ORIGINAL ARTICLE

Evaluation of the amount of apically extruded debris during retreatment of root canals filled by different obturation techniques

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Abstract

Objective: To evaluate the amount of apically extruded debris during retreatment (with or without solvent) of root canals filled by two obturation techniques.

Materials and Methods: Forty-eight root canals were prepared using ProTaper Universal F3 and filled with Gutta-percha and AH 26 sealer using single cone or lateral condensation techniques. The root canal fillings were removed using ProTaper Universal Retreatment system with or without solvent, and the canals were further prepared with ProTaper F4. The operating time was measured. The debris extruded was collected into preweighed Eppendorf tubes. The dry weight of the extruded debris was calculated by subtracting the weight of the empty tube from that of the tube containing debris. Statistical analysis was performed with two-way analysis of variance test, with Bonferroni correction at a 95% confidence level.

Results: There was no statistically significant difference in the amount of extruded debris between the two obturation techniques ($P = 0.332$). The mean amount of debris was higher in the nonsolvent groups than the solvent groups, particularly with the single cone technique ($P = 0.013$). There was a significant difference between groups with regard to the retreatment time ($P < 0.001$). Gutta-percha removal took less time in the single cone group than in the lateral condensation group ($P < 0.001$). Gutta-percha removal in the nonsolvent groups took significantly less time than that in the solvent groups ($P < 0.001$).

Conclusions: The amounts of apically extruded debris were similar in both obturation techniques. A greater amount of apically extruded debris was observed in the nonsolvent groups than the solvent groups.

Key words: Apical extrusion, retreatment, solvent

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Introduction

The main purpose of nonsurgical root canal retreatment is to reestablish healthy periapical tissues. These procedures require complete removal of the preexistent root canal filling material, reinstrumentation, redisinfection, and refilling of the root canal system.[1] Effective removal of the obturation material is considered essential for the success of endodontic retreatment. Gutta-percha and root canal sealers are the most widely used obturation materials. These filling materials can be used with several obturation techniques. The most accepted and common technique is the lateral condensation of Gutta-percha in combination with a sealer.[2-4] Lateral condensation offers the advantage of controlled placement of Gutta-percha into the root canal. However, the technique is time-consuming.[5] Recently, a single cone technique was advocated, wherein

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a single Gutta-percha cone that matches the taper and size of the rotary nickel-titanium (Ni-Ti) instruments is used in combination with a sealer. The single-cone technique is much faster and easier to operate than the lateral condensation technique.[6,7]

Removal of Gutta-percha from the root canal system can be performed using several techniques. These include the use of stainless steel hand files, Ni-Ti rotary instruments, heat-bearing instruments, and ultrasonics[8] with or without the use of solvents.[9] Ni-Ti rotary instrumentation systems were recently suggested for removal of Gutta-percha from the root canal. They have been shown to be more effective than hand files.[10] Therefore, Ni-Ti rotary retreatment kits were developed. ProTaper Universal Retreatment Instruments (Dentsply Maillefer, Ballaigues, Switzerland) consist of three files (D1, D2 and D3), which have a convex triangular cross-section designed to facilitate the removal of filling material.[11]

During removal of previous filling materials, Gutta-percha, irrigants, and microorganisms might be extruded from the root canal into the periapical tissues, resulting in postoperative inflammation flare-up or failure of apical healing.[12,13] Therefore, an appropriate retreatment technique should be selected to completely remove the preexisting filling material as fast as possible while minimizing the amount of apical extrusion.

Until, no study has evaluated the effect of solvent on the amount of apically extruded debris in the retreatment of root canals obturated by two different oburation techniques. Therefore, the purpose of this study was to evaluate the amount of apically extruded debris during retreatment of root canals using ProTaper Universal Retreatment (ProTaper UR) files, with or without solvent. The time taken for complete removal of Gutta-percha was also recorded and compared.

Materials and Methods

Specimen preparation

Forty-eight extracted human mandibular premolar teeth with similar lengths, diameters, no root fillings, and one straight root canal (<5°) were selected. The degree of curvature was calculated using the methodology described by Schneider.[14] Only teeth with intact root apices, no visible signs of fractures or cracks, and canal width near the apex approximately compatible with size 15 were included. This was checked with silver points sizes 15 and 20 (VDW, Munich, Germany). Soft tissue remnants and calculi on the external root surfaces were removed mechanically. For more uniform samples, the crowns were flattened using steel discs, and a final dimension of 18 mm root length was achieved for each tooth. After access cavity preparation, the canal patency was established with a size 10 K-type file (Dentsply Maillefer, Ballaigues, Switzerland).

