Comparison of the efficacy of three different techniques in the removal of gutta-percha and two types of sealers during endodontic retreatment

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ABSTRACT
Background: root canal retreatment is a common practice to preserve the teeth. This study aimed to assess the efficacy of ProTaper rotary re-treatment files, D-RaCe rotary desobturation files and gates glidden drills in combination with Hedstrom files for removal of gutta-percha and sealer from root canals.

Materials and methods: Palatal roots of sixty extracted maxillary first molars were instrumented with ProTaper rotary files to size $F_2$, then samples were randomly divided into two main groups (30 specimens each) according to the sealer used (Apexit Plus for group A and TubliSeal sealer for group B). The teeth were obturated with lateral compaction of Gutta-Percha points and placed in incubator for a period of one week. After that each group was subdivided into three subgroups (10 samples each) according to the removal techniques. After removal of the root filling material the roots were sectioned longitudinally. The percentage of root filling material area remained and times for all of the samples were calculated. Data were analyzed statistically by ANOVA and Student t-test at 5% significant level.

Results: The results showed that all retreatment techniques left filling material inside the canal. The mean percentage of remaining root filling material areas with Ca(OH)$_2$ based sealer groups were less than ZOE-based sealer groups. Gutta-Percha removal with D-RaCe rotary desobturation files was better than other techniques. The time of removal with D-RaCe rotary desobturation files was significantly faster than other techniques.

Conclusion: In conclusion, complete removal of gutta-percha cannot be achieved with any of the techniques used. D-RaCe desobturation system for re-treatment is more effective and faster in removing Gutta-Percha than other techniques.

Key words: ProTaper rotary retreatment files, D-RaCe desobturation instruments, retreatment. (J Bagh Coll Dentistry 2011;23(4):24-30).

INTRODUCTION
Root canal therapy despite having a high degree of success, may not lead to the desired response and failure may occurs, when failure occur treatment options include: conventional endodontic re-treatment, periradicular surgery or extraction. However, there is growing interest in endodontic re-treatment because it is the most conservative way to preserve the teeth (1).

Endodontic re-treatment requires complete removal of original root filling materials, which represent a mechanical barrier to the medicaments and harboring microorganisms with infected debris that often required time and effort to remove, in addition to further cleaning and refilling (2).

The techniques used to remove gutta-percha from root canals include hand instruments, ultrasonics, lasers, heat carrying instruments, as well as NiTi rotary instruments (3).

The advance in endodontic field led to the use of NiTi rotary instruments which are not only effective in root canal shaping, but also proved to be efficient and require less time in removing gutta-percha/sealer during endodontic retreatment. These instruments have a high elastic flexibility in bending and torsion and resistance to fracture which make them more accessible to the apical third of the root canal. The rotary movement produces a frictional heat to further soften the gutta-percha, making it easier to remove, it has been reported that the re-treatment time using rotary instruments was significantly shorter than using conventional manual files (4).

One of these rotary retreatment systems which are especially designed for root filling materials removal during retreatment is ProTaper Universal re-treatment files (1). New special retreatment system has been introduced which is the D-RaCe desobturation system.

The aim of this study is to evaluate in vitro the efficacy of ProTaper universal rotary re-treatment files (Dentsply/Maillfefer, Ballaigues, Switzerland), D-RaCe desobturation rotary files (FKG Dentaire, Switzerland), and gates glidden in combination with Hedstrom files (Dentsply/Maillfefer) for removal of gutta-percha from obturated root canals and two sealers: a calcium hydroxide -based sealer (Apexit Plus;
Ivoclar Vivadent, Liechtenstein) and a zinc oxide-eugenol based sealer (TubliSeal, SybronEndo, Italy).

MATERIALS AND METHODS

Sixty extracted maxillary first molars collected from different health centers were used in this study. The teeth were kept in 10% formalin solution for two weeks. The criteria for teeth selection (diagnostic x-ray was taken to confirm some of these criteria) include: a palatal root with a single straight canal, a fully formed root with a single straight canal, a fully formed apex, no visible root apex, no signs of internal resorption, calcification or previous endodontic therapy, no visible root caries, Patent apical foramen. \(^{(5, 6)}\)

Length of the root was determined by a vernier and marker and was sectioned to a length of twelve millimeters of the palatal root (measured from the apex) to standardize canal length in all teeth; the working lengths of the roots were about 11mm from a flat reference point to the root apex.\(^{(5)}\)

Clear cold cure acrylic was mixed and placed in a rubber surgical tube which was used as a mold where the root was embedded. The root was held in the correct position by attaching it to a dental surveyor.

