Comparative Evaluation of the Efficiency of Manual and Rotary Gutta-percha Removal Techniques

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Abstract

Introduction: This study aimed to evaluate the efficiency of 2 manual and 2 rotary gutta-percha (GP) removal techniques in terms of both the total operating time and GP remnants left in the canal. **Methods:** GP was removed with manual techniques using H-files and xylene (H + X) and H-files and System B (H + SB) (SybronEndo, Orange, CA) and with rotary techniques using the ProTaper Univeral Retreatment (PTUR) (Dentsply Maillefer, Ballaigues, Switzerland) and D-RaCe Retreatment (D-RR) (FKG Dentaire, La Chaux-de-Fonds, Switzerland) systems. The total operating time was evaluated as the time taken to reach the working length and completely remove GP until no radiopaque remnants were observed in the final radiograph. Any GP remnants left in the canal were evaluated in terms of percentage in the whole canal. **Results:** Rotary techniques were significantly faster and left lesser GP remnants than manual techniques ($P < .05$). In rotary techniques, the D-RR system was significantly faster than the PTUR system ($P < .05$), but there was no significant difference between them regarding GP remnants ($P > .05$). In manual techniques, H + X was significantly faster and left lesser GP remnants than H + SB ($P < .05$). **Conclusions:** Rotary techniques were more efficient than manual techniques in GP removal. Overall, the D-RaCe Retreatment system was most efficient, whereas manual use of H-files with System B was least efficient. However, because all the techniques showed GP remnants in the canal and radiographs failed to show these remnants, additional measures would be required to ensure complete GP removal and check for cleaner canals during endodontic retreatment. *(J Endod 2015;41:1871–1874)*

Key Words

D-RaCe, gutta-percha removal, H-files, ProTaper, retreatment, System B, xylene

A manual technique with the combined use of H-files and a commonly used chemical solvent such as chloroform or xylene is suggested for the removal of a well-compacted gutta-percha (GP) obturation during endodontic retreatment (1, 2). Similarly, another manual technique is suggested with the combined use of hand files and an electrically heated spreader or plugger such as System B Heat Source (SybronEndo, Orange, CA) (1). However, the removal of a well-compacted GP is tedious and time-consuming. Therefore, rotary files are recommended for saving time and reducing patient and operator fatigue (3, 4).

Recently, the rotary nickel-titanium ProTaper Universal Retreatment (PTUR) (Dentsply Maillefer, Ballaigues, Switzerland) and D-RaCe Retreatment (D-RR) (FKG Dentaire, La Chaux-de-Fonds, Switzerland) systems have been specifically introduced for retreatment. The PTUR system consists of D1, D2, and D3 files, whereas the D-RR system is composed of DR1 and DR2 files. D1 and DR1 files have an active working tip to promote initial entry into the obturating material, and the rest of the files have a nonactive tip to reduce procedural errors during obturation removal (5, 6).

Clinical efficiency of a GP removal technique depends on the total operating time, which is the time taken to reach the working length and, ideally, achieve complete removal of the obturation material (7). Many studies using various methods have evaluated and/or compared the effectiveness and/or the efficiency of various manual and rotary retreatment file techniques of GP removal. These studies have shown varying and/or contradictory results and, irrespective of the techniques used, have reported residual GP in the canal (4–18). However, only 2 studies have compared the rotary PTUR and D-RR systems. Although 1 study compared the effectiveness (4), the other study compared the efficiency (6) between these systems. However, these studies reported residual GP with both the systems but in a contradicting manner (4, 6). Otherwise, hardly any studies have evaluated and compared the efficiency in terms of the operating time and the effectiveness of the previously mentioned rotary systems and the aforementioned manual techniques.

Radiographs are routinely used in a clinical practice to monitor GP removal and to verify the presence of root filling debris (19). Therefore, clinically it is more relevant to evaluate the efficiency of a GP removal technique in terms of the total operating time taken for the removal of GP until its radiopaque remnants are not seen in the radiograph and assessing any residual GP still left in the canal. In this context, the present study was conducted to evaluate and compare the efficiency of the aforementioned manual techniques and rotary retreatment systems in removing GP.

Materials and Methods

Forty extracted intact single-rooted human teeth were decoronated to obtain a standardized root length of 15 mm. The working length was determined, and canal cleaning and shaping were done with ProTaper (Dentsply Maillefer) rotary files up

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0099-2399/$ - see front matter

http://dx.doi.org/10.1016/j.joen.2015.07.012

to file size F2 using a crown-down technique. Canals were obturated with GP cones and zinc oxide–eugenol sealer (Endofill; Dentsply Ind e Com Ltda, Petrópolis, RJ, Brazil) by using the lateral compaction technique. The obturated roots were randomly divided into 4 groups, with 10 roots (n = 10) each, for GP removal using H-files and xylene (H + X), H-files and System B (H + SB), the PTUR system, and the D-RR system, respectively. H + X and H + SB represented manual techniques, whereas the PTUR and D-RR systems represented rotary techniques for studying their efficiency in terms of the total operating time and any GP remnants left in the canal.

Evaluation of the Total Operating Time

The total operating time was measured in seconds using an electric stopwatch.