Root canal preparation and obturation

A size 15 K-file (Dentsply Maillefer, Ballaigues, Switzerland) was placed into the canal until it was visible at the apical foramen. The working length (WL) was established as 1 mm shorter than this length. The canals were prepared with ProTaper Universal Rotary Instruments (Dentsply Tulsa Dental Specialties,Tulsa, OK, USA) with a sequence of SX, S1, S2, F1, F2, and F3 in a crown-down manner, in combination with a torque-controlled engine (X-Smart; Dentsply Maillefer, Ballaigues, Switzerland) operated at 250 rpm according to the manufacturer's instructions. On withdrawal of each instrument, root canals were irrigated with 2 mL of 2.5% NaOCl. Following instrumentation, each root canal was flushed with 10 mL of 17% ethylenediaminetetraacetic acid and 10 mL of distilled water, and then dried with paper points. During all irrigation procedures, 27 gauge needle (Ultradent, South Jordan, UT, USA) was placed as deep as possible into the canal without resistance, until 1 mm short of the predetermined WL. The teeth were randomly divided into two groups (24 in each group) and were allocated different obturation techniques.

Lateral condensation technique

A size #30.02 taper Gutta-percha cone Gutta-percha cone (Dentsply Maillefer, Ballaigues, Switzerland) was prefitted into the canal at the WL. AH 26 sealer (Dentsply, DeTrey, Konstanz, Germany) was mixed according to the manufacturer's instructions. The tip of the master cone was lightly coated with AH 26 and slowly inserted into the canal. Then, a size 20 finger spreader was inserted, rotated, and withdrawn; #20.02 taper Gutta-percha accessory cones, coated with a thin layer of the sealer, were placed into the space created by the spreader. The process was repeated until it was not possible to place another accessory cone beyond 2–3 mm into the root canal.

Single cone technique

Root canals were filled with the matched-taper Gutta-percha cone and AH 26 sealer. AH 26 was mixed according to the manufacturer's instructions. An F3 master Gutta-percha cone (Dentsply Maillefer, Ballaigues, Switzerland) with good tug-back was coated with sealer and slowly inserted into the canal until the WL was reached.

After filling the root canals, radiographs of each tooth were taken from the mesial and buccal sides to ensure adequate obturation of the canals. In both groups, excessive coronal Gutta-percha was removed, access cavities were sealed with Cavit (Dentsply, DeTrey, Konstanz, Germany), and samples were stored in 100% humidity for 2 weeks to allow the sealer to set.

Debris collection and retreatment

In this study, a modified experimental model described by Myers and Montgomery[15] was used. Stoppers were separated from the Eppendorf tubes. An analytical balance (Radwag, Radom, Poland) with an accuracy of 10^{-4} g was used to measure the initial weights of the tubes. Three consecutive weights were obtained for each tube, and the mean value was calculated. A hole was created on each stopper. Each tooth was inserted up to the cementoenamel junction, and a 27-gauge needle (Ultradent, South Jordan, UT, USA) was placed alongside the stopper. This acted as a drainage cannula and helped to balance the air pressure inside and outside the tubes. Then, each stopper with the tooth and the needle was attached to its Eppendorf tube, and the tubes were fitted into vials.

Each group was divided into two subgroups (12 canals for each subgroup) and was allocated a retreatment technique using ProTaper UR files with or without solvent.

In solvent groups, the coronal filling was removed to allow access to the entrance of the canal. The D1 (size 30, 0.09 taper) and D2 (size 25, 0.08 taper) files were used at a rotational speed of 550 rpm and 200 g/cm torque in the cervical and middle thirds of the root canals respectively, and the D3 (size 20, 0.07 taper) file was used at a rotational speed of 250 rpm and 150 g/cm torque, using an X Smart electric motor (Dentsply Maillefer, Ballaigues, Switzerland), until the WL was reached. After using the D1 file, 0.5 mL of chloroform was injected into the coronal part of the canal to soften the filling material. To maximize the Gutta-percha removal, the final apical preparation was performed with a ProTaper Universal F4 at a rotational speed of 250 rpm and 200 g/cm torque in a brushing circumferential motion.

In the without solvent groups, the method of removing the root canal fillings in the lateral condensation or single cone groups was the same as that for the with solvent groups, except that no chloroform was used.