A bench vice was used to achieve standardized position of the resin mounted root throughout the whole procedure. Then the teeth were prepared with ProTaper rotary system in crown-down manner by using speed reduction handpiece connected to an electric motor (Endo-Mate DT) at constant speed of 250 RPM and torque of 4 N/cm following manufacturer instruction. Shaping files were used with brushing motion from inside to outside the root canal while finishing files F1 followed by F2 were taken to the full WL (11 mm) and immediately withdrawn. All instruments were used with light apical pressure and wiped clean on clean stand at each file removal. The canal was irrigated with 1ml of 2.5% NaOCl solution at each change of file size to remove debris and prevent canal blockage. The final irrigation was carried with 5ml of 2.5% NaOCl solution followed by 5ml of distilled water, then the canal was dried with size F2 paper points for Protaper instruction.\(^{(5)}\)

Gates-Glidden drills (sizes 3 and 2) were activated by an electric engine (Endomate DT) at 1000 rpm speed and 1.4 N/cm torque for DR1 (30, .10) which has an active (cutting) tip to facilitate its initial penetration into the filling material at the cervical canal third and 600 rpm speed and 0.7 N/cm torque for DR2 (25, .04) at the middle and apical canal thirds, respectively, until reaching the working length.\(^{(5)}\)

After standardization of the procedure, D2 (25, .08) was re-inserted after D3 to have a file with ISO 25 tip size at the apical foramen.

D-RaCe desobturation files.

D-RaCe desobturation files were activated by an electric engine (Endomate DT) at 1000 rpm speed and 1.4 N/cm torque for DR1 (30, .10) which has an active (cutting) tip to facilitate its initial penetration into the filling material at the cervical canal third and 600 rpm speed and 0.7 N/cm torque for DR2 (25, .04) at the middle and apical canal thirds, and used with a brushing action in a crown-down manner, until reaching the working length.

Group A3 and Group B3 (Gates-glidden in combination with Hedström files).

Gates-Glidden drills (sizes 3 and 2) were activated by an electric engine (Endomate DT) at 1000 rpm speed and 3 N/cm torque for GG #3 at the cervical canal third and 1000 rpm speed and 1.4 N/cm torque for GG #2 at the middle canal third, and used with a brushing action in a crown-down manner. The remaining filling mass then will be penetrated with a size 40 Hedström...
file, this file was inserted into the mass of GP and rotated quarter turn clock wise with push pull filing motion, wiped clean on clean stand before re-insertion, the removal of GP was continued with sizes 35 and 30 until the WL was reached with a size 25 file (5, 13).

For all techniques, the canals were irrigated with 1% NaOCl between files and at the end of the procedure then dried with paper point. No solvent was applied so that the sealers did not have their removal affected by solvent use (5).

For group A and group B, the criteria for complete removal from each third was that no more GP appeared on the flutes of the file that was used in that third while the retreatment was considered to be completed when the initial WL was reached and no more GP could be seen on last instrument flutes and in the irrigating solution (2, 12, 14). To achieve standardization during re-treatment, one set of instruments was used per each tooth.

Evaluation

The roots were grooved longitudinally from the buccal and lingual aspects with a diamond disk and split into halves with a hand chisel. The root half with the greater amount of filling debris on visual inspection was examined. Images were captured with a digital camera (Nikon, Tokyo, Japan) and analyzed with adobe photoshop CS2 software. A specific software tool was used to outline the total canal area and the filling debris area (5).

The percentage of filling material remained for all of the samples were calculated which is equal to the (filling debris area/canal area).

The time from the beginning of root filling removal till the final irrigation and dryness of the canal was calculated using a digital stop watch and expressed as the time of filling material removal in minutes.

Statistical analysis

Descriptive statistics including: minimum, maximum, mean and standard deviation was calculated for the percentage of filling material remaining for each group. The data were collected and analyzed using SPSS (version 15) for statistical analysis. One-Way Analysis of Variance (ANOVA) was used to determine whether there is a statistical difference among the groups and Student t-test was used to evaluate the significance of difference between each pair of subgroups and between similar techniques of the both groups. Descriptive and inferential statistics were also carried for time of removal. In the above tests, Level of significance was set at P < 0.05.

RESULTS

Data that represents the minimum, maximum, mean values and the (±SD) for the percentage of remaining filling material (The filling debris area/canal area) by different removal techniques are shown in (Table 1).

Table 1: Descriptive statistical analysis for the percentage of remaining root filling material.

