**In Vitro** Evaluation of the Effectiveness of ProTaper Universal Rotary Retreatment System for Gutta-Percha Removal with or without a Solvent

Cristiane Midori Takahashi, MSc, Rodrigo Sanches Cunha, PbD, Alexandre Sigrist De Martin, PbD, Carlos Eduardo Fontana, MSc, Cláudia Fernandes M. Silveira, MSc, and Carlos Eduardo da Silveira Bueno, PbD

**Abstract**

**Introduction:** Effective removal of gutta-percha in endodontic retreatment is a significant factor to ensure a favorable outcome from failed procedures. The purpose of this study was to evaluate the efficacy of a nickel-titanium rotary instrument system with or without a solvent versus stainless steel hand files for gutta-percha removal. **Methods:** Forty extracted human maxillary anterior teeth were prepared and filled. They were divided into 4 groups: Gates-Glidden and K-files, Gates-Glidden and K-files with chloroform, ProTaper Universal rotary retreatment system, and ProTaper Universal rotary retreatment system with chloroform. The operating time was recorded. The teeth were longitudinally sectioned and photographed. The images were analyzed and the filling remnants were quantified by using the IMAGE TOOL software. **Results:** With Kruskall-Wallis test, statistical analysis showed that there was no significant difference between the techniques in regard to the amount of the endodontic filling remnants ($P < .05$); however, the ProTaper Universal rotary retreatment system was faster than the hand files ($P < .05$). **Conclusions:** All of the techniques proved helpful for the removal of endodontic filling material, and they were similar in material remaining after retreatment, but the ProTaper Universal rotary retreatment system without chloroform was faster. *(J Endod 2009;35:1580–1583)*

**Key Words**

Gutta-percha, nickel-titanium files, root canal retreatment, solvents

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**Materials and Methods**

**Specimen Preparation**

Forty extracted single-rooted maxillary anterior teeth were selected with a single straight root canal, fully formed apices in which the first file fitted at the apex was a size 15, and no calcification or internal resorption.

The crowns were removed with a diamond disk (KG Sorensen, Barueri, SP, Brazil) to leave a 16-mm root measured with the aid of calipers. A size 10 K-file was introduced into the canal until it was visible at the apical foramen. The working length was determined by subtracting 1 mm from this measurement.

**Root Canal Treatment**

Instrumentation was performed by a single operator. The cervical third was flared with sizes 3 and 2 Gates-Glidden drills (Dentsply Maillefer) in decreasing order, and the working length was determined. The files were then exchanged for the ProTaper Universal rotary retreatment system, with or without solvent, versus stainless steel hand files for endodontic filling removal from root canals. The required retreatment time for each system was also determined and compared.

Even though advances in instruments and techniques have facilitated endodontic therapy, clinicians must still deal with cases of failure caused by several factors and requiring endodontic retreatment (1–3).

When nonsurgical retreatment is indicated, efficient removal of the filling material from the root canal system is essential to ensure a favorable outcome (4). However, some studies have shown that it is almost impossible to remove the root canal filling completely (5–7). Many techniques and materials have been used to obturate the root canal system, but gutta-percha combined with a sealer is still the most commonly used combination of materials. Several techniques can be used to remove the gutta-percha, including the use of stainless steel hand files, nickel-titanium (NiTi) rotary instruments, heat-bearing instruments, and ultrasonics (8). In addition, use of a solvent is recommended to facilitate the removal of gutta-percha by softening it (9). Chloroform is the most commonly used solvent because of its effectiveness. There are some limitations to its use, particularly because it has been suggested that chloroform might be a potential carcinogen. Nonetheless, chloroform is considered safe if used carefully and in a clinically controlled manner (10). Another limitation is that chloroform leaves a fine layer or film of softened gutta-percha (11).

Recently, a NiTi rotary instrument system was developed for gutta-percha removal, the ProTaper Universal (Dentsply Maillefer, Ballaigues, Switzerland) system for retreatment. It consists of 3 instruments: D1 with tip 30 and taper 0.09, D2 with tip 25 and taper 0.08, and D3 with tip 20 and taper 0.07. In addition, the D1 working tip facilitates initial penetration into the filling material.

Nevertheless, there is no agreement about which methods should be used for the removal of root canal filling. Novel techniques seek improved results through NiTi rotary instruments and the operating microscope.

The purpose of this study was to evaluate the efficacy of a NiTi rotary instrument system (ProTaper Universal rotary retreatment system), with or without solvent, versus stainless steel hand files for endodontic filling removal from root canals. The required retreatment time for each system was also determined and compared.
order. Root canals were prepared by using a crown-down technique up to a size 35 K-type file (Dentsply Maillefer) apically and were flared cervically up to a size 50 K-type file. At each change of instrument, the canals were irrigated with 20 mL of a 2.5% NaOCl solution (Fórmula & Ação Fâmâcia, São Paulo, SP, Brazil) per sample. When instrumentation of the root canals was completed, 17% ethylenediaminetetraacetic acid was applied for 3 minutes for smear layer removal, and the canals were again irrigated with 5 mL of 2.5% NaOCl.

The root canals were dried with paper points and obturated with gutta-percha (Dentsply, Petrópolis, RJ, Brazil) and zinc oxide–eugenol sealer (Endoﬁll; Dentsply) by using thermomechanical compaction with a hybrid technique (12). This consists of a lateral compaction of cold gutta-percha followed by the application of a rotating gutta condenser to thermally soften and condense the gutta-percha. The coronal access cavities were sealed with a temporary filling material (Cavit; DeTrey Dentsply, Konstanz, Germany). All teeth were stored at 100% humidity and 37°C for a period of 30 days to allow the sealer to set completely.