To avoid variation and elimination biases, the retreatment procedures of all samples were completed by the same trained operator. An aluminum leaf that covered the vials was used to ensure that the operator did not see the root apex during instrumentation. In each sample, 4 mL of distilled water was used as the irrigation solution between files. Each retreatment instrument was discarded after being used in four root canals.

The retreatment procedure was considered finished when the WL was reached, no more Gutta-percha and sealer could be seen on the surface of the last used instrument, and further radiographic examination revealed no radiopaque material. If the canal was judged unclean, the final rotary file (F4) was again inserted several times. In addition, the time required for complete removal of the root filling was recorded. The time for instrument removal was not added to the working time. After the instrumentation was complete, the stopper, needle, and tooth were separated from the Eppendorf tube, and the debris adhered to the root surface was collected by washing the root with 1 mL distilled water in the tube. The tubes were then stored in an incubator at 70°C for 5 days to evaporate the distilled water before weighing the dry debris. Weight calculation was performed by a second examiner who was blinded to the group assignment. The Eppendorf tubes were weighed to obtain the final weight of the tubes including the extruded debris using the same analytical balance. Three consecutive weights were obtained for each tube and the mean value was calculated. The dry weight of the extruded debris was calculated by subtracting the weight of the empty tube from that of the tube containing debris.

Statistical analysis was performed using SPSS version 21.0 software (SPSS Inc., Chicago, IL, USA). Data are presented as mean and standard deviation values. The data were analyzed using two-way analysis of variance, with Bonferroni correction at a 95% confidence level ($P < 0.05$).

Results

The weights of apically extruded debris for each group are shown in Table 1. It was found that all techniques resulted in a measurable amount of debris. In terms of debris extrusion, there were no statistically significant differences between obturation techniques ($P = 0.332$). The mean amount of debris was higher in nonsolvent groups than solvent groups, particularly in single cone technique ($P = 0.013$).

The operating times are shown in Table 2. There was a significant difference between groups. Gutta-percha removal took less time in the single cone group than the lateral condensation group ($P < 0.001$). Gutta-percha removal in

Table 1: Amount of apically extruded debris (g)

Groups	Mean	SD
Single cone with solvent	0.0014[b]	0.0008
Single cone without solvent	0.0026[a]	0.0014
Lateral condensation with solvent	0.0013[b]	0.0011
Lateral condensation without solvent	0.0020[ab]	0.0012

Values with the same superscript letters were not statistically significant different. P=0.332. SD=Standard deviation

Table 2: Time required for filling material removal (min)

Groups	Mean	SD
Single cone with solvent	3.7167[b]	0.4431
Single cone without solvent	2.6033[d]	0.4563
Lateral condensation with solvent	4.2042[a]	0.9600
Lateral condensation without solvent	3.4650[cb]	0.4229

Values with the different superscript letters were statistically significant different. P<0.001. SD=Standard deviation the nonsolvent groups took significantly less time than that in the solvent groups ($P < 0.001$).

Discussion

In root canal retreatment, complete removal of preexisting obturation material is an important factor because it allows reinstrumentation and redisinfection of the root canal system. An appropriate retreatment technique should be selected to completely remove the preexisting filling material as fast as possible, while reducing the amount of apical extrusion, to prevent pain and inflammation.

In this study, the teeth were decoronated, and the length of each root canal was standardized at 18 mm. Although decoronation does not reflect the clinical situation, it allows specimen standardization by eliminating some variables such as crown anatomy and root canal length.[16] Root canals were filled using two different obturation techniques: Lateral condensation and single cone technique. Lateral condensation is a commonly used obturation technique where several Gutta-percha cones and a cementing substance are tightly pressed together and joined by the frictional grip, rather than a homogeneous mass of Gutta-percha. The accessory and master cones are laminated and remain separate.[17] The single cone technique instead uses a single Gutta-percha cone matching the taper and size of the rotary Ni-Ti instruments and root canal sealer.

The apical diameters of ProTaper Universal Retreatment Instruments used in this study were D1 (size 30, 0.09 taper), D2 (size 25, 0.08 taper) and D3 (size 20, 0.07 taper). The D3 instrument has been designed to reach the WL but may not permit a complete cleaning. To obtain better apical cleaning, reinstrumentation at the WL using instruments of size greater than those used in the initial treatment is necessary. Some studies have shown that apical enlargement by 2 sizes beyond the initial preparation size significantly reduces the amount of residual filling material in straight root canals.[18,19] Therefore, in the present study, apical enlargement was increased from size 30 (F3) to size 40 (F4).