<table>
<thead>
<tr>
<th>groups</th>
<th>N</th>
<th>Min. %</th>
<th>Max. %</th>
<th>Mean %</th>
<th>±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>10</td>
<td>6.65</td>
<td>10.98</td>
<td>8.8921</td>
<td>1.31340</td>
</tr>
<tr>
<td>A2</td>
<td>10</td>
<td>4.21</td>
<td>7.26</td>
<td>6.0393</td>
<td>1.15848</td>
</tr>
<tr>
<td>A3</td>
<td>10</td>
<td>6.63</td>
<td>11.99</td>
<td>9.3214</td>
<td>1.51476</td>
</tr>
<tr>
<td>B1</td>
<td>10</td>
<td>6.77</td>
<td>12.82</td>
<td>10.4115</td>
<td>1.71789</td>
</tr>
<tr>
<td>B2</td>
<td>10</td>
<td>6.46</td>
<td>9.77</td>
<td>7.8014</td>
<td>1.06173</td>
</tr>
<tr>
<td>B3</td>
<td>10</td>
<td>7.83</td>
<td>12.49</td>
<td>10.0199</td>
<td>1.43227</td>
</tr>
</tbody>
</table>

It is clear that the groups where filling material remained when D-RaCe desobturation files were used with either Apexit Plus or TubliSeal sealers (A2 & B2) had the lowest mean percentage of remaining root filling material. It is also clear that using any of the three techniques for removal of filling material where Apexit Plus was used as a sealer result in mean percentages of remaining filling material (8.8921 %, 6.0393 %, 9.3214 %) that were less than the groups that were retreated by the same techniques where TubliSeal was used as a sealer (10.4115 %, 7.8014%, 10.0199 %). (Figure 1).

To see if there is any difference exist in the mean percentage of remaining filling material, ANOVA test was performed and showed a highly significant difference (P value < 0.01) among the groups according to the types of sealers used (Table 2).
Table 2: ANOVA test for the percentage of remaining root filling material using two different types of sealers.

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>26.401</td>
<td>1</td>
<td>26.401</td>
<td>7.408</td>
<td>0.009</td>
<td>HS</td>
</tr>
<tr>
<td>Within Groups</td>
<td>206.699</td>
<td>58</td>
<td>3.564</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>233.099</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Student t-test showed a highly significant difference in the mean percentage of the remaining filling material between groups that were retreated with D-RaCe desobturaion files (A2,B2) and groups that were retreated with either ProTaper rotary retreatment files (A1, B1) or gates glidden drills in combination with hedstrom files (A3, B3) when used with canals filled with both types of sealers, also a highly significant difference was found between groups that were retreated with D-RaCe desobturaion files when used with canals filled with both types of sealers (A2 & B2), while a significant difference was found between groups that were retreated with ProTaper rotary retreatment files when used with canals filled with both types of sealers; while a non significant difference was found between the remaining groups.

The minimum, maximum, mean (minutes) and ±SD of the time required for filling material removal for each group are listed in (Table 3).

Table 3: Descriptive statistics of the time required for root filling material removal.

<table>
<thead>
<tr>
<th>groups</th>
<th>N</th>
<th>Min. (min.)</th>
<th>Max. (min.)</th>
<th>Mean (min.)</th>
<th>±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>10</td>
<td>4.10</td>
<td>4.53</td>
<td>4.302</td>
<td>0.14635</td>
</tr>
<tr>
<td>A2</td>
<td>10</td>
<td>2.47</td>
<td>4.29</td>
<td>3.3810</td>
<td>0.52059</td>
</tr>
<tr>
<td>A3</td>
<td>10</td>
<td>4.53</td>
<td>7.48</td>
<td>6.3660</td>
<td>0.87951</td>
</tr>
<tr>
<td>B1</td>
<td>10</td>
<td>3.29</td>
<td>5.45</td>
<td>4.3850</td>
<td>0.77121</td>
</tr>
<tr>
<td>B2</td>
<td>10</td>
<td>2.41</td>
<td>4.35</td>
<td>3.5460</td>
<td>0.70662</td>
</tr>
<tr>
<td>B3</td>
<td>10</td>
<td>4.40</td>
<td>7.40</td>
<td>5.9520</td>
<td>0.93303</td>
</tr>
</tbody>
</table>

It is clear that root filling material removal with both NiTi rotary files required less time than the removal with gates glidden drills in combination with hedstrom files (Figure 2). It is also clear that using Apexit Plus or TubliSeal sealers had no great effect on the time required for the removal of root canal filling material when using the same technique for removal.

Figure 2: Bar chart showing the time required to remove the root filling material.

To see if there is any difference in the time required for removal of root canal filling material, ANOVA test was performed and showed a non significant difference (P value > 0.05) among groups filled with different types of sealers (Table 4).

Table 4: ANOVA test of the time required for root filling material removal.

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>0.046</td>
<td>1</td>
<td>0.046</td>
<td>0.026</td>
<td>0.873</td>
<td>NS</td>
</tr>
<tr>
<td>Within Groups</td>
<td>103.831</td>
<td>58</td>
<td>1.790</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>103.877</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DISCUSSION

Removal of the sealer and gutta-percha completely from inadequately prepared and filled root canal systems is essential in root canal retreatment because it is likely to uncover remaining necrotic tissue or bacteria that may be responsible for periapical inflammation and post-treatment disease (15).