H + X Group. GP was softened incrementally by depositing 0.1 mL xylene (Merck Specialties, Mumbai, India). A size 20 H-file (Dentsply Maillefer) was used to penetrate and remove softened GP until the working length was reached. A size 30 H-file was used circumferentially to remove the remaining GP until its traces were not seen on the file. A radiograph was taken, and radiopaque remnants, if any, were removed by further instrumentation. The removal of GP was considered complete when no more remnants were detected in the final radiograph. The total operating time was calculated as the sum of the time taken for the initial removal of GP until the working length was reached and for the complete removal of GP excluding the time taken for the change of instruments, irrigation, and radiographs.

H + SB Group. GP was softened using a Buchanan 0.06 taper plugger (SybronEndo) attached to the SB. The plugger was heated to 200°C and inserted into the obturation to a depth 3 mm short of the working length to transfer heat and soften GP. The plugger was kept for 15 seconds before removing. GP removal, radiographic monitoring, and the total operating time calculation were performed as described in the H + X group.

PTUR System Group. The PTUR system was employed using D1 (size 30, .09 taper), D2 (size 25, .08 taper), and D3 (size 20, .07 taper) files sequentially to remove GP from the cervical, middle, and apical thirds, respectively, until the working length was reached. These files were used with an X Smart electric motor (Dentsply Maillefer) in a brushing motion at the manufacturer's recommended speed (300 rpm) and torque (2 N/cm). GP removal was considered complete when no more radiopaque remnants were detected in the radiograph. The total operating time was calculated as the sum of the time taken by D1, D2, and D3 files excluding the time taken for the change of files, irrigation, and radiographs.

D-RR System Group. The D-RR system was employed using DR1 (size 30, .10 taper) and DR2 (size 25, .04 taper) files to remove GP from the coronal and apical half areas, respectively, until the working length was reached. These files were used with an X Smart electric motor (Dentsply Maillefer) at the manufacturer's recommended speed and torque. The DR1 file was used at a speed of 1000 rpm and a torque of 1.5 N/cm, whereas the DR2 file was used at a speed of 600 rpm and a torque of 0.7 N/cm. The verification of complete GP removal and the total operating time calculation were done as in the PTUR system group. However, the total operating time was considered as the sum of the time taken by the DR1 and DR2 files.

Evaluation of GP Remnants

The roots were grooved longitudinally in a buccolingual direction with a diamond disk and split into 2 halves with a chisel. The canal walls of the sectioned roots were imaged using a compound microscope of magnification ×40 (Olympus cx21; Olympus, Melville, NY). The images were analyzed using Image J 1.42a/Java 1.6.0-10 image analyzer software (National Institutes of Health, Bethesda, MD) to measure the area of GP remnants on the whole canal surface and the area of the canal walls. The percentage of GP remnants (A) was calculated using the following equation: A = (area of the remnants × 100)/area of the root canal. The results were analyzed using the SPSS 15 software package (SPSS Inc, Chicago, IL) and applying 1-way analysis of variance and the Tukey post hoc test.

Results

The mean total operating time and the percentage of GP remnants with a significant difference ($P < .05$) among the study groups are shown in Table 1. Rotary techniques (PTUR and D-RR systems) were significantly faster and left lesser GP remnants than manual techniques (H + X and H + SB) ($P < .05$, Tables 2 and 3). There were also significant differences ($P < .05$) between the groups in rotary and manual techniques. In manual techniques, H + X was significantly faster and left lesser GP remnants than H + SB ($P < .05$, Tables 2 and 3). However, in rotary techniques, the D-RR system was significantly faster than the PTUR system ($P < .05$, Table 2), but there was no significant difference between them regarding GP remnants ($P > .05$, Table 3). Overall, the D-RR system was most effective because it was the fastest with the least amount of GP remnants, and its differences with all the remaining groups were significant ($P < .05$) except with the PTUR system regarding GP remnants ($P > .05$). On the contrary, H + SB was the least effective because it was the slowest with the most GP remnants and had significant differences ($P < .05$) with all the remaining groups (Tables 2 and 3).

Discussion

In the present study, rotary techniques were significantly faster than manual techniques. This is in agreement with most related studies although a few studies have reported the contrary. Rotary techniques are faster because of the motion, inherent speed, greater taper, flute design, and active tip of the rotary files. Rotary files in motion generate frictional heat, which plasticizes and softens GP (6, 7, 20–22). Their active working tip facilitates the initial penetration of GP and penetration of the subsequent files. Their flutes allow coronal extrusion of GP in spirals around the files to remove GP faster (1, 4–11).

In our study, both the manual and rotary techniques had GP remnants in the canal despite the removal of GP until no more radiopaque traces were detected in the radiograph. This indicates the limitation of the radiographs in verifying the complete removal of the obturation from the canal. Radiographs are a 2-dimensional image of a 3-dimensional structure and prone to magnification and distortion. They are less

TABLE 1. Total Operating Time (in seconds) for Complete GP Removal and GP Remnants (in percentage) Seen in the Whole Canal

Groups	Number of samples (n)	Mean total operating time ± SD (in seconds)	Mean GP remnants ± SD (in percentage)	P Value
H + X	10	219.80 ± 29.68	45.58 ± 13.39	<.001
H + SB	10	451.20 ± 7.82	60.47 ± 12.38	
PTUR	10	111.70 ± 3.56	30.23 ± 11.29	
D-RR	10	70.70 ± 2.83	29.57 ± 6.43	

D-RR, DRaCe Retreatment; GP, gutta-percha; H + SB, H-files and System B; H + X, H-files and xylene; PTUR, ProTaper Universal Retreatment; SD, standard deviation.

$P < .05$ is statistically significant.