An in-vitro study to evaluate the efficacy of hand and rotary instruments; with and without RC solvent in root canal retreatment

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Abstract

Nonsurgical endodontic retreatment consists of cleaning, shaping, and three dimensional filling of previously obturated root canals. It is the treatment of choice for the management of endodontic failures when access to the root canals is feasible. To successfully accomplish retreatment, all the obstructions preventing a direct access to the root canals need to be removed. For this study 60 freshly extracted human mandibular premolars with single canals were collected. These 60 teeth were endodontically treated and then again divided into 2 groups consisting of 30 samples each for retreatment. Of the two groups on one group retreatment was performed with RC solvent and other group without RC solvent. Efficacy of two nickel titanium instruments over H files with and without use of RC solvent in removal of gutta-percha in root canal retreatment was evaluated in this study. The amount of remaining gutta-percha was evaluated using image analysis software.

Keywords: Retreatment, Nickel Titanium, RC solve, Image analysis software.

Introduction

The major factors associated with endodontic failure are the persistence of microbial infection in the root canal system and/or the periradicular area. The clinician is often misled by the notion that procedural errors such as broken instruments, perforations, overfilling's, under fillings, ledges and so on are the direct cause of endodontic failure. In most cases, procedural errors do not jeopardize the outcome of endodontic treatment unless a concomitant infection is present. In truth, a procedural accident often impedes or makes it impossible to accomplish appropriate intracanal procedures.(1) Clinically, failure of endodontic treatment is determined on the basis of radiographic findings and clinical signs and/or symptoms of the treated teeth.(2) All cases of endodontic failure however do not substantiate the need for surgical treatment. In recent years retreatment by non-surgical means has accounted for an increasing portion of endodontic treatment procedures as it is the most conservative method to solve the problem.(3) Nonsurgical endodontic retreatment consists of cleaning, shaping, and three dimensional filling of previously obturated root canals. It is the treatment of choice for the management of endodontic failures when access to the root canals is feasible.(4) Regardless of the technique used, endodontic retreatment requires total regaining of canal patency. This is invariably accomplished by exerting pressure in the apical direction with rigid instruments, with the purpose of removing the root filling material. When executed indiscriminately this procedure may be ineffective and even harmful.(4) However, when it is performed systematically canal patency can be successfully regained in most retreatment cases. Subsequently, endodontic-retreatment may be accomplished by using routine endodontic procedures.(5) Removal of gutta-percha can be obtained with several techniques. One of these methods is the chemical technique, using different types of solvents, such as chloroform, eucalyptol, xylene, halothane, turpentine, or orange solvent, in combination with K-type or Hedstrom files.(l0) Care should be taken to avoid forcing the softened gutta-percha or solvent through the apical foramen to avoid periradicular tissue irritation.(35) Other methods of gutta-percha removal include removing the coronal portion of gutta-percha using Gates Glidden, heat pluggers,(4) ultrasonic technique,(13) and lasers.(l4) Additionally, rotary instruments can also be used, such as the inflexible XGP drills,(16) the canal finder,(l5) or more recently flexible rotary nickel-titanium (NiTi) files in a slow-speed handpiece. The purpose of this study is to evaluate the efficiency of ProTaper (DENTSPLY MAILLEFER, Switzerland), R-ENDO (MICRO MEGA, FRANCE) & H files (MANI, Japan) with & without a GP solvent (RC Solve-PRIME DENTAL, India) in the removal of gutta-percha from root.

Materials & Methods

Sixty freshly extracted human mandibular premolars were collected from Department of Oral and Maxillofacial Surgery. Soft tissue and calculus were mechanically removed from root surfaces. These sixty teeth were further divided into 2 groups, each group consisting of 30 teeth.

Access opening was made on each tooth with high speed round diamond bur no. 2 with air- water spray. The canals were prepared using crown-down technique. The cervical and middle thirds were flared with Gates

Glidden drills 1, 2 and 3. Root canal instrumentation was completed using Protaper rotary files with a master apical file size of F_2. The canals were debrided using sodium hypochlorite (5.25%) and chlorhexidine (2%) irrigants.

Canal obturation: The root canal of each tooth was dried with paper points and obturated using lateral compaction. A master gutta-percha cone 6% corresponding to size F_2 was selected and tug-back was checked. AH Plus sealer (DENTSPLY MAILLEFER, Switzerland) was mixed according to the manufacturer's instructions. The master cone was coated with sealer and positioned into the canal. Then accessory cones were laterally compacted until they could not be introduced more than 5 mm into the canal. The access cavities were filled with the Cavit G (3M ESPE). All teeth were stored in a humidor at 37°C for 2 weeks to allow complete setting of the sealer.