There is an absence of physical back-pressure provided by the periapical tissues in *in vitro* studies. Therefore, the clinical relevance of the results of the present study should be interpreted with caution. Myers and Montgomery have discussed such shortcomings of *in vitro* studies.[15] The use of floral foam as a simulation of back-pressure of periapical tissues has been suggested.[20,21] However, foam has several disadvantages such as absorption of irrigant and debris. Therefore, no attempt has been made in the present study to simulate periapical resistance.

In the root canal retreatment procedure, solvents can be used to soften and dissolve the obturation material. Chloroform is commonly used because of its effectiveness and dissolving capacity.[22] In the present study, chloroform was used after using the D1 file to soften the coronal filling material and improve the penetration of the files to reach the WL. According to the results of the present study, the use of chloroform with ProTaper UR increased the time required to satisfactorily remove Gutta-percha in both the groups. The mean time to achieve satisfactory Gutta-percha removal was less in the nonsolvent groups than the solvent groups for both obturation techniques. These results are in accordance with previous findings.[17,23] Ma *et al.*[17] reported that less time was required to achieve satisfactory Gutta-percha removal and root canal refinement in nonsolvent groups than in solvent groups. Horvath *et al.*[23] found that solvents led to more Gutta-percha and sealer remnants on root canal walls and inside dentinal tubules. It was difficult to remove the filling material when solvent was used because a fine layer of softened Gutta-percha adhered to the root canal wall. Therefore, the nonsolvent groups required less time to achieve satisfactory Gutta-percha removal than the solvent groups.

The results of the present study revealed that the mean weight of apically extruded debris in the solvent groups was less than the nonsolvent groups after using different obturation techniques. The use of a solvent could account for less extrusion as it renders the filling material softer and led to more Gutta-percha and sealer remnants on root canal walls and inside dentinal tubules. Therefore, reduced extrusion of filling material through the apical foramen was observed in nonsolvent groups.

When the obturation techniques were compared, there were no significant differences between the groups. In the previous studies,[6,7,24] no significant differences was found between lateral condensation and single cone technique regard to the percentage of Gutta-percha filled area. However, in a previous report Schäfer *et al.*[25] reported that single cone obturation resulted in significantly lower Gutta-percha filled areas than the lateral condensation technique. Gordon *et al.*[6] reported a similar percentage of Gutta-percha filled areas between single cone and lateral condensation techniques. Additionally, Hörsted-Bindslev *et al.*[26] reported that the lateral condensation technique did not differ from the single cone technique with regard to the radiographic quality of the root filling. Tasdemir *et al.*[27] found that the single cone technique produced a significantly greater percentage of Gutta-percha filled area than the lateral condensation technique at 2 mm from the apex, but there was no significant difference between the techniques at 4 mm from the apex. These previous findings help support the present results that the canals filled using the single cone technique lateral condensation technique had the similar bulk of Gutta-percha.

Conclusion

Under the conditions of the present study, apical extrusion was seen in all groups. Amount of apically extruded debris was similar in both obturation techniques. Greater amounts of apically extruded debris were observed in the nonsolvent groups than in the solvent groups. This was particularly evident in the single cone technique. Less time was required to achieve satisfactory Gutta-percha removal in the single cone technique than in the lateral condensation technique. Nonsolvent groups took significantly less time than solvent groups to achieve satisfactory Gutta-percha removal.