Retreatment Techniques

The teeth were randomly divided into 4 groups with 10 specimens each, and the temporary filling was removed. Gutta-percha was removed by using one of the following techniques.

Stainless Steel Hand Files (SS) Group. The gutta-percha was removed from the coronal and middle thirds with sizes 3 and 2 Gates-Glidden drills. A size 40 K-type file was then introduced into the root canal by using a crown-down technique until the working length was reached with a size 20 K-type file.

Stainless Steel Hand Files With Chloroform (SS+C) Group. Gates-Glidden drills sizes 3 and 2 were used to remove the coronal and middle thirds of the filling material. A 0.1 mL of chloroform was placed in the canal to soften the gutta-percha. A size 40 K-type file was then used to penetrate the softened gutta-percha by using a crown-down technique until the working length was reached with a size 20 K-type file.

ProTaper Universal Retreatment Instruments (PTR) Group. ProTaper Universal retreatment instruments were used to remove the filling material. D1, D2, and D3 were used sequentially, applying a crown-down technique, until the working length was reached. The instruments were used with an electric motor (X-Smart; Dentsply Maillefer) at a constant speed of 500 rpm for D1 and 400 rpm for D2 and D3, with a torque of 3 Ncm.

ProTaper Universal Retreatment Instruments with Chloroform (PTR+C) Group. The technique used here was similar to that used in PTR group, but 0.1 mL of chloroform was placed into the root canal after using instrument D1. Next, the softened gutta-percha was removed by using D2 and D3 sequentially until the working length was reached.

On withdrawal, the files were cleansed of any obturating material before being reintroduced in the root canal. Each file was discarded after being used in 5 teeth. Irrigation with 2.5% NaOCl was performed during the procedure at each change of instrument. All the teeth were re-treated by a single operator.

Retreatment was considered complete for all groups when no filling material was observed on the instruments, and no filling material could be detected inside the canal by the operating microscope (DF Vasconcelos S.A., São Paulo, SP, Brazil) with 12.5× magnification. The retreatment time was recorded for each tooth.

Evaluation

The teeth were grooved buccolingually with a diamond disk and sectioned longitudinally with a rongeur. Both root halves were photographed with a camera (Sony PC120, Sony Corporation, Tokyo, Japan) adapted to an operating microscope with 5× magnification. To evaluate the remaining filling material, the images taken were transferred to a specific software (Image Tool for Windows v.3.00; University of Texas Health Science Center, San Antonio, TX), which was used to measure the areas of remaining filling material (Fig. 1) and root canal periphery that were computed and expressed by using square pixels. The images of the sections were evaluated by 3 independent precalibrated examiners who observed and quantified root canal filling remnants. Mean percentage values were calculated and compared.

Statistical Analysis

The mean percentage amounts of remaining gutta-percha and sealer for each group and the mean retreatment times were compared by using the Kruskall-Wallis test (P < .05).

Results

All of the teeth examined had some endodontic filling remnants in the canals. The mean amounts of remaining gutta-percha/sealer in each group are shown in Table 1. There was no statistically significant difference (P < .05) between the groups.

A significant statistical difference (P < .05) was found between the groups in regard to retreatment time (Table 2). PTR group was faster than SS, SS + C, and PTR + C groups.

Discussion

The complete removal of endodontic filling material is difficult (5, 7, 13–15), and it is one of the main goals of nonsurgical endodontic retreatment. The root canal system of inadequately instrumented and obturated teeth is especially subject to presenting necrotic tissues and microorganisms responsible for endodontic treatment failure (16–18).

A hybrid obturation technique was chosen in the present study because it produces a better gutta-percha adaptation to the root canal walls than the lateral condensation technique (6, 12, 19).

Countless retreatment techniques have been suggested to effectively clean the root canal system, including stainless steel hand files.

Figure 1. Measurement of area covered by filling material remnants in the IMAGE TOOL 3.00 software.
Takahashi et al.

Under the experimental conditions of the present study, all techniques proved helpful for removal of endodontic filling material, and there were no significant differences between them. However, the ProTaper Universal retreatment system without chloroform proved to be faster than the other experimental groups. Further studies are necessary to evaluate the effectiveness of this system in curved canals.

### Basic Research—Technology

<table>
<thead>
<tr>
<th>Group</th>
<th>SS</th>
<th>SS+C</th>
<th>PTR</th>
<th>PTR+C</th>
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<td>19.4%</td>
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<td>24.7%</td>
<td>28.0%</td>
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<tr>
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<td>14.3%</td>
<td>14.2%</td>
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</table>

PTR, ProTaper Universal Retreatment Instruments; PTR+C, ProTaper Universal Retreatment Instruments with Chloroform; SS, Stainless Steel Hand Files; SS+C, Stainless Steel Hand Files with Chloroform.

### TABLE 1. Percentage of Remaining Obturating Material in Root Canal System after Retreatment

<table>
<thead>
<tr>
<th>Group</th>
<th>SS</th>
<th>SS+C</th>
<th>PTR</th>
<th>PTR+C</th>
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</thead>
<tbody>
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<td>5.7</td>
</tr>
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</table>

PTR, ProTaper Universal Retreatment Instruments; PTR+C, ProTaper Universal Retreatment Instruments with Chloroform; SS, Stainless Steel Hand Files; SS+C, Stainless Steel Hand Files with Chloroform.

### TABLE 2. Time in Minutes for Retreatment

References