Retreatment Technique: All samples were randomly divided into six groups with 10 specimens each.

Group A: Thirty teeth were retreated using RC solve.

Group A was further divided into three subgroups consisting of ten samples each.

A_1 - Ten samples were retreated using RC solve & Protaper retreatment kit.

A_2 - Ten samples were retreated using RC solve & R-ENDO retreatment kit.

A_3 - Ten samples were retreated using RC solve & H files.

Group B: Thirty teeth were retreated without using RC solve.

Group B was also divided into three subgroups consisting of ten samples each.

B_1 - Ten samples were retreated using Protaper retreatment kit.

B_2 - Ten samples were retreated using R-ENDO retreatment kit.

B_3 - Ten samples were retreated using H files.

All roots had 6 mm of obturation material removed from the cervical part of the canal using Gates Glidden drills 2 and 3. After using the Gates Glidden drills, a drop of RC Solve was introduced into (group A) each canal to soften the gutta-percha. Two or three additional drops of solvent were applied as required to reach the working length. Sodium hypochlorite 5% and chlorhexidine 2% irrigations were used after each instrument. Each root canal was irrigated with a total of 30 ml sodium hypochlorite and 30 ml chlorhexidine. Protaper & R-ENDO retreatment rotary instruments were driven with a torque-controlled motor (Anthogyr, Dentsply) according to the manufacturer's instructions.

Teeth were divided into 6 groups, each group consisting of 10 teeth.

Group A_1: (n=10) ProTaper retreatment instruments with RC solve: As suggested by the manufacturer, the gutta-percha was removed by the following sequence using light apical pressure: Finishing files #3 (ISO size 30, taper 0.09-0.05), #2 (ISO size 25, taper 0.08-0.055), and #1 (ISO size 20, taper 0.07-0.055) were used in a crown down technique with RC solve to remove the gutta-percha until the working length was reached. Finishing files #2 and #3 were used again to the working length to complete gutta-percha removal and cleaning of the canal walls.

Group A_2: (n=10) R-ENDO retreatment instruments with RC solve: R-ENDO instruments Rm (Hand-Stainless steel,0.04 taper-n^{0}25), Re(NiTi,.12 taper-n^{0}25), R1(NiTi,.08 taper,n^{0}25), R2(.06 taper, n^{0}25), R3(0.04 taper-n^{0}25) & Rs(0.04 taper-n^{0}30) were used with RC solve following the manufacturer's instructions.

Group A_3: (n=10) Hedstrom files (Mani) with RC solve: ISO size 15 and 20 Hedstrom files were used for deep penetration until they reached the working length. The removal of gutta-percha was completed using size 25 to 35 Hedstrom files in a circumferential quarter-turn push-pull filing motion. RC solve was used.

Group B_1: (n=10) ProTaper retreatment instruments without using RC solve: As suggested by the manufacturer, the gutta-percha was removed by the following sequence using light apical pressure: Finishing files #3 (ISO size 30, taper 0.09-0.05), #2 (ISO size 25, taper 0.08-0.055), and #1 (ISO size 20, taper 0.07-0.055) were used in a crown-down technique without RC solve to remove the gutta-percha until the working length was reached. Finishing files #2 and #3 were used again to the working length to complete gutta-percha removal and cleaning of the canal walls.

Group B_2: (n=10) R-ENDO retreatment instruments without using RC solve: R-ENDO instruments Rm (Hand-Stainless steel,0.04 taper-n^{0}25), Re(NiTi,.12 taper-n^{0}25), R1(NiTi,.08 taper,n^{0}25), R2(.06 taper, n^{0}25), R3(0.04 taper-n^{0}25) & Rs(0.04 taper-n^{0}30) were used without RC solve following the manufacturer's instructions.

Group B_3: (n=10) Hedstrom files (Mani) without using RC solve: ISO size 15 and 20 Hedstrom files were used for deep penetration until they reached the working length. The removal of guttapercha was completed using size 25 to 35 Hedstrom files in a circumferential quarter-turn push-pull filing motion. Here RC solve was not used.

One set of instruments was used for preparation of five root canals. Files were wiped regularly using gauze to remove obturation material and debris. Preparation was deemed complete when there was no gutta-percha sealer covering the instruments. Each root canal was prepared, filled and retreated by the same operator to reduce inter-operator variability.

Evaluation

Canal Wall Cleanliness: The sectioned root was divided into thirds, namely the cervical, middle and the apical one-third. The amount of gutta-percha/ sealer on the canal walls was imaged in a standardized way at these three levels and measured in volumetric percentage using image analysis software connected to

a stereomicroscope with 10 X magnification via a CCD-sensor. The evaluator was blinded to group assignment. Samples of control group were evaluated to check the efficacy of image analysis software.

