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Efficacy of three different instruments for gutta-percha removal in root canal retreatment

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Abstract
The present study evaluated the efficacy of retreating gutta-percha obturated root canals with Pro Taper Universal Retreatment files, R Endo Retreatment files and Hedstrom files. The canals of 60 extracted human premolars were obturated by lateral condensation technique using gutta-percha and AH plus sealer. Samples were divided into 3 groups with 20 specimens each. Chloroform was introduced into each canal to soften the gutta-percha. Pro Taper Universal retreatment files (Group1), R-Endo retreatment files (Group 2) and Hedstrom files (Group3) were used to remove the gutta-percha. Canal wall cleanliness was evaluated through Optical Stereo Microscope at 4X magnification and the area of remaining gutta-percha was calculated. The results showed that the gutta-percha remaining after retreatment was minimum in the Group 3 (Hedstrom files) followed by Group 2, whereas; Group 1 showed maximum amount of gutta-percha. Hedstrom files showed cleaner canals during retreatment as compared to Pro Taper retreatment files and R-Endo files.

Keywords: Pro taper retreatment files, r-endo files, hedstrom files, stereomicroscope

Introduction
When the root canal therapy fails, treatment options include conventional retreatment, periradicular surgery, or extraction. Despite favorable success rates of surgical retreatment, currently the preferred treatment is a conservative nonsurgical approach [1]. The main goal of retreatment is to regain access to the apical foramen by complete removal of the root canal filling material thereby facilitating cleaning and shaping of the root canal system and proper obturation. It is important to remove as much sealer and root canal filling material as possible during retreatment to uncover remnants of necrotic tissues or bacteria that might be responsible for periapical inflammation and post-treatment-disease [2].

Gutta-percha removal can be achieved by several techniques, one of which is the manual use of endodontic hand files, e.g. K-files or Hedstrom files. Other methods of gutta-percha removal include removing the coronal portion of gutta-percha using Gates Glidden or heat pluggers [3], and the rest by an ultrasonic technique [4]. Additionally, rotary instruments can also be used, such as inflexible GPX burs [5] or the canal finder [6]

Recently, new NiTi rotary instruments have been introduced for the removal of gutta-percha in retreatment cases: the Pro Taper Universal retreatment system and R-Endo systems (Micro-Mega, Besancon, France)

The Pro Taper NiTi rotary system has been upgraded to the Pro Taper Universal system, which includes shaping, finishing and retreatment instruments. The three retreatment instruments are designed for removing filling materials from root canals. They have various tapers and diameters at the tip. It consists of three 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.

R-Endo retreatment instruments are machined into a round blank and their cross-section is characterized by three equally spaced cutting edges; the instrument has neither radial lands nor an active tip.

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

The purpose of this study was to evaluate the efficacy of two engine-driven NiTi rotary instruments ProTaper Retreatment system (Dentsply, Maillefer, Ballaigues, Switzerland) and R-Endo systems (Micro-Mega, Besancon, France) versus hand instruments (Hedstrom files) for endodontic filling removal from root canals.

Material and Method

A total of 60 extracted human single-canal mandibular premolar teeth with fully formed apices and no calcification, internal resorption, or previous root canal treatment were used. Access cavity preparation was made on each tooth using high speed round end diamond bur and further with Endo Access bur and water spray. The working length was determined by placing 15 K-file into each canal until it was just seen at the apical foramen, and then 1 mm was subtracted from this length. For more uniform samples the crowns were resected so that a final dimension with the working length of 16 mm was achieved.

Canal instrumentation was completed using K-type files with a master apical file of size #40 Coronal preparation was done upto 60 K-file size using Step Back Technique. Each instrument was coated with a lubricant containing EDTA (Glyde) before placement. After each instrumentation, the canals were irrigated with 5.25% Sodium hypochlorite and chlorhexidine 2%.

The root canals were obturated using lateral compaction method. Tug-back was checked with the master cone of size 40. AH Plus sealer was mixed and coated on the canal walls using a lentulospiral. The master cone was lightly coated with sealer and positioned into the canal. Then the accessory cones were laterally compacted until they could not be introduced more than 5mm into the canal. The gutta-percha cones were seared off with the use of a heated instrument and a plugger was used to vertically compact the gutta-percha. The teeth were temporarily sealed with Cavit. Teeth were radiographed to evaluate and confirm the adequacy of the root canal obturation. All teeth were stored in an incubator at 37 ^{0}C for two weeks to allow complete setting of the sealer.

Retreatment Technique

All the samples were randomly divided into three groups of 20 teeth each. Cavit was removed to gain access to the root canal orifices. The retreatment procedure was as follows

Group 1 (Pro Taper Retreatment System)

File Design

It consists of three instruments D1, D2 and D3. D1 with tip 30,taper 0.09 and length 16mm, D2 with tip 25, taper 0.08 and length 18mm, and D3 with tip 20,taper 0.07 and length 22mm. The D1 working tip facilitates initial penetration into the filling material.

Procedure

Pro Taper retreatment files were used with a rotary electric motor and handpiece at a constant speed of 300 rpm and a low torque of 2 Nm^{-1}. D1 Pro Taper file was used to remove the filling material from 3mm of the coronal third of the root canal and 0.1mL of chloroform was deposited for 3 min into the reservoir created. A D2 Pro Taper file was used in the coronal two thirds of the root canal. The D3 Pro Taper file was used with light apical pulses of pressure until the working length was reached and no further filling material could be removed.

Group 2 (R-Endo systems)

File Design

R-Endo instruments are available in sizes Rm, Re, R1, R2 and R3. All R-Endo files have a 25 tip size but different tapers: 0.04 for Rm, 0.12 for Re. 0.08 for R1, 0.06 for R2, 0.04 for R3. Rm is a hand file (K file) and all other are rotary nickel-titanium files.

Procedure

R-Endo retreatment files were used with a rotary electric motor and handpiece at a constant speed of 300 rpm and a low torque of 2 Nm^{-1}. A size 25, 0.04 taper Rm hand file (K file) was used with ¼ turn pressure directed towards the apex to create a pathway thus allowing the centering and the alignment of the next instrument. A size 25, 0.12 taper Re NiTi rotary file was used 1 to 3 mm apical to orifice with circumferential filing. 0.1mL of chloroform was deposited into the created reservoir for 3 min. A size 25, 0.08 taper R1 NiTi rotary file was used to penetrate the coronal third through repeated apically directed pushing motions. A size 25, 0.06 taper R2 NiTi rotary file was used in the middle third. A size 25, 0.04 taper R3 NiTi rotary file was used till the working length with circumferential filing motion action.

Group 3 (Hedstrom files)

Gates Glidden burs 2 and 3 were used to remove 3 mm of obturation material removed from the cervical part of the canal creating a reservoir. After using the Gates Glidden burs, a drop of chloroform solvent was introduced into the reservoir to soften the gutta-percha. The canals were reinstrumented with Hedstrom file sizes 25,30,35,40 in a circumferential quarter turn push-pull filing motion to remove gutta-percha and sealer from the canal until the working length was achieved with a size 40 H-type file. Two or three additional drops of solvent were applied as required to reach the working length.

Criteria for the assessment of removal of filling material were the absence of gutta-percha or sealer on the instrument used last. Each instrument was used for a maximum of five canals. If any deformation occurred, the instrument was discarded and in case of fracture of the instrument in the root canal, the tooth was replaced.

The teeth were grooved buccolingually with a diamond disc and sectioned longitudinally. The samples were visualized under the stereomicroscope at 4X magnification and the area was calculated using Motic Images Plus 2.0 ML software. With this software it is possible to compute entire area or portions of an image. It can choose from line or area: ellipse, circular, rectangular, irregular shape and polygon measuring tools. Choices of units include mm, µm and inches. It uses an easy and automatic calibration process with enclosed calibration slide.

With this software the area of the whole canal, and the remaining filling materials in the whole canal and in each third were traced and then percentages were calculated. No attempt was made to distinguish between the gutta-percha and sealer.

Result

Table 1

Groups	Mean ± S.D.	Standard Error of Mean
Group 1	12.49 ± 6.53	1.46
Group 2	11.92 ± 4.59	1.02
Group 3	8.86 ± 4.56	1.02

On comparing mean and SD values as shown in Table 1 it was seen that the sample of Group 3 showed the minimum amount of gutta-percha in the root canal followed by Group 2 and Group 1 showed the maximum amount of remaining gutta-percha.

Table 2

Groups Under Comparison	p-value
Groups 1 & 2	$p>0.05$
Groups 2 & 3	$p<0.05$
Groups 1 & 3	$p<0.05$

Table 2 shows the statistical analysis of Inter Group comparison between the three files. The comparisons were made by applying unpaired "t" test statistic and obtaining t value.

The results from the calculated values show that at 5% level of significance, there was no significant difference between groups 1 and 2. But a significant difference was observed between the groups 2 and 3 and the groups 1 and 3. (I.e. $p<0.05$)

The results of the present study showed that the Group 3 (Hedstrom files) showed minimum amount of gutta-percha followed by Group 2, whereas, Group 1 showed maximum amount of remaining gutta-percha..

Discussion

The conventional method for gutta-percha removal is the Hedstrom files. Hedstrom files used in conjugation with solvents is a tedious, time consuming procedure, especially when the root filling material is well condensed [7] thus, for faster removal of gutta-percha, mechanical systems have been proposed as an alternative to hand instrumentation.

With the introduction of nickel-titanium in endodontics, various nickel-titanium (NiTi) rotary endodontic instruments have been used to facilitate cleaning and shaping of root canals which have their inherent advantages and disadvantages. These instruments had also been used for the removal of filling materials from root canal walls, and various studies have reported their efficacy, cleaning ability and safety [8].

However, studies reported a higher risk of instrument fractures when using NiTi rotary files versus hand files [5, 8]. To overcome this drawback, NiTi rotary files that are specifically designed for retreatment of root canal fillings were introduced. For improved safety precautions and to prepare more appropriate shapes, new retreatment instrument designs had non-cutting tips, radial lands, varying tapers and rake angles, and changing pitch length. The improved instrument design led to less number of perforations, blockages, or ledging [9].

The newer NiTi rotary instruments introduced for the removal of gutta-percha in retreatment cases are the Pro Taper Universal retreatment system and R-Endo systems (Micro-Mega, Besancon, France)

The new system was integrated with three new Pro Taper retreatment files, D1, D2, D3. The three Pro Taper Universal System Retreatment files (PTUS) are designed to facilitate the removal of filling material [10]. Similar to the shaping and finishing instruments, the retreatment series have a convex cross section. The D1 PTUS instrument has an active tip to facilitate initial penetration into the filling material. The nonactive tips of D2 and D3 reduce the incidence of ledging, perforation, and stripping during the removal of filling materials.

One of the most important and critical points in the study is the method of evaluation of the amount of remaining filling material. Different methodologies have been reported for this purpose. Analysis has been done by radiographic method, visual examination by longitudinal cleavage of the teeth, association of longitudinal and transverse cleavage, making teeth transparent, photography in association with radiographic examination etc. with the advancement being Computed Tomography.

In this study, evaluation of remaining filling material was performed by calculating the percentage of debris in the whole canal using stereomicroscope. The roots were split longitudinally, and the evaluation of remaining filling material was performed by calculating the percentage of debris in the canal. This method appears to be effective and has been performed in previous studies by numerous investigators who demonstrated its efficacy in evaluating the amount of remaining filling materials [6, 7]. This procedure was undertaken to minimize the subjectivity that may be seen in evaluation methods using radiographs or photographs that are evaluated on a scoring system based on scales [5].

However, there are certain limitations of this method. Using this method, precision is required because gutta-percha remnants could be displaced during cleavage of tooth leading to inaccurate measurement [11]. The method of cleavage should be done with an instrument such as a rongeur or vise in order not to touch the root canal wall [11].

In this study, residual root canal filling material was observed in all groups, which is consistent with previous reports [8, 12]. It was observed that during material removal, canals in all groups tended to accumulate more debris apically regardless of the protocol or material used [9, 12]. The results of this study indicated that the efficacy of Hedstrom files in removing the gutta-percha was statistically more significant than the Pro Taper Retreatment files and the R-Endo files. However, no statistically significant difference appeared among the Pro Taper Retreatment files and the R-Endo files.

The performance of Pro Taper Retreatment instruments is attributed to the three progressive tapers and length design of D1, D2 and D3 files. It has been mentioned that these features enable the retreatment instruments to cut not only the gutta-percha but also the superficial layer of dentine during root filling removal [13]. These files remove large amounts of gutta-percha in spirals around the instruments [14].

The R-Endo instruments are designed specifically for the retreatment as they have three equally spaced edges, no radial land and active tip [15].

This study is also in agreement with the study done by Hammad *et al.* [16], which indicates that gutta-percha was more efficiently removed by using hand K-files as compared to Pro Taper retreatment files. In future, a combination of the two techniques, hand files and Pro Taper retreatment files, might result in more efficient removal of material.

In contrast, some studies observed similar amounts of residual root filling material and sealer after NiTi and manual instrumentation in straight and curved root canals [1, 11, 15].

The master apical file size was 40 and the final retreatment Hedstrom file used in the study was also 40 as compared with that of Pro Taper Retreatment file size which was 20 and R-Endo file size which it was 25. These could have resulted in less instrumentation in the apical areas of the canal leading to more residual debris with rotary instruments.

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