References

1. Stabholz A, Friedman S. Endodontic retreatment – Case selection and technique. Part 2: Treatment planning for retreatment. J Endod 1988;14:607-14.
2. Gulabivala K, Holt R, Long B. An *in vitro* comparison of thermoplasticised gutta-percha obturation techniques with cold lateral condensation. Endod Dent Traumatol 1998;14:262-9.
3. McMurtrey LG, Krell KV, Wilcox LR. A comparison between Thermafil and lateral condensation in highly curved canals. J Endod 1992;18:68-71.
4. De-Deus G, Reis C, Beznos D, de Abranches AM, Coutinho-Filho T, Paciornik S. Limited ability of three commonly used thermoplasticized gutta-percha techniques in filling oval-shaped canals. J Endod 2008;34:1401-5.
5. Marlin J, Krakow AA, Desilets RP Jr, Gron P. Clinical use of injection-molded thermoplasticized gutta-percha for obturation of the root canal system: A preliminary report. J Endod 1981;7:277-81.
6. Gordon MP, Love RM, Chandler NP. An evaluation of. 06 tapered gutta-percha cones for filling of. 06 taper prepared curved root canals. Int Endod J 2005;38:87-96.
7. Romania C, Beltes P, Boutsioukis C, Dandakis C. *Ex-vivo* area-metric analysis of root canal obturation using gutta-percha cones of different taper. Int Endod J 2009;42:491-8.
8. Gordon MP. The removal of gutta-percha and root canal sealers from root canals. N Z Dent J 2005;101:44-52.
9. Friedman S, Stabholz A, Tamse A. Endodontic retreatment – Case selection and technique. 3. Retreatment techniques. J Endod 1990;16:543-9.
10. Sae-Lim V, Rajamanickam I, Lim BK, Lee HL. Effectiveness of ProFile. 04 taper rotary instruments in endodontic retreatment. J Endod 2000;26:100-4.
11. Giuliani V, Cocchetti R, Pagavino G. Efficacy of ProTaper universal retreatment files in removing filling materials during root canal retreatment. J Endod 2008;34:1381-4.
12. Seltzer S, Naidorf IJ. Flare-ups in endodontics: I. Etiological factors. J Endod 1985;11:472-8.
13. Tinaz AC, Alacam T, Uzun O, Maden M, Kayaoglu G. The effect of disruption of apical constriction on periapical extrusion. J Endod 2005;31:533-5.
14. Schneider SW. A comparison of canal preparations in straight and curved root canals. Oral Surg Oral Med Oral Pathol 1971;32:271-5.
15. Myers GL, Montgomery S. A comparison of weights of debris extruded apically by conventional filing and Canal Master techniques. J Endod 1991;17:275-9.
16. Barletta FB, Rahde Nde M, Limongi O, Moura AA, Zanesco C, Mazocatto G. *In vitro* comparative analysis of 2 mechanical techniques for removing gutta-percha during retreatment. J Can Dent Assoc 2007;73:65.
17. Ma J, Al-Ashaw AJ, Shen Y, Gao Y, Yang Y, Zhang C, *et al.* Efficacy of ProTaper Universal Rotary Retreatment system for gutta-percha removal from oval root canals: A micro-computed tomography study. J Endod 2012;38:1516-20.
18. Roggendorf MJ, Legner M, Ebert J, Fillery E, Frankenberger R, Friedman S. Micro-CT evaluation of residual material in canals filled with Activ GP or GuttaFlow following removal with NiTi instruments. Int Endod J 2010;43:200-9.
19. Rödig T, Hausdörfer T, Konietschke F, Dullin C, Hahn W, Hülsmann M. Efficacy of D-RaCe and ProTaper Universal Retreatment NiTi instruments and hand files in removing gutta-percha from curved root canals-A micro-computed tomography study. Int Endod J 2012;45:580-9.
20. Altundasar E, Nagas E, Uyanik O, Serper A. Debris and irrigant extrusion potential of 2 rotary systems and irrigation needles. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;112:e31-5.
21. Hachmeister DR, Schindler WG, Walker WA 3rd, Thomas DD. The sealing ability and retention characteristics of mineral trioxide aggregate in a model of apexification. J Endod 2002;28:386-90.
22. Tamse A, Unger U, Metzger Z, Rosenberg M. Gutta-percha solvents – A comparative study. J Endod 1986;12:337-9.
23. Horvath SD, Altenburger MJ, Naumann M, Wolkewitz M, Schirrmeister JF. Cleanliness of dentinal tubules following gutta-percha removal with and without solvents: A scanning electron microscopic study. Int Endod J 2009;42:1032-8.
24. Schäfer E, Köster M, Bürklein S. Percentage of gutta-percha-filled areas in canals instrumented with nickel-titanium systems and obturated with matching single cones. J Endod 2013;39:924-8.
25. Schäfer E, Nelius B, Bürklein S. A comparative evaluation of gutta-percha filled areas in curved root canals obturated with different techniques. Clin Oral Investig 2012;16:225-30.
26. Hörsted-Bindslev P, Andersen MA, Jensen MF, Nilsson JH, Wenzel A. Quality of molar root canal fillings performed with the lateral compaction and the single-cone technique. J Endod 2007;33:468-71.
27. Tasdemir T, Yesilyurt C, Ceyhanli KT, Celik D, Er K. Evaluation of apical filling after root canal filling by 2 different techniques. J Can Dent Assoc 2009;75:201a-d.

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