Extracted permanent maxillary first molars with straight palatal root were used in this study; the palatal root of maxillary first molar was used to reduce variables. For disinfection all extracted
studies the canal, this is in agreement with previous retreatment techniques left filling material inside during the preparation of samples. In order to ensure consistent results, conducting the experiments to avoid variables throughout the study, only one operator remained.

Percentage of root filling material area

To achieve standardized procedures throughout the study, only one operator conducted the experiments to avoid variables during the preparation of samples. From the results of the present study, all retreatment techniques left filling material inside the canal, this is in agreement with previous studies (3, 6, 15, 23) this result has been attributed to the anatomical variability and difficulty of instrumentation in some regions of the root like deep grooves and depressions on dentine walls especially in the apical third of the canal making it impossible to direct NiTi instruments against entire root canal walls; while this result disagrees with another study (3) which may be due to the use of radiography as an evaluation method.

The result of this study revealed that mean percentage of remaining root filling areas with Ca(OH)2 based sealer groups were less than ZOE based sealer, this result is in agreement with results of previous study (24) that found that the solubility of Apexit is very high compared with AH Plus and Tubliseal and that Apexit performed poorly in dentin adhesion experiments irrespective of the presence of smear layer. In addition, another study (25) noted that ZOE based sealer exhibited very low bond strength (0.014 MPa) to GP while calcium hydroxide based sealer, revealed significantly higher mean bond strength (0.25 MPa) to GP which may cause the sealer to be removed with GP in Ca(OH)2 based group better than ZOE based sealer group.

This study also showed that removal of root filling material with D-RaCe desobturation instruments for both types of sealers was better than hedstrom in combination with gates glidden drills and this result coincides with other studies (12,23) that found that automated instruments are better than hand instruments due to the design of the automated instruments which have negative cutting angle and radial lands while it disagrees with other studies (3, 5) who found that hand instruments were better than automated instruments, due to the tactile sensation associated with hand instruments and the use of curved root canals. This study also revealed that removal of root filling material with D-RaCe desobturation instruments for both types of sealers was better than ProTaper rotary retreatment files; this may be due to the instrument’s design; the higher flexibility of DR2 and the presence of alternating cutting edges which eliminate the undesirable screwing effect and the smooth surface of the instruments that is caused by the special chemical surface treatment. It is also possible that the gutta-percha adhered less to the flutes so that the file had a better cutting efficiency, additionally the higher rotational speed plasticized the gutta-percha more rapidly making it easier to remove (4,26).

No significant difference was found between ProTaper rotary retreatment files and hedstrom in combination with gates glidden drills and this result is consistent with previous reports (6, 15, 25) that attributed this result to the
higher rotational speed of gates glidden drills (1000 RPM) compared to (500 RPM) for ProTaper retreatment files and the fact that stainless steel gates glidden drills remove root dentin in addition to the filling material more aggressively, in addition to the tactile sensation associated with hand files which indicates the presence of root filling material. While this result conflicts with former studies (3, 5) which found that GG in combination with Hedstrom was better than Ni-Ti instruments, due to the tactile sensation associated with hand instruments.

Time of root filling material removal.

The conventional methods of removing GP by using hand files can be a tedious, time consuming process and several studies demonstrated that rotary systems working significantly faster than Hedstrom files (14, 17, 21, 22, 23) and this agrees with the results of the present study that shows significant difference between A1 & A3, A2 & A3, B1 & B2 and B2 & B3. This result explained by the fact that the specific flute design of the rotary retreatment instruments and rotary motion of the retreatment instruments tend to pull GP into the file flutes and direct it towards the orifice. Furthermore, it is possible that the rotary movements of engine-driven files produce a certain degree of frictional heat which might plasticized GP more rapidly making it easier to remove. The plasticized GP would thus present less resistance and become easier to remove, while Hedstrom files mainly did not adhere to the GP (17, 23), while these results disagree with other studies (3, 27) whom reported that SS hand files are faster in removing filling materials than rotary files and attributed their finding to the change of instruments in the hand piece and the removal of gutta-percha in larger pieces by Hedstrom files.

Active instruments changes with frequent irrigation also affect the time required for removal of root filling material. It was reported by Celik et al in 2009 that the number of the instruments in the removal process of filling materials influenced the working time; in the present study, six instruments were used in groups A3 & B3 (two GG drills and four hedstrom files) compared to three instruments in groups A1 & B1 (D1, D2 and D3) and two instruments in groups A2 & B2 (DR1 & DR2). Additionally, the design of the D1 & DR1 files has a cutting tip and this facilitates the initial penetration of GP and subsequent removal of filling materials in less time.

REFERENCES

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