Results

Volumetric percentage of gutta-percha/sealer using image analysis software connected to a stereomicroscope with 10 X magnification:

System Used (with RC solve)	Apical	Middle
H file	26.83%	4.36%
Protaper Retreatment	11.23%	2.66%
R-endo Retreatment	18.23%	2.86%

System Used (without RC solve)	Apical	Middle
H file	34.43%	4.86%
Protaper Retreatment	20.43%	3.56%
R-endo Retreatment	23.43%	3.86%

H File (26.83%)

Protaper (11.23%)

Race (20.43%)

Statistical analysis report: As P value is less than 0.01, we can conclude that there is significant statistical difference observed in the amount of apical GP remaining after retreatment with Protaper & R-endo using RC solve& without RC solve.(Less in Protaper and maximum in R-endo). (Table 1)

Table 1

	Protaper	R-endo	t cal	P value	Result
Mean	11.042	18.008	17.90804	1.17457E-13	**
S.D.	1.433584	0.985423			

As P value is less than 0.01, we can conclude that there is significant statistical difference observed in the amount of apical GP remaining after retreatment with Protaper & H files using RC solve &without RC solve. (Less in Protaper and maximum H files). (Table 2)

Table 2

	Protaper	H files	t cal	P value	Result
Mean	11.042	26.0475	33.74418	1.00734E-18	**
S.D.	1.433584	1.378301			

As P value is less than 0.01, we can conclude that there is significant statistical difference observed in the amount of apical GP remaining after retreatment with R-endo & H files using RC solve & without RC solve. (Less in R-endo and maximum H files). (Table 3)

Table 3

	R-endo	H files	t cal	P value	Result
Mean	18.008	26.0475	21.21996	5.41281E-15	**
S.D.	0.985423	1.378301			

Discussion

Imura et al evaluated the relative efficacies of four hand and rotary instrumentation techniques during endodontic retreatment. The results showed that the Hedstrom group revealed the greatest number of samples with remaining gutta-percha/sealer material although it left less length of residual filling material than the Quantec group. The conclusion made was that Hedstrom files removed gutta-percha in large pieces leaving remaining material of such small size that they

were not visible on radiographs.[11]

Schirrmeister conducted a study to evaluate efficacy, cleaning ability and safety of different rotary NiTi instruments in root canal retreatment. The time required by ProTaper files was significantly shorter compared with that of GT Rotary files. This finding can be explained probably by the greater efficiency of ProTaper files to remove large amounts of gutta-percha around the instruments in spirals.[13]

Saad et al evaluated the efficacy of two rotary NiTi instruments in the removal of gutta-percha during root canal retreatment. It was concluded that ProTaper and K^3 rotary files required less time than Hedstrom files in the removal of gutta-percha. This finding could probably be due to the inherent design characteristics of instrument design of Pro Taper and K^3 rotary files.[15]

Saad AV evaluated the retreatment efficacy of hand versus rotary instrumentation in oval-shaped root canals and it was concluded that rotary instruments required less time for retreatment of gutta-percha as faster rotation plasticizes the gutta-percha more rapidly making it easier to remove.[14]

Contrary results were found by Masiero who studied the effectiveness of NiTi rotary instruments and stainless steel hand files during gutta-percha retreatment. The results showed that stainless steel hand files were a bit faster than Profile NiTi rotary instruments. The probable reason was that longer time for NiTi may be caused by the switching and replacing different file sizes in the hand piece.[12]

Gutta-percha is the most frequently used filling material for root canal obturation. The methods used for removal of gutta-percha during endodontic retreatment are mechanical, thermal, chemical, or even an association of them, and also special instruments such as ultrasound instruments can be used. Most often Gutta-percha cones are composed of a vegetable resin, which lends its name to the product, and they are softened by chemical solvents. Among the organic solvents more frequently used in endodontics, prominent are: chloroform, xylol, halothane, eucalyptol, turpentine (terebintine) and orange oil. However, these substances seem to show variable degrees of success regarding dissolution and removal of this material from the root canal. Organic solvents have been used for a long time as an auxiliary or principal method of gutta-percha removal, being the more effective chemical substances to dissolve the filling endodontic material. Chloroform and xylene are the two most commonly used solvents, but the U.S. Food and Drug Administration prohibit chloroform because of its potential carcinogenicity. Xylene is available nowadays for clinical use, and it is not considered a carcinogen, but is very toxic to tissues. Gutta-percha is also soluble to essential oils. Some of them have been reported as safe and useful for this purpose, like eucalyptus (eucalyptol) and pine tree (turpentine) essential oils. According to Pécora et al (1992), orange oil acts on gutta-percha in the same way that xylol does, without presenting any deleterious effect of that. Nowadays, the procedures of retreatment have become even more important in endodontics, replacing traditional surgical methods. Different solvents have been largely used to empty the root canal. Their properties should be taken in consideration regarding effectiveness in the dissolution of the endodontic filling material.[16]

