Bruno Cavalini Cavenago

Postgraduate Student, Department of Restorative Dentistry, Endodontics and Dental Materials, Bauru Dental School, Bauru, São Paulo, Brazil

Gisele Faria

Assistant Professor, Department of Restorative Dentistry, Araraquara Dental School, UNESP—Univ Estadual Paulista, Araraquara, São Paulo, Brazil