The results of our study demonstrate that Protaper NiTi rotary (DENTSPLY MAILLEFER, Switzerland) system with RC solve (PRIME DENTAL, India) has better cleaning efficacy and takes less time during retreatment of root canals when compared to R-ENDO (MICRO MEGA, FRANCE) & Hedstrom files (MANI, Japan). In Protaper the decreasing taper sequence of the finishing files enhances the strength of the files, but it increases the stiffness of their tips. According to the manufacturer, the ProTaper instrumentation should lead to consistent, predictable, and reproducible root canal shaping. ProTaper instruments might be better suited for curved and constricted canals than wide, immature ones. The use of solvent with hand or rotary NiTi instruments in retreatment results in easy, quick & efficient removal of gutta-percha. The space created by removal of coronal gutta-percha with Gates Glidden or Peeso reamers acts as reservoir for solvents thus facilitating its actions.[9] RC solve (PRIME DENTAL, India) was used as a solvent in our study as it has been reported to be a safe and efficient alternative to chloroform. However further studies are required to assess the efficiency of hand and rotary instruments in a clinical scenario.

Conclusion

Protaper rotary system with RC solve showed least remaining obturating material and was faster in removing gutta-percha when compared to the other systems. In ProTaper group final apical preparation diameter was of size 30 (F3) compared to final apical preparation diameter in the R-endo group which was of size 25. Hence cleaning ability of Protaper was more when compared to R-endo. As stated in literature rotary instrumentation took less time and cleaned canal walls better than hand instrumentation, likewise H-files showed the maximum amount of remaining gutta-percha within the root canals and took more time than R-endo & ProTaper. However, additional in-vivo and in-vitro studies are desirable to further substantiate the findings of our study.

References

1. Lin LM, Pascon EA, Skribner JE, Gaengler P, Langeland K. Clinical, radiographic, and histologic study of endodontic treatment failures. Oral Surg Oral Med Oral Pathol 1991;11:603-11.
2. Friedman S, Stabholz A. Endodontic retreatment: case selection and technique. Part 1: criteria for case selection. J Endod 1986;12:28-33.
3. Stabholz A, Friedman S. Endodontic retreatment: case

selection and technique. Part 2: treatment planning for retreatment. J Endod 1988;14:607-14.
4. Mandel E, Friedman S. Endodontic Retreatment: A Rational Approach to Root Canal Reinstrumentation. J Endod 1992;11:565-9.
5. IF. Siqueria Jr. Aetiology of root canal treatment failure: why well-treated teeth can fail. lnt Endod J 2001;34:1-10.
6. Lovdahl PE. Endodontic retreatment. Dent Clin North Am 1992;36:627-33.
7. Lin LM, Skribner JE, Gaengler P. Factors associated with endodontic treatment failures. J Endod 1992;18,625-7.
8. Friedman S, Stabholz A, Tamse A. Endodontic retreatment: case selection and technique. Part 3: retreatment techniques. J Endod 1990;16:543-9.
9. Tamse A, Unger U, Metzger Z, Rosenberg M. Gutta-percha solvents: a comparative study. J Endod 1986;12:337-9.
10. Krell KV, Neo J. The use of ultrasonic endodontic instrumentation in the retreatment of a paste-filled endodontic tooth. Oral Surg Oral Med Oral Pathol 1985:60:1 00-2.
11. Betti LV, Bramante CM. Quantec SC rotary instruments versus hand files for gutta-percha removal in root canal retreatment. Int Endod J 2001;34:514-9.
12. Schirrmeister JF, Meyer KM, Hermanns P, Altenburger MJ, Wrbas KT. Effectiveness of a hand and rotary instrumentation for removing a new synthetic polymer-based root canal obturation material (Epiphany) during retreatment. Int Endod J 2006;39:150-6.
13. Masiero A V, Barletta FB. Effectiveness of different techniques for removing gutta-percha during retreatment. Int Endod J 2005;38:2-7.
14. Tasdemir T, Er K, Yildirim T, Celik D. Efficacy of three rotary NiTi instruments in removing gutta-percha from root canals. Int Endod J 2007;41:191-6.
15. Saad A Y, Al-Hadlaq SM, Al-Katheeri NH. Efficacy of two rotary instruments in the removal of Gutta-percha during Root Canal Retreatment. J Endod;33:38-41 36.
16. Dissolving efficacy of some organic solvents on gutta-percha. Brazalian Oral research 2007;21(4